Caffeinated Energy Drink Use in Adolescents and Young Adults: Associations With Mental Health, Academic Performance, and Problem Behaviour

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Peer-Reviewed Publications Resulting From This Thesis

At the time of final submission (December 1st, 2016), sections of this PhD thesis had been published in the following peer-reviewed journal articles (though please note that Richards & Smith, 2016e, relates to an abstract for the *Public Health Science Conference*, held at the Radisson Blu Hotel, Cardiff, on November 25th, 2016, which appeared in a Special Issue of *The Lancet*):

Richards, G., & Smith, A. P. (2015a). Caffeine consumption and self-assessed stress, anxiety, and depression in secondary school children. *Journal of Psychopharmacology, 29*(12), 1236-1247. doi:10.1177/0269881115612404

Richards, G., & Smith, A. P. (2015b). Risk factors for, and effects of, stress, anxiety, and depression in adolescents. *British Journal of Education, Society & Behavioural Science, 10*(4), 1-10. doi:10.9734/BJESBS/2015/19501

Richards, G., & Smith, A. P. (2016a). A review of energy drinks and mental health, with a focus on stress, anxiety, and depression. *Journal of Caffeine Research, 6*(2), 49-63. doi:10.1089/jcr.2015.0033

Richards, G., & Smith, A. P. (2016b). Breakfast and energy drink consumption in secondary school children: Breakfast omission, in isolation or in combination with frequent energy drink use, is associated with stress, anxiety, and depression cross-sectionally, but not at 6-month follow-up. *Frontiers in Psychology, 7*, 106. doi:10.3389/fpsyg.2016.00106

Richards, G., & Smith, A. P. (2016c). Demographic and lifestyle correlates of school attendance, English and maths attainment, and behavioural sanctions in British secondary school children. *British Journal of Education, Society & Behavioural Science, 17*(1), 1-15. doi:10.9734/BJESBS/2016/26393

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Richards, G., Malthouse, A., & Smith, A. P. (2015). The diet and behaviour scale (DABS): Testing a new measure of food and drink consumption in a cohort of secondary school children from the South West of England. *Journal of Food Research, 4*(3), 148-161. doi:10.5539/jfr.v4n3p148

Richards, G., Millward, N., Evans, P., Rogers, J., & Smith, A. P. (2015). Acute effects of energy drinks on behavioural sanctions in secondary school children: A preliminary study. *Journal of Food Research, 4*(4), 1-9. doi:10.5539/jfr.v4n4p1

Table of Contents

List of Tables

List of Figures

Summary

Caffeinated energy drinks have become a cause for concern, with numerous mainstream media accounts relating their usage to undesirable outcomes. This thesis aimed to investigate the accuracy of such claims, and more specifically, to determine whether the consumption of these products is associated with stress and mental health problems, disruptive behaviour, and low academic attainment. The research carried out here also took a novel approach by investigating energy drink use both in isolation and in combination with a number of other dietary variables (e.g. cola and chewing gum consumption, breakfast omission).

Three questionnaire surveys were conducted to investigate whether energy drink use was associated with mental health and academic attainment in university students. The findings then helped direct a large-scale longitudinal study of secondary school children from the South West of England. Finally, a preliminary investigation was conducted to investigate acute effects of diet on the likelihood of children incurring behavioural sanctions at school.

The results suggested that energy drink use is associated with undesirable mental health, behavioural, and academic outcomes. Although many of the effects observed were cross-sectional, a number of significant longitudinal findings were also made. Taken together with the observation that energy drink consumption in combination with breakfast omission was a significant predictor of the acute occurrence of detentions, these results imply that the relationships could be causal. However, until intervention studies have better determined the nature of the effects, a cautious approach to policy change may be required. The reason for this is that, although many advocate banning adolescent use of energy drinks, doing so has been shown to create additional problems, such as the subsequent emergence of junk food black markets in secondary schools.

Chapter 1: Introduction

1.1 General Introduction

Although it is widely known that poor quality nutrition is associated with physical health complications, such as obesity, cardiovascular disease, diabetes, and the metabolic syndrome (e.g. Bonow & Eckel, 2003), the effects of diet on psychological outcomes are often less well understood. The consumption of certain food types has been associated with positive effects. For instance, regularly eating breakfast may benefit memory and wellbeing (see Smith, 2011), and consuming high quantities of vegetables (particularly cruciferous and green leafy varieties; Kang, Ascherio, & Grodstein, 2005) can slow the rate of age-related cognitive decline (Morris, Evans, Tangney, Bienias, & Wilson, 2006). In addition, supplementation of fish oils may reduce aggressive behaviour and impulsivity (Long & Benton, 2013), and daily usage of vitamins and minerals has been shown to reduce antisocial behaviour (Schoenthaler & Bier, 2007). However, undesirable effects have also been observed in regards to less healthy dietary practices.

Junk food has been defined by Bayol, Farrington, and Stickland (2007, p. 843) as foods that are "heavily processed, highly palatable and hyper-energetic and are often deprived of the vitamins and essential nutrients found in whole unprocessed foods." Junk food is considered to be particularly problematic, with its intake at 4.5 years of age being shown to predict hyperactivity at age seven (Wiles, Northstone, Emmett, & Lewis, 2009). Furthermore, a junk food dietary pattern at age three has been found to predict later school attainment, even after subsequent dietary patterns are controlled for (Feinstein et al., 2008). This worryingly suggests that an improvement in diet may not be able to repair all the damage caused by poor nutritional habits at an early age (see Benton, 2010). However, such findings, taken together with those relating to the positive effects of diet on psychological outcomes, highlight the need to study the intake of a range of different foods and drinks in order to gain a balanced perspective of their actions.

In recent years, concern has been expressed regarding the meteoric rise in popularity of caffeinated 'energy drinks', and particularly so in terms of the effects that they may have on young consumers. This PhD thesis therefore intends to address gaps in the literature concerning whether energy drinks affect the mental health, behaviour, and academic attainment of adolescents and young adults.

1.2 Energy Drinks

Energy drinks (sometimes also referred to as 'stimulant drinks'; Finnegan, 2003) are caffeinated soft drinks that claim to boost performance and endurance (Meadows-Oliver & Ryan-Krause, 2007). They should not be confused with sports drinks, which are instead marketed to rehydrate and replace electrolytes lost through exercise (Committee on Nutrition and the Council on Sports Medicine and Fitness, 2011). Although highly caffeinated soft drinks appeared in Europe and Asia in the 1960s (Reissig, Strain, & Griffiths, 2009), energy drinks as we know them initially became available to the public with the introduction of Red Bull® to Austria in 1987, and subsequently to North America in 1997. The energy drinks industry has since grown exponentially, becoming a multi-billion dollar market (Kaminer, 2010).

Concerns have been expressed because energy drink consumption has been associated with a number of very serious health complaints including arrhythmias, tachycardia, stroke, psychotic symptoms/mania, seizures, and even death (Seifert, Schaechter, Hershorin, & Lipschultz, 2011). Though such occurrences may often be the result of extreme caffeine sensitivity and overdose, it is important to consider that these products are popular among young populations. This potentially dangerous combination of highly caffeinated products and at-risk consumers is concerning, yet has so far received surprisingly little attention (Smith, 2013). Current UK legislation (i.e. Food Standards Agency, 2015) dictates that drinks containing caffeine from any source at a level over 150mg/l must state 'High caffeine content. Not recommended for children or pregnant or breast-feeding women' in the same field of vision as the product's name, and that the caffeine content must be expressed in mg per 100ml. However, this policy means that the sale of energy drinks to children and adolescents remains legal, regardless of the potential safety concerns that have been expressed.

A specific issue with energy drinks is that the caffeine content (reportedly sometimes as high as 505mg per serving; Reissig et al., 2009) may have potential to cause intoxication (Seifert et al., 2011). In addition, such products can contain numerous other substances, such as taurine, L-carnitine, glucuronolactone, B-vitamins, ginseng, and guaraná. As these additives vary considerably both in presence and in concentration between products, a general problem with research in the area is that it can be difficult to compare like for like. A further concern is that certain additives (e.g. guaraná, kola nut, yerba maté, cocoa) may increase overall caffeine content unbeknownst to the consumer, because in some countries manufacturers are not required to list that which is attributable to herbal supplements in the nutritional information (Seifert et al., 2011). It is also concerning that these additional substances are often under-studied and unregulated, and that interactions between them (as well as potentially with prescription drugs) are not yet fully understood (Seifert et al., 2011). However, the European Food Safety Authority (2009, as cited in Szpak & Allen, 2012) determined a 'No Observed Adverse Effect Level' (NOAEL) of 1000mg/kg of body weight for both taurine and glucuronolactone; this means that this is the highest concentration found through observation or experimentation to cause no detectable adverse effects. Although ingredients other than taurine and glucuronolactone are often present in energy drinks, the finding that these two common components are unlikely to produce adverse effects suggests that caffeine may be the main ingredient of interest within the current context (e.g. McLellan & Lieberman, 2012).

Considering the negative outcomes associated with their use, a question that must be asked is why do some young people choose to consume energy drinks? The findings of a qualitative focus group study of 12-15 year old Australians (Costa, Hayley, & Miller, 2014) suggests that adolescents use the products for three main reasons: enjoyment, function, and social. The functional reasons cited were typically to relieve the effects of fatigue and tiredness. Specific examples for this included the need to stay awake when tired, and to help wake up in the morning after a late night. Although a study of US college students (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007) found that 67% of energy drink users consumed the products to combat the effects of insufficient sleep, their use has also been associated with poor sleep quality itself (Katagiri et al., 2014; Sanchez et al., 2013), as well as with daytime sleepiness (Kristjánsson, Sigfúsdóttir, Allegrante, & James, 2011). Malinauskas et al. further reported that students used energy drinks to increase energy (65%), to drink with alcohol while partying (54%), whilst studying/completing a major course project (50%), whilst driving a car for a long period of time (45%), and to treat a hangover (17%).

Of particular concern is the way in which energy drinks are aggressively marketed at young people (Reissig et al., 2009), with 30-50% of adolescents and young adults being known to consume the products (Seifert et al., 2011). This is of particular concern when considering the claim that "caffeine and other stimulant substances contained in energy drinks have no place in the diet of children and adolescents" (Committee on Nutrition and the Council on Sports Medicine and Fitness, 2011, p. 1182). However, as black markets in junk food and energy drinks are known to exist in UK secondary schools, and that they may be an unintended consequence of restrictive policies intended to improve children's diets (Fletcher, Jamal, Fitzgerald-Yau, & Bonell, 2014), banning the sale of such products to minors may be an overly simplistic and ineffective solution.

1.3 Pool Academy Pilot Study

After persistent claims from the mainstream media that energy drink use may be related to mental health problems (e.g. Dunham, 2012; Hodgekiss, 2014; Miller, 2015; Ubelacker, 2014), and disruptive behaviour (e.g. Boseley, 2014; Cassidy, 2015; Coughlan, 2015; Tozer, 2014), a pilot study was conducted at Pool Academy, Cornwall, to investigate whether certain aspects of diet were associated with undesirable outcomes (Millward, as cited in Smith, 2014). This initial study reported that pupils with high intakes of sugar throughout the day, those who consumed energy drinks, and those who did not regularly eat breakfast were more likely to behave poorly during school hours. Furthermore, those from higher socioeconomic backgrounds who ate good quality diets, but also consumed energy drinks, were found to behave more poorly than similar children who did not consume energy drinks. This last finding was of particular interest as it implied an effect above and beyond that accountable for by demographic and socioeconomic factors alone.

The results of the pilot study identified the need for a more thorough investigation of the effects of energy drink use in young consumers. On this reasoning funding was obtained from The Waterloo Foundation (grant number: 503692), and a collaborative research project was developed between Cardiff

University and three secondary schools (henceforth referred to as ‘academies’) from the South West of England (Pool Academy, Penrice Community College, and Treviglas Community College). Although initially planned as a Masters project, Cardiff University’s School of Psychology provided additional funding so the area could be explored in greater detail over the course of a three-year PhD studentship.

1.4 Objectives of the Thesis

Based on findings from the pilot study, this thesis intends broadly to investigate associations between energy drink use and three types of outcome: 1) mental health, 2) academic attainment, and 3) problem behaviour. More specific details of the aims are provided below.

1.4.1 Objective 1: To Review the Literature Relating to Associations Between Energy Drink Use and Mental Health and Academic Attainment

The first task undertaken was to systematically review the literature relating the use of energy drinks to mental health and academic attainment. The mainstream media has provided many reports of negative effects being associated with energy drink use, and particularly so in regards to young consumers. A systematic review of the academic literature was therefore advantageous in determining whether such anecdotal reports are supported empirically, and helped to provide direction for the current research. It was also considered important to build upon previous research rather than simply replicate it. For instance, it has been suggested by others (e.g. Ríos et al., 2013; Trapp et al., 2014) that longitudinal research should be conducted, though few studies have so far addressed this need.

1.4.2 Objective 2: To Develop a Questionnaire for Recording the Frequency and Amount of Consumption of Common Foods and Drinks That May Have Effects on Psychological Outcomes

Numerous food frequency questionnaires (FFQs) exist, though most have been designed with the intention of calculating macronutrient composition, micronutrient profiles, or food categories. Many of these measures are also time-consuming to implement, and often do not record the consumption of foods and drinks that add little of nutritional value but are known to have effects on psychological outcomes. An objective of the current research was therefore to address the need for such a tool, and a 29-item measure was developed and tested.

1.4.3 Objective 3: To Assess Consumption Patterns of Energy Drinks, As Well As Their Correlates

Dietary patterns are closely related to other health behaviours, including exercise frequency and television viewing, as well as with demographic variables such as age, sex and ethnicity (e.g. French, Harnack, & Jeffery, 2000; Wardle et al., 2004). A particularly important variable related to diet is socioeconomic status (SES). It is known, for example, that higher SES is associated with a lower fat diet, increased exercise, and higher prevalence of dieting for weight management (Jeffery, French, Forster, & Spry, 1991), and indeed, with health in general (e.g. Adler et al., 1994). Observations such as these make it clear that demographic and lifestyle correlates of energy drink consumption should be identified so that they can be controlled for during statistical analysis.

As well as identifying demographic and lifestyle covariates, research that manipulates energy drink consumption (e.g. double-blind studies) should be put into context by investigating naturally occurring dietary patterns that include energy drinks. Empirical data were therefore collected from British university students and secondary school children, and analyses conducted allowed for other dietary, demographic, and lifestyle covariates to be controlled for statistically. Although some research investigating the effects of energy drinks has taken demographic and lifestyle variance into account, few studies have so far controlled for other aspects of one's diet. Due to the well-established finding that the consumption of many foods and drinks are highly inter-correlated (e.g. Northstone, Emmett, & The ASPAC Study Team, 2005), this was considered to be of particular relevance to the current research.

1.4.4 Objective 4: To Investigate Whether Energy Drink Consumption Is Associated With Mental Health, Academic Attainment, and Problem Behaviour

Anecdotal reports claiming that energy drinks cause hyperactivity, disruptive behaviour and mental health problems in young consumers are abundant. However, few large-scale empirical research projects have so far been conducted to determine whether such claims are justified. As many have campaigned for energy drinks to be banned in schools, even though considerable gaps still exist in the scientific literature, an aim of the current research was to investigate these claims, and to determine whether such effects may occur across the population as a whole, or within specific subgroups.

1.4.5 Objective 5: To Determine Whether Associations Between Energy Drink Use and Mental Health, Academic Attainment, and Problem Behaviour Rely Primarily on the Action of Caffeine

Although much of the literature relating to caffeine is equivocal, some findings suggest that high consumption is associated with undesirable outcomes. Therefore, one of the aims of the current research was to investigate the effects of caffeine itself, as well as those attributable to energy drinks. In order to help determine whether such effects might rely on general caffeine intake, or on that obtained through specific sources, analyses were conducted in which caffeine from energy drinks, cola, tea, and coffee could be examined separately.

1.4.6 Objective 6: To Investigate Whether Energy Drink Consumption Is a Cause or Outcome of Poor Mental Health, Low Academic Attainment, and Problem Behaviour, or Whether the Variables Are Merely Correlated

Although negative outcomes have been associated with the use of energy drinks, few studies have satisfactorily examined the nature of these effects. Many reports claim that energy drinks actively cause harm, though such accusations may not be justified without conducting research in a manner that allows for causation to be inferred. For instance, it might be that energy drinks do directly cause harm regarding mental health, academic attainment, and behaviour, but equally it could be that a subpopulation, which performs poorly in these regards in the first place, also consumes the products at a disproportionately high rate. The current research therefore aims to identify the nature of these relationships, and to determine whether or not they are causal. In order to do this, the effects of dietary change over time were investigated.

1.5 Overview of the Thesis Contents

A systematic review of the relevant academic literature is conducted in Chapter 2, and Chapters 3, 4, and 5 present empirical data from three studies of university students. More specifically, Chapter 3 provides an overview of a newly developed FFQ entitled the 'Diet and Behaviour Scale' (DABS), and each of these three chapters aim to explore the factor structures associated with it, as well as to investigate whether certain dietary patterns are related to academic performance and mental health outcomes. Chapter 3 presents cross-sectional data from a study of first and second year undergraduate psychology students. Because energy drink use was found to be relatively uncommon, Chapter 4 then presents a second cross-sectional study, which examined a sample of student participants who specifically claimed to be frequent consumers of the products. As both of these studies were cross-sectional, meaning that causation could not be inferred, Chapter 5 presents longitudinal data from a cohort of first year psychology students. These participants were initially sampled during the first week of term, and then followed-up 10 weeks later. The aim of this study was to investigate whether changes in diet were associated with measures of academic performance and mental health at the latter time-point.

The main focus of the thesis comes from data collected for the Cornish Academies Project, a large-scale longitudinal study of secondary school children from the South West of England. Chapter 6 provides a more comprehensive investigation of the efficacy of the DABS as a measure of food and drink consumption. This chapter also identifies a number of demographic and lifestyle correlates of diet, mental health, academic attainment, and problem behaviour. Chapter 7 then presents a cross-sectional analysis of diet and mental health. Chapter 8 investigates diet and academic attainment and problem behaviour cross-sectionally, and Chapter 9 addresses these effects longitudinally.

Chapter 10 aims to address the need to look at specific time periods rather than just general dietary consumption. A preliminary study is presented, which provides evidence to suggest that children in detention are more likely to have consumed an energy drink and skipped breakfast that day compared to on a control day later in the same week. Conclusions and a general discussion of the thesis and its major findings are then presented in Chapter 11.

1.6 A Note on Ethical Approval

All research described in this thesis was approved by Cardiff University's School of Psychology Ethics Committee, and separate applications were made for research involving university students (ethical clearance number: EC.13.09.10.3507RRA) and secondary school children (ethical clearance number: EC.12.09.11.3187). Informed consent was acquired from each participant prior to data collection, and all analysis was conducted using IBM SPSS Statistics Version 20. In order to determine the initial direction of the research, the literature relating to energy drink consumption, mental health, and academic attainment was reviewed, and is presented in Chapter 2.

Chapter 2: A Review of Energy Drinks, Mood, Mental Health, and Academic Attainment[1]

2.1 Introduction

As discussed in Chapter 1, the consumption of highly caffeinated energy drinks has become a particular cause for concern in recent years. These products have been widely discussed in the mainstream media, with numerous anecdotal accounts linking them to detrimental effects in young consumers. Of particular concern has been reports claiming that energy drink use can cause behavioural problems and that they negatively impact academic attainment, mental health and wellbeing. However, a Japanese telephone survey (Yamashita, Tsukayama, & Sugishita, 2002) observed that 43.1% of those who had utilised complementary and alternative medicine within the previous year had used nutritional and tonic drinks (under which label energy drinks could be classified). In a similar manner, Smith and Atroch (2010) reported that drinks containing guaraná have been used for medicinal purposes in Brazil for hundreds of years. Due to such conflicting accounts, it is important to consider whether energy drinks do indeed impact a person's mental health and academic success, and if so, are the effects positive, negative, or variable. The current chapter therefore presents a review of the relevant literature, which helped to determine the direction of research carried out in the rest of this thesis. As the review of energy drinks and mental health will be presented before that relating to academic attainment, the next section will briefly explore what is currently known regarding associations between caffeine consumption and mental health.

2.1.1 Caffeine and Mental Health

It is important to consider relationships between mental health and caffeine use, as the substance appears to be the main active ingredient in energy drinks (McLellan & Lieberman, 2012). Although caffeine consumption is moderately associated with a number of psychiatric disorders, the relationships appear not to be

[1] Note that Richards and Smith (2015a) and Richards, Malthouse, and Smith (2015) are included in the review article (Richards & Smith, 2016a) that resulted from this work; they are not discussed in the current chapter because they relate to research conducted as part of this PhD thesis.

causal (Kendler, Myers, & Gardner, 2006) and discrepancies in the literature are common (Lara, 2010). Some studies have observed positive effects: for example, low doses have been shown to elevate mood (Haskell, Kennedy, Wesnes, & Scholey, 2005). Evidence suggests, however, that such outcomes likely depend on the dosage consumed. Kaplan et al. (1997), for instance, reported that 250mg increased elation, whereas 500mg increased irritability. Acute effects may also vary between studies depending on whether or not the research participants in question were tested in a state of caffeine withdrawal. Further to this, baseline characteristics of caffeine consumers are likely to differ from non-consumers. For instance, when investigating daily caffeine consumption in psychology students, Gilliland and Andress (1981) reported that trait anxiety and depression were higher in moderate and high consumers compared to abstainers.

2.1.2 Acute Effects of Energy Drink Consumption on Mood

Energy drink companies often market their products with claims of boosting physiological functioning, providing short-term boosts to mood and performance. A current review article (Ishak, Ugochukwu, Bagot, Kalili, & Zaky, 2012), as well as several more recently published reports (Salinero et al., 2014; Sünram-Lea, Owen-Lynch, Robinson, Jones, & Hu, 2012; Wesnes, Barrett, & Udani, 2013) would suggest that there may be some accuracy to these claims. For instance, double-blind trials have shown benefits of energy drinks compared to placebo in relation to wellbeing, vitality, and social extrovertedness (Seidl, Peyrl, Nicham, & Hauser, 2000), depression and anxiety (Wesnes et al., 2013) and in improving or maintaining mood under fatiguing or cognitively demanding tasks (Smit, Cotton, Hughes, & Rogers, 2004). However, Scholey and Kennedy (2004) observed no mood effects in relation to drinks containing caffeine, glucose, ginseng, and ginkgo biloba. A recent study by Grasser, Dulloo, and Montani (2015) also reported no difference in perceived stress between energy drinks and water conditions after a stress-inducing mental arithmetic task.

Negative effects have also sometimes been reported. For instance, Wesnes et al. (2013) observed that tension/anxiety scores (measured using the Profile of Mood States) increased significantly in the energy drink condition relative to placebo at 1h post-consumption (although no such effect was detected thereafter). Salinero et al.

(2014) also observed increased nervousness, insomnia, and activeness when energy drinks were consumed rather than placebos; each of these effects occurred in females, but only the effect of insomnia was statistically significant in males. However, due to the placebo condition also containing the same ingredients other than caffeine (i.e., water, taurine, sodium bicarbonate, L-carnitine, and maltodextrin), these effects may be attributable to caffeine rather than to energy drinks per se.

Although beneficial acute mood effects of energy drinks have been frequently reported in the literature, null findings and undesirable side effects have also been observed. Furthermore, manufacturers have rarely addressed the potential long-term effects that consuming the products may have. For this reason, the current chapter aims to review the literature relating to chronic energy drink use and its associations with mental health, before also asking the question whether consumption of these products is related to academic attainment.

2.2 Method

PubMed and PsycINFO were searched for English language articles published between 1990 and 2015, and the following search terms were used: ‘energy drinks’ and ‘mental health’, ‘well-being’, ‘wellbeing’, ‘stress’, ‘anxiety’, ‘depression’. Excluding duplicates 56 articles were initially identified (for a flow diagram of their inclusion/exclusion, see Figure 2.1). The author read each of the abstracts, and acquired and read all articles deemed potentially relevant. Of these, 17 (along with one other identified by reading through reference lists) were included in the review. The findings of case reports were considered separately to those of empirical studies; three papers were identified through the literature search, and another five were identified through references made in other articles. PubMed and PsychInfo were then searched for articles relating to ‘energy drinks’ and ‘GPA’ (grade point average) or ‘attainment’. Although this produced no results, three relevant papers were identified via reading through reference lists of other articles in the area.

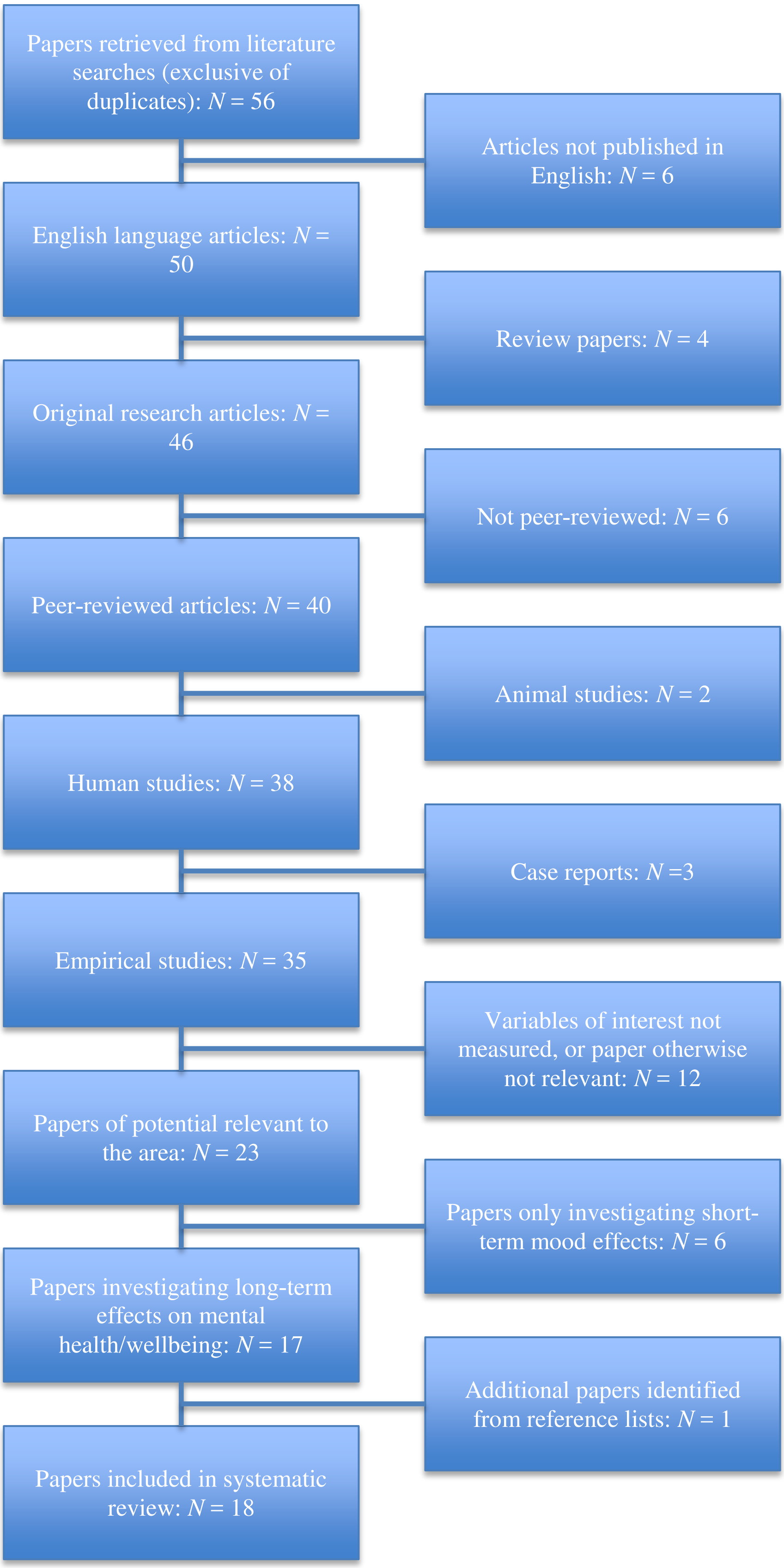

Figure 2.1. Flow chart showing the inclusion/exclusion of studies used in the systematic review of energy drinks and mental health.

2.3 Results & Discussion

2.3.1 Case Reports of Energy Drink Consumption and Mental Health Problems

Initial anecdotal evidence to suggest that energy drink use can be associated with the occurrence/reoccurrence of psychiatric symptoms comes from eight articles that have together presented 12 case reports (see Table 2.1). Although some of these relate to phenomena outside the general scope of the current review, they are included because they provide a useful starting point from which to examine associations between energy drink use and mental health.

The first reported case to appear in the literature that related energy drink use to mental health problems came from Machado-Vieira, Viale, and Kapczinski (2001). These authors described the case of a 36-year-old man with a DSM-IV diagnosis of Bipolar Disorder Type I. Although the man in question had been without subclinical mood episodes for the previous five years, he was admitted to hospital with manic symptoms. One week prior to this episode he reportedly drank three cans of Red Bull® energy drink at night, and another three cans three days later. Seven days after admission, the patient's symptoms subsided, even though the only treatment used was lithium at the normal dosage (0.9 Meq/L). The authors suggested that the man's manic symptoms might have been caused by the presence of inositol in the drink, as lithium (commonly used to treat bipolar disorder patients) is known to deplete the brain of this chemical.

Rizkallah et al. (2011) presented three similar cases to the one described above. Of these, two subjects had been diagnosed with Bipolar Disorder Type I, one had been diagnosed with Bipolar Disorder Type II, and all three had comorbid substance use disorder and abused cocaine. In each case, excessive energy drink consumption occurred for at least one week prior to the onset of manic or depressive relapse. Following cessation, two of these patients remained abstinent of drug use and remained psychiatrically stable; the third case relapsed three months post-treatment and once again began using cocaine and energy drinks.

A further three cases of energy drink use preceding psychiatric relapse were presented by Chelben et al. (2008). One case was very similar to those presented

	Case details	Psychiatric history	Energy drink use	Presentation symptoms
Berigan (2005)	25-year-old male	No prior diagnosis, no chronic medical issues, or family history of psychiatric problems	6-8 (8oz) cans daily for previous four months	Anxiety, restlessness, fidgetiness, irritability, difficulties concentrating, problems falling asleep
Cerimele, Stern, and Jutras-Aswad (2010)	43-year old male	Schizophrenia (Paranoid Type), and alcohol dependence (in full sustained remission)	Began use eight weeks before hospitalisation; use escalated to 8-10 (16oz) cans daily	Paranoia, religious delusions, agitation
Chelben et al. (2008)	Case 1: 41-year old female	Long history of psychiatric disorder; primarily Cluster B personality disorder with salient hysterical attributes, a tendency toward dramatization, impulsivity and suicide attempts in response to relatively low scale triggers	At least five a day (considerably more on some days) for one week; consumption stopped immediately prior to hospitalisation due to running out of money	Severe psychomotor agitation, hypervigilance, verbal and physical aggression, impulsive behaviour, low threshold for aggressive outbursts
	Case 2: 38-year old female	Comorbid bipolar disorder and borderline personality disorder, and a long history of multiple substance abuse	5-10 energy drinks per day for one month	Moderate psychomotor agitation, increased alertness, insomnia impulsivity, self-mutilation ideation
	Case 3: 25-year old male	Schizophrenia	8-9 cans of energy drink at a time for one month	Psychomotor unease, hypervigilance, verbal aggression, intensive preoccupation with thoughts of death
Machado-Vieira, Viale, and Kapczinski (2001)	36-year old White male	Bipolar Disorder Type I (DSM-IV)	One week before episode drank three cans of Red Bull® at night; three days later drank three more cans	Mania: euphoria, hyperactivity, insomnia, increased libido, irritability
Menkes (2011)	27-year old obese New Zealand Maori male	Schizophrenia; previously used alcohol and cannabis to excess; currently drank up to 10 cups of instant coffee per day	First incident: two Demon Shots an hour apart; second incident: three Demon Shots in 15 minutes	First incident: unease, irritability, paranoia; second incident: restlessness, withdrawal, argumentativeness, rapid pulse, insomnia
Rizkallah et al. (2011)	Case 1: 40-year old male	Bipolar Disorder Type I (DSM-IV), prior intranasal cocaine dependence	Up to six small cans a day for one week	Manic episode: elated mood, irritability, grandiosity
	Case 2: 30-year old female	Bipolar Disorder Type II (DSM-IV), intranasal cocaine dependence	Several incidents of using up to eight small cans a day during previous month; this pattern occurred every day for two weeks before admission	Irritability, flight of ideas, reduced need for sleep, heightened sexually oriented activities
	Case 3: 36-year old male	Bipolar Disorder Type I (DSM-IV), cannabis dependence, and And cocaine abuse	Up to nine small cans almost daily for two weeks	Sleep disturbance, increased daytime sleepiness, irritability, anxiety, and depression
Sharma (2010)	32-year old German male	No prior diagnoses, no psychiatric history (other than occasional mood swings). Family history of mental illness (postpartum depression and suicide)	Began drinking Red Bull® four weeks before admission; 1-2 cans daily escalated to 6-8 large (550ml) cans daily during a week before hospitalisation	Decreased sleep requirement, hyperactivity, pressured speech, racing thoughts, delusions of grandiosity and paranoia, risk-taking behaviour, and lack of insight
Szpak and Allen (2012)	28-year old male professional boxer	No personal history of psychiatric problems, although one brother committed suicide, another died from a drug and alcohol overdose (unclear if intentional or not), and his father became an alcoholic	Drank 14 (250ml) cans of energy drink in the day and evening (seven each consecutive day)	Acute suicidality following sleep deprivation

Table 2.1. Published case reports relating psychiatric symptoms to energy drink consumption.

above, being a 38-year old female diagnosed with comorbid bipolar disorder and borderline personality disorder, and a history of substance abuse. One month prior to hospitalisation this individual began consuming 5-10 energy drinks per day, and eventually presented with moderate psychomotor agitation, increased alertness, insomnia, impulsivity, and self-mutilation ideation. A second case, that of a 41-year old female also had a diagnosed personality disorder. In this case the individual in question had a long history of psychiatric illness, primarily characterised by Cluster B personality disorder with hysterical attributes, a tendency towards dramatization, impulsivity, and suicide attempts. She drank at least five energy drinks per day for a week prior, though stopped using them immediately before hospitalisation due to running out of money. She presented with severe psychomotor agitation, hypervigilance, verbal and physical aggression, impulsive behaviour, and a low threshold for aggressive outbursts. The final case described by Chelben et al. was that of a 25-year old man diagnosed with schizophrenia. This man had spent a few months in a hospital day ward, but was then transferred to a status of full hospitalisation after his mental state deteriorated. His symptoms included psychomotor unease, hypervigilance, verbal aggression, and a preoccupation with thoughts of death. For the month preceding his admission to full-hospitalisation, this man had begun consuming 8-9 cans of energy drink at a time. Following the cessation of energy drink use, though hospitalisation for longer periods of time was required in some cases, all three described by Chelben et al. calmed down and returned to pre-admission levels of psychomotor behaviour after approximately one week.

In a similar case to one of those presented by Chelben et al. (2008), Cerimele, Stern, and Jutras-Aswad (2010) described a 43-year old man with paranoid schizophrenia and alcohol dependence in full sustained remission, who presented with a six-week history of worsening symptoms of paranoia, religious delusions, and agitation. He had begun drinking 8-10 (16oz) cans of energy drink for the previous eight weeks prior to admission, and had increased his intake after noticing improved mood and interest in activities upon first consumption. Ten days after caffeine cessation (and with no new antipsychotic treatments having been prescribed), the man was better related, less paranoid, calmer, had diminished religious delusions, and so was discharged. Menkes (2011) described a third case of psychotic relapse in a schizophrenic patient after consumption of energy drinks. In this instance, a 27-year old New Zealand Maori man was observed to become uneasy, irritable, and paranoid after using energy shots. What was of particular interest in this case was that two separate instances of this pattern were observed in the same individual. The authors also reported that once the patient stopped consuming energy shots he remained stable for the next 15 months.

Each of the case reports so far presented relate to individuals already suffering from psychiatric conditions, implying that excessive consumption of energy drinks may act as a trigger for relapse in certain vulnerable people. However, cases have also been reported in which serious psychiatric symptoms are found in otherwise healthy individuals. Berigan (2005) presented the case of a 25-year old man with no chronic medical issues, who used no prescription or over-the-counter medications, and did not have a family history of psychiatric problems, but complained of anxiety, restlessness, fidgetiness, irritability, difficulties concentrating, and problems falling asleep after drinking 6-8 (8oz) cans of energy drinks daily for four months. The patient's symptoms subsequently disappeared after discontinuing the use of energy drinks, and he appeared healthy and symptom-free at three-month follow-up.

Sharma (2010) described the case of a 32-year old man with no psychiatric history (other than occasional mood swings) who was involuntarily hospitalised after presenting with severe manic symptoms. Although the man had begun drinking 1-2 (550ml) cans of Red Bull® per day four weeks previously, his consumption in the week prior to hospitalisation was reported to be 6-8. On admission the man met the DSM-IV criteria for substance-induced mood disorder with manic features. He had also reportedly not slept for four days, and was observed to have signs of caffeine toxicity, including restlessness, psychomotor agitation, tremor, and excessive sweating. After three days of treatment the man was discharged; six weeks later he denied any further Red Bull® consumption, and had remained psychiatrically stable. Furthermore, although he reported a history of episodic heavy drinking and occasional cocaine use, the man denied using either substance in the previous three months. However, though the individual himself did not have a significant history of psychiatric illness himself, it did emerge that his mother and aunt had suffered from post-partum depression, and his grandfather had died by suicide.

Szpak and Allen (2012) described the case of a 28-year old man who drank 14 250ml cans of energy drink over a two-day period, did not sleep for 72 hours, and then attempted suicide. In a similar manner to the case presented by Sharma (2010), though the man in question had no previous psychiatric issues, a family history of mental health problems was revealed. The man's suicide attempt appeared unplanned and out of character, with no prior depressive symptoms or suicidal thoughts being reported. Neurological and psychiatric assessments of the individual after the event indicated that he was normal and healthy, suggesting that the event may have been triggered by caffeine intoxication.

Although the case studies presented in this section cannot prove a causal relationship between energy drink use and the onset of acute psychiatric problems, the chronicity of such accounts is compelling. In addition, though the majority of these reports suggest that excessive energy drink consumption may exacerbate/trigger symptoms in those who have a prior diagnosis, some studies (Berigan 2005; Sharma, 2010; Szpak & Allen, 2012) provided accounts of individuals who did not have personal histories of psychiatric disorders. However, in two of these cases (Sharma, 2010, and Szpak & Allen, 2012) familial history of mental health problems were confirmed, suggesting the possibility of genetic susceptibility. The only case in which no such susceptibility to mental health problems was present was Berigan (2005). However, given the symptomatology and extreme consumption (6-8 8oz cans per day for four months), this case may simply reflect the effects of caffeine toxicity. This idea is supported by findings from other case studies, which have reported high caffeine consumption to be capable of inducing manic symptoms (Krankl & Gitlin, 2015; Ogawa & Ueki, 2007). These reports are also not necessarily indicative of energy drinks being a problem when used moderately by the general population. To address this concern, the next section will present findings from studies investigating chronic energy drink consumption and mental health.

2.3.2 Empirical Studies of Chronic Energy Drink Consumption and Mental Health Outcomes

The literature search conducted for this review identified 17 articles that examined chronic energy drink usage in relation to mental health; one further article was identified from reference lists. For details of all 18 studies, see Table 2.2.

Study	Variables of interest	Design	Sample	Effects
Arria et al. (2011)	-Depression (BDI)	Cross-sectional interviews and questionnaires (collected as part of a longitudinal study)	1097 fourth-year US university students	-No difference in BDI scores between frequent users and either infrequent users or non-users
Azagba, Langille, and Asbridge (2014)	-Depression (12-item version of the CES-D)	Cross-sectional survey (two-stage stratified cluster sample from three provinces)	8210 public school students (grades 7, 9, 10, and 12) in Canada	-Higher depression associated with frequent (once a month or more) use
Evren and Evren (2015)	-Anxiety (PSTA) -Depression (PSTA) -Self-mutilation (unspecified) -Suicidal thoughts (unspecified)	Cross-sectional online questionnaire in 15 districts of Istanbul, Turkey	4957 10th grade students from 45 schools (representative sample)	-Frequency of energy drink use positively associated with anxiety -Frequency of energy drink use positively associated with depression -Frequency of energy drink use positively associated with self-harming behaviour -Frequency of energy drink use positively associated with suicidal thoughts -Multivariate level: no association with anxiety or depression -Multivariate level: self-harming and suicidal thoughts associated with consuming energy drinks every day
Hofmeister, Muilenburg, Kogan, and Elrod (2010)	-Stress (DASS-21) -Anxiety (DASS-21) -Depression (DASS-21)	Cross-sectional online questionnaire	456 US veterinary students: University of Georgia (UOG; $N = 227$); Colorado State University (CSU; $N = 229$)	-UOG: energy drink users had higher anxiety than non-users (no differences for stress or depression); regular users had higher stress than non-regular users (no differences for anxiety or depression) -CSU: energy drink users had higher anxiety than non-users (no differences for stress or depression); regular users had higher depression, anxiety, and stress scores than non-regular users
Malinauskas, Aeby, Overton, Carpenter-Aeby, and Barber-Heidal (2007)	-Jolt and crash episodes -Heart palpitations	Cross-sectional questionnaire	496 randomly surveyed US students	-29% reported weekly jolt and crash episodes from energy drink use (significant dose-dependent effect) -19% reported heart palpitations from energy drinks (marginally significant dose-dependent effect, $p = .09$)
Peters et al. (2010)	-PTSD symptoms after Hurricane Ike	Cross-sectional questionnaire	170 low-income at-risk African American/ Latino male youth (9-19) from Houston, Texas	-Initial associations between PTSD symptoms and 30-day prior use of anti-energy drinks (significant) and energy drinks (marginally significant, $p = .09$) -Multivariate: no associations between PTSD symptoms and energy drink or anti-energy drink use
Pettit and DeBarr (2011)	-Stress (items from PSS)	Cross-sectional online questionnaire	136 US undergraduate students	-Significant positive relationships between perceived stress and three measures of energy drink consumption -Relationships between perceived stress and three other measures of energy drink consumption were not significant
Ríos et al. (2013)	-Academic stress (questionnaire adapted from the Systemic Cognitive Model of Academic Stress)	Cross-sectional questionnaire (administered in August, participants asked to answer retrospectively for January-May). Representative stratified sample of medical-based subjects	275 first- and second-year Puerto Rican students	-Energy drink consumption not associated with academic stress -Soft drinks and coffee consumption increased in times of high stress (although no effects regarding energy drinks, tea, and hot chocolate) -49% reported that consuming caffeinated beverages was useful for coping with stress, with 42.6% admitting they would probably use caffeinated beverages as a stress coping strategy in the future
Rizvi, Awaiz, Ghanghro, Jafferi, and Aziz (2010)	-Increased consumption of caffeine /energy drinks (did not isolate energy drinks)	Cross-sectional questionnaire (though asked if participants had experienced increases/decreases in consumption in relation to pre-examination stress)	226 second-year medical students in Karachi, Pakistan	-Increased consumption of coffee, tea, and energy drinks in 38.94% of respondents at pre-examination time

Study	Variables of interest	Design	Sample	Effects
Snipes, Jeffers, Green, and Benotsch (2015)	-Anxiety sensitivity (SURPS) -Hopelessness (SURPS)	Cross-sectional online questionnaire	757 US undergraduate students	-AmED users scored lower on anxiety sensitivity compared to alcohol-only users -No difference between AmED users and alcohol-only users for hopelessness
Stasio, Curry, Wagener, and Glassman (2011)	-Anxiety (BAI)	Seven-day retrospective survey (questionnaire)	107 young adults (college student athletes, Reserve Officers Training Corp cadets, and psychology students)	-Energy drink use explained 29% of variance in anxiety scores (after controlling for sleep quality, coffee, tea, and soft drink consumption)
Toblin, Clarke-Walper, Kok, Sipos, and Thomas (2012)	-Sleep disruption due to stress	Cross-sectional questionnaire (although design is not formally stated)	988 male US Army and Marine combat platoons deployed in Afghanistan in 2010 (initially 1249 surveyed using a cluster sample, 1000 consented to their data being used for research purposes, 988 answered energy drink question)	-Those consuming ≥3/d more likely to report sleep disruption related to stress -No differences between 0, 1-2, and ≥3/d on level of concern regarding not getting enough sleep -Those consuming ≥3/d more likely to report sleep disruption on more than half the nights in the past 30 days because of stress related to combat, personal life, and illness
Trapp et al. (2014)	-Stress (DASS-21) -Anxiety (DASS-21) -Depression (DASS-21)	Cross-sectional questionnaire (population-based sample from the Western Australian Pregnancy Cohort [Raine] Study, a prospective cohort followed from gestation to early adulthood)	1062 young adult Australians	-Univariate: energy drink consumption associated with depression (total sample, and males, but not females), anxiety (total sample, males, females), and stress (total sample, males, females) -Multivariate (most conservative model): only significant relationship was between energy drink use and anxiety in males -Multivariate: ≥ 250ml/d energy drink users (compared to 0ml/d) had higher anxiety and stress (total sample, and males, but not females), but not depression -Multivariate - total sample: 100ml/d energy drink consumption associated with anxiety and depression, but not stress -Multivariate - males: 100ml/d energy drink consumption associated with stress and anxiety, but not depression -Multivariate - females: 100ml/d energy drink consumption not associated with stress, anxiety, or depression
Vilija and Romualdas (2014)	-PTSD symptoms after lifetime traumatic experiences (IES-R)	Cross-sectional questionnaire (10 secondary schools randomly selected from 15 city districts in Kaunas, Lithuania)	1747 eighth grade pupils from Lithuania	-PTSD symptoms associated with energy drink use (controlled for sex, index trauma, physical activity, smoking and sense of coherence)
Waits, Ganz, Schillreff, and Dell (2014)	-Change in energy drink use from Pre-deployment to deployment in Operation Enduring Freedom	Cross-sectional questionnaire Assistance Force personnel in Afghanistan	183 deployed International Security Monster®, and Rockstar® (not significant)	-Increase in weekly consumption of Rip-It® (significant) and Tiger® (not significant) and decreases in Red Bull®, -Overall change in total number of consumers of energy products from pre-deployment to deployment was not significant (though this also included other 'energy products', such as soda, coffee, Hydroxycut® etc.), although number of servings per week increased from 16.6 (pre-deployment) to 24 (deployment).
Walther, Aldrian, Stüger, Kiefer, and Ekmekcioglu (2014)	-Wellbeing (based on questions from the HBSC, KIGGS, and MDMQ)	Cross-sectional online questionnaire	500 adolescents and young adults (14-24 years old) from all provinces in Austria	-Proportion with high wellbeing (55%) was higher in those who consumed energy drinks and alcohol once a week or less -Proportion with low wellbeing was higher in those who consumed energy drinks and alcohol two to six times a week, daily, or several times daily

Study	Variables of interest	Design	Sample	Effects
Wing et al. (2015)	-Mental health status (GHQ-12) -Emotional problems (SDQ) -Conduct problems (SDQ) -Peer relationships (SDQ) -Hyperactivity/inattention (SDQ) -Pro-social behaviours (SDQ)	Cluster randomised controlled trial with 14 schools in Hong Kong	3713 (1545 intervention, 2168 control) secondary school (7th-11th grade: 12-18-year-old) students from Hong Kong	-Lower incidence of consuming energy drinks in the intervention group -Improvement in GHQ-12 score in intervention group compared to control -Improvements in total difficulty, conduct, and hyperactivity in intervention group compared to control -No differences between groups for peer relationships, emotional problems, or pro-social behaviour
Yudko and McNiece (2014)	-Depression (BDI II) -State anxiety (STAI) -Trait anxiety (STAI)	Prospective quasi-experimental	69 polydrug users (19 males, 50 females) receiving substance abuse treatment in a rural area of Hawaii	-No association between having had an energy drink in the previous hour and BDI -No association between having had an energy drink in the previous hour and state anxiety -No association between having had an energy drink in the previous hour and trait anxiety

Table 2.2. Studies that have examined associations between chronic energy drink use and mental health outcomes.

Note. This table does not include case reports (see Table 2.1) or studies that only investigated short-term effects (see acute effects of energy drink consumption on mood section).

Abbreviations: AmED, alcoholic energy drink; BDI, Beck Depression Inventory; CES-D, The Center for Epidemiologic Studies Depression Scale Revised; DASS-21, Depression Anxiety Stress Scale-21; GHQ-12, General Health Questionnaire-12; HBSC, Health Behaviour in School-aged Children; IES-R, Impact of Event Scale-Revised; KIGGS, Study on the Health of Children and Adolescents in Germany; MDMQ, Multidimensional Mood Questionnaire; PSS, Perceived Stress Scale; PSTA, Psychological Screening Test for Adolescents; PTSD, Post-traumatic Stress Disorder; SDQ, Strength and Difficulties Questionnaire; STAI, State-Trait Anxiety Inventory; SURPS, Substance Use Risk Profile Scale.

Walther, Aldrian, Stüger, Kiefer, and Ekmekcioglu (2014) investigated associations between energy drink use and wellbeing in 500 adolescents and young adults from Austria. The study found a higher proportion of high wellbeing in those who consumed energy drinks and alcohol once a week or less, and a higher proportion of low wellbeing in those who consumed alcohol and energy drinks twice a week or more. An issue with this article was that the authors considered alcohol and energy drinks together, making it impossible to determine their individual effects. However, the results presented make it plausible to believe that frequent energy drink consumption may have been associated with low wellbeing.

Wing et al. (2015) conducted an intervention study to improve sleep knowledge in a large sample (N = 3713) of secondary school children from Hong Kong. The article reported improvements in the intervention group relative to the control regarding sleep knowledge, mental health status, total difficulty, conduct problems, and hyperactivity, although no differences were observed for peer relationships, emotional problems, or pro-social behaviour. What was of interest to the current review was that the intervention group was significantly less likely to consume energy drinks three times a week or more compared to the control. Although it is not possible to tell from the data reported whether this observation was in any way associated with the changes in mental health, it is conceivable that it may have been. Furthermore, the study does provide hope that such interventions might be effective in reducing energy drink consumption and promoting better sleeping habits and mental health in adolescents. The next three sections will aim to address whether chronic energy drink use is associated with stress, anxiety, and depression.

2.3.2.1 Stress

The studies identified that examined energy drink use in relation to stress generally reported positive relationships. Hofmeister, Muilenburg, Kogan, and Elrod (2010) found higher stress levels in regular energy drink users (i.e., those who consumed more than one per week) compared to non-regular users (i.e., those who consumed one or fewer per week) in two samples of students. However, no differences were detected between energy drink users (i.e., those who consumed one or more per month) and non-users. Trapp et al. (2014) measured energy drink consumption in ml/d, with estimates being based on frequency of consumption in days per month/week, and the amount of consumption in usual number of cans consumed on a day in which energy drinks were used. The study found stress to be positively associated with energy drink use in a large sample (*N* = 1062) of young adult Australians. Although these initial relationships disappeared once other factors were controlled for, higher stress did remain associated with consuming ≥ 100ml/d or ≥ 250ml/d. Compared to non-users, consumption of ≥ 250ml/d was associated with higher stress levels in the whole sample and in males separately. However, no such effect was observed in females. Furthermore, although males who consumed ≥ 100ml/d reported higher stress levels than non-consumers, no such effects were observed in females or in the sample as a whole.

In a large study (*N* = 988) of US Army and Marine personnel stationed in Afghanistan, Toblin, Clarke-Walper, Kok, Sipos and Thomas (2012) found that those who consumed three or more energy drinks per day were more likely to report sleep disruption due to stress. However, another study of International Security Assistance Force personnel in Afghanistan (Waits, Ganz, Schillreff, & Dell, 2014) found that, out of four energy drinks investigated, the number of servings consumed per week only increased significantly for one brand between pre-deployment and deployment. This effect was also considered likely to reflect the differential availability of brands between the United States and Afghanistan, and so may have been unrelated to the increased stress levels associated with military deployment. Furthermore, certain factors associated with military deployment make these data more difficult to interpret than studies that use non-military samples. For instance, increased mental and physical requirements, as well as dysregulated sleep, might account for increases in both stress and energy drink use, and the two may not necessarily be causally linked.

Rizvi, Awaiz, Ghanghro, Jafferi, and Aziz (2010) provided evidence to suggest that stressful situations may be associated with increased use of energy drinks. This study found that 38.94% of a Pakistani student sample claimed to have increased their coffee, tea, and energy drink consumption during pre-examination time. However, a limitation of the study was that it did not report the use of these products individually, making it impossible to relate the findings specifically to energy drinks. Furthermore, findings from this study should be interpreted with caution in light of the fact that the authors made a number of unsubstantiated claims.

For instance, they stated, “it was observed that the intake of caffeine, tea and energy drinks most commonly affected metabolism, immunity, moods and sleeping patterns, which is in accordance with studies previously published” (p. 153), when their research was cross-sectional in nature and no inferential statistics were reported. The authors also stated that “According to our study the students consume increased amounts of energy drinks and caffeine in the form of coffee, tea because they think it helps lift their mood and improves alertness” (p. 154), although no reasons for using the products were actually reported. The authors then concluded by saying “In light of the statistics obtained through this research, we recommend that students should inculcate physical activity and regular praying in their lives to combat stress effectively” (p. 154). This suggestion is again unfounded as no links between such activities and stress levels were reported in their article.

Pettit and DeBarr (2011) conducted a study to investigate whether perceived stress in undergraduate students was related to six measures of energy drink consumption. Significant positive correlations were observed with the following three measures: 1) number of days on which at least one energy drink was consumed in the previous 30 days, 2) average number of days per week on which energy drinks were consumed in the previous 30 days, and 3) the largest number of energy drinks consumed on any occasion in the previous 30 days. Although relationships with the number of energy drinks consumed the previous day, number of days on which energy drinks were consumed in the previous seven days, and the approximate number of energy drinks consumed on days in which energy drinks were consumed in the previous 30 days were not significant, the effects were all in the same (positive) direction.

Ríos et al. (2013) found no difference between those who consumed energy drinks and those who did not regarding academic stress in a sample of Puerto Rican university students, even though nearly half of those surveyed claimed that using caffeinated products was useful for coping with stress. However, although soft drink and coffee consumption appeared to increase in times of high stress, no such effects were observed regarding energy drinks, hot chocolate, or tea. When interpreting these findings, it should be noted that the questionnaires were administered in August, and participants were asked to answer retrospectively from January to May (term time), potentially leading to recall bias.

Two studies were identified that examined energy drink usage in relation to post-traumatic stress disorder (PTSD). Although it is acknowledged that this phenomenon should not be classified under the broader definitions of stress used by other studies discussed in this section, a consideration of their findings is still deemed to be useful. Peters et al. (2010) investigated substance use by Houstonian youth following Hurricane Ike. Actively trying to avoid thinking about the event was associated with a prior 30-day use of anti-energy drinks (sometimes referred to as 'relaxation drinks'; drinks that include ingredients such as melatonin, kava, valerian, and tryptophan, which are marketed with claims of promoting calmness and relaxation; Stacy, 2011) and energy drinks, although the latter effect was only marginally significant (p = .09). However, although the effect relating to anti-energy drinks was retained in an unadjusted logistic regression model, which controlled for additional substance use, neither effect was significant when an adjusted model was used.

Vilija and Romualdas (2014) found PTSD symptoms to be positively correlated with frequency of energy drink consumption in a large sample (N = 1747) of Lithuanian secondary school children, even after controlling for sex, index trauma, physical activity, smoking, and sense of coherence. This article appeared to measure energy drink consumption based on a previously published FFQ (Zaborskis, Lagunaite, Busha, & Lubiene, 2012), which measured weekly intake using seven possible responses: 'never', 'less than once a week', 'about once a week', 'two to four days a week', 'five to six days a week', 'once a day, every day', and 'every day, more than once'. It should, however, be noted that a number of other food products were also associated with PTSD symptoms (e.g., light alcoholic drinks, spirits, soft drinks, flavored milk, coffee, fast food, chips, salty snacks, processed foods). More importantly, energy drinks appeared to have been grouped together with sports drinks, which may have confounded the analysis.

2.3.2.2 Anxiety

Hofmeister et al. (2010; described previously) found anxiety levels to be higher in energy drink consumers compared to non-consumers in two samples of students. However, anxiety was only higher in regular users compared to non-regular users in one of the two samples, making it difficult to conclude whether such a relationship may be dose dependent or not. In addition to this, Evren and Evren (2015) reported energy drink use in a very large sample (*N* = 4957) of 10th grade students from Turkey to be associated with anxiety; compared to non-use in the past year, anxiety scores were higher in those who had used the products once in their lifetime, once to three times in a month, once to five times a week, and every day. However, the effects observed in this study did not remain significant at the multivariate level.

Stasio, Curry, Wagener, and Glassman (2011) found that 29% of variance in anxiety scores in a sample of young adults comprised of college student athletes, Reserve Officers Training Corps cadets, and psychology students was explained by energy drink consumption (measured in terms of the number of cans consumed in the previous seven days), even once sleep quality and other caffeinated drink consumption were controlled for statistically. In a similar manner, Trapp et al. (2014; described earlier) observed anxiety scores to correlate positively with energy drink use in their total sample, as well as in males and females separately. However, in their most conservative multivariate analysis, the effect only remained significant in males. Those who consumed either ≥ 100ml/d or ≥ 250ml/d were also found to report higher anxiety levels than non-consumers; these effects were observed in both the total sample and in males, although not in females. In addition to these findings, a study of US university students (Malinauskas et al., 2007) investigated energy drink use in relation to heart palpitations and 'jolt and crash episodes'. The authors defined this latter term as "a feeling of increased alertness and energy (the jolt) followed by a sudden drop in energy (the crash)." (p. 35). A dose-dependent relationship between the total number of energy drinks consumed at one time and experiencing weekly jolt and crash episodes was observed, though a similar association with heart palpitations was only marginally significant (p = .09).

Although most studies have reported positive relationships, Yudko and McNiece (2014) found no association between trait or state anxiety and having used energy drinks in the previous hour in a sample of polydrug users attending a rehabilitation clinic in Hawaii. However, considering the relatively small sample size

(N = 69), and that only nine participants had consumed an energy drink in the previous hour, it is likely that this study lacked the level of statistical power required to detect such effects. In further relation to the use of other substances, a study of 757 undergraduate students conducted by Snipes, Jeffers, Green, and Benotsch (2015) found that anxiety sensitivity was lower in users of alcoholic energy drinks (i.e. drinks in which alcohol and energy drinks are mixed together) compared to alcohol-only users. The explanation given by the authors was that people with high anxiety sensitivity might avoid energy drinks due to the stimulant properties having potential to exacerbate their symptoms.

2.3.2.3 Depression

Arria et al. (2011) found no differences in depression scores between high-frequency energy drink users (i.e. ≥ 52 during the past year), low-frequency energy drink users (i.e. 1-51 in the past year), and non-users in a large sample (N = 1097) of fourth-year US undergraduate students. In a similar manner, Hofmeister et al. (2010; described earlier) observed no differences between energy drink users and non-users in two samples of US veterinary students. However, in one of these samples, regular users were found to report significantly higher depression scores than non-regular users. A very large study of Canadian schoolchildren (N = 8210) conducted by Azagba, Langille, and Asbridge (2014) also observed higher depression scores to be associated with using energy drinks once per month or more.

Trapp et al. (2014; described earlier) found initial positive relationships between energy drink consumption and depression in a sample of young adult Australians. However, although these relationships were observed in both the total sample and in males, they were not observed in females and did not remain significant once other factors had been controlled for statistically. Interestingly, although reported consumption of ≥ 250ml/d was not associated with depression in the total sample, or in males or females separately, those who consumed ≥ 100ml/d reported higher levels of depression than those who did not consume energy drinks at all. However, this relationship was observed only in the total sample and not in either sex independently.

Evren and Evren (2015; described earlier) observed positive associations between energy drink use and depression, self-harming behaviour, and suicidal thoughts in 10th grade students from Turkey. In each case, the effects appeared to be dose dependent. Although the relationships with depression disappeared at the multivariate level, self-harming behaviour and suicidal thoughts remained associated with consuming energy drinks every day compared to not at all. Snipes et al. (2015; described earlier) reported no difference in hopelessness scores between users of alcoholic energy drinks and alcohol-only consumers, and Yudko and McNiece (2014; described earlier) observed no relationship between depression scores and having consumed an energy drink in the previous hour.

2.3.2.4 Discussion of Energy Drinks and Mental Health

Although acute mood effects associated with energy drinks appear often to be positive, chronic use tends to be associated with undesirable mental health effects. Nine studies were identified that examined stress or stress-related outcomes in relation to energy drink use. Of these, two studies investigated PTSD: one reported a significant positive association (Vilija & Romualdas, 2014), whereas the other did not (Peters et al., 2010). Three further studies did not include a direct measure of stress (Rizvi et al., 2010; Toblin et al., 2012; Waits et al., 2014), although one of them (Toblin et al., 2012) reported a positive association between energy drink consumption and sleep disruption due to stress. Of the four studies that did provide direct measurements of energy drink consumption and stress, one (Ríos et al., 2013) reported no association; the other three (Hofmeister et al., 2010; Pettit & DeBarr, 2011; Trapp et al., 2014) each reported positive relationships, as well as null findings, depending on which analyses were evaluated. For example, Hofmeister et al. (2010) presented findings from two different samples and also compared between energy drink users and non-users, as well as between regular users and non-regular users. Some of these analyses yielded statistically significant results, whereas others did not. Quantifying the overall outcome of such studies in relation to those that presented more straightforward analyses was therefore somewhat difficult. Similar issues relating to three studies (Evren & Evren, 2015; Hofmeister et al., 2010; Trapp et al., 2014) are also encountered when discussing findings relating to anxiety and depression.

Seven studies investigated energy drinks and anxiety, or anxiety-related variables. Malinauskas et al. (2007) utilised indirect measures: a positive association was observed with weekly jolt and crash episodes, but the relationship with reported heart palpitations was not significant. Of the six studies that provided direct measures, one (Yudko & McNiece, 2014) reported no significant relationships, another (Stasio et al., 2011) reported a positive relationship, three (Evren & Evren, 2015; Hofmeister et al., 2010; Trapp et al., 2014) reported both positive relationships and null findings, depending on which analyses were examined, and one (Snipes et al., 2015) reported a negative relationship. However, it should also be pointed out that this last study compared consumers of alcoholic energy drinks to alcohol-only users, whereas the other studies listed investigated associations with energy drinks in the absence of alcohol. In addition to this, it has been suggested by some (e.g. Johnson, Alford, Verster, & Stewart, 2016), that studies of alcoholic energy drink use should be conducted using within-subjects designs, in order to avoid being confounded by personality differences between consumers and non-consumers. For a review of the effects of mixing energy drinks and alcohol, see McKetin, Coen, and Kaye (2015).

Seven studies examined depression in relation to energy drink use. Snipes et al. (2015) investigated a related concept, 'hopelessness', although no association was found with alcoholic energy drink use. Of the six studies that provided direct measures, two (Arria et al., 2011; Yudko & McNiece, 2014) reported no significant relationships, one (Azagba et al., 2014) reported a positive relationship, and three (Evren & Evren, 2015; Hofmeister et al., 2010; Trapp et al., 2014) reported both positive relationships and null findings. In addition, Evren and Evren (2015) also reported positive associations between energy drink use and self-harming behaviour and suicidal thoughts.

From the studies identified that related to stress, anxiety, and depression, only one (Snipes et al., 2015) reported a negative association with energy drink use. Although null findings were also observed, a considerable number of studies reported positive relationships. This latter observation was therefore in line with the case reports identified in the area, which associated energy drink usage with a number of mental health conditions.[2]

2.3.3 Energy Drinks and Academic Attainment

Considering that mental health problems and low wellbeing are known predictors of poor academic attainment, it was considered likely that energy drink use would be associated with undesirable academic outcomes. However, energy drinks may also be used as an aid to studying. For instance, Maier, Liechti, Herzig, and Schaub (2013) found that 35.9% of a large sample (*N* = 6275) of Swiss university students had reportedly used energy drinks for the purpose of neuroenhancement. Furthermore, 29.7% claimed to have used the products for neuroenhancement purposes in the month leading up to an exam, though only 4% used them on a daily

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[2] Since the literature review presented in the current chapter was carried out, a paper of particular relevance (Marmorstein, 2016) has been published. This study utilised a sample of predominantly Hispanic and African American adolescents from low-income families (FSM = 81%) taking part in the Camden Youth Development Study (*N* = 144; *M* age = 11.9 years, *SD* = 0.8). At 16-month follow-up, the sample consisted of 134, and both cross-sectional and longitudinal analyses were reported. Frequency of energy drink consumption (over the previous four months) was examined in relation to self-reported symptoms of the following mental health outcomes: depression (Mood and Feelings Questionnaire), anxiety (Screen for Child Anxiety and Related Disorders; three subscales were used: Panic Disorder or Significant Somatic Symptoms, Generalized Anxiety Disorder, Social Anxiety Disorder), conduct disorder (modified version of the Conduct Disorder Rating Scale). ADHD symptoms were assessed via teacher report measures using the Child and Adolescent Symptom Inventory-4th edition, Revised (separate subscales were used for hyperactivity and inattention).

Cross-sectional analyses were conducted by entering each of the psychopathological variables separately (along with age, sex, and ethnicity as covariates), in order to predict frequency of energy drink usage. These analyses showed that energy drink consumption was positively associated with ADHD inattention, conduct disorder, depression, and panic disorder. A trend ($p < .1$) was also detected in which energy drink consumption was negatively associated with social anxiety. Once additionally controlling for frequency of coffee consumption, energy drink use remained significantly associated with conduct disorder and depression.

Two types of longitudinal analyses were presented. The first investigated whether initial energy drink consumption was associated with psychopathological symptoms at follow-up (whilst controlling for initial levels of psychopathology, age, sex, and race). This analysis found that initial energy drink consumption was positively associated with ADHD inattention, conduct disorder, ADHD hyperactivity, and panic disorder (although the latter two findings were only marginally significant). When also controlling for coffee consumption, each of these observations remained. However, that relating to hyperactivity became significant ($p < .05$), whereas the effect relating to conduct disorder became marginally significant ($p < .1$).

The second type of longitudinal analysis investigated whether initial levels of psychopathology could predict later energy drink consumption (whilst also controlling for initial frequency of energy drink consumption, age, sex, and race). High initial ADHD inattention symptoms predicted high consumption of energy drinks at follow-up, whereas high initial social anxiety symptoms predicted low consumption of energy drinks at follow-up (although both effects were only marginally significant). Once initial coffee consumption had also been controlled for, the effect relating to social anxiety became significant at the $p < .05$ level, whereas that relating to ADHD inattention remained marginally significant.

basis at this time and for this purpose. The products also appeared to be considered effective, with 82.1% claiming that they fulfilled their expectations. Further to this, Hofmeister et al. (2010) found that the most common reasons given by US veterinary students for using over-the-counter medication (under which definition they included energy drinks) was to help with studying and to fall asleep at night. These authors also reported higher stress and anxiety, and more sleep difficulties in those who used energy drinks compared to those who did not, and suggested that this might have affected their overall health and academic performance. Furthermore, as mentioned in the previous section, Rizvi et al. (2010) found that caffeinated drink consumption increased in pre-examination time for 38.94% of a sample of second year medical students from Pakistan, though no differentiation between beverage types was provided.

In addition to the above findings, Ianni and Lafreniere (2014) reported that being grade oriented predicted the inability to stop using energy drinks in a sample of 96 female undergraduate students from Canada. However, when grade orientation and negativism were entered together into a multiple regression model, grade orientation did not remain a significant predictor. Furthermore, this study found no associations between grade orientation and energy drink tolerance, and no associations between learning orientation and tolerance or inability to stop. No associations were made between mixing alcohol and energy drinks and either grade or learning orientation. However, the lack of significant effects in this study may reflect the relatively small sample size and absence of male participants.

2.3.3.1 Energy Drink Use and GPA

Only three papers were identified that reported direct associations between energy drink use and measures of academic attainment (details of these are provided in Table 2.3). The first of these (Pettit & DeBarr, 2011) found a significant negative association between GPA in US university students and a measure of the largest number of energy drinks consumed on any occasion during the previous 30 days. However, this study had a modest sample size (N = 136), did not control for covariates, and found no significant associations between GPA and five other measures of energy drink use (although it should be noted that each of these non-significant effects was in the expected direction). The authors explained the possible

Study	Variables of interest	Design	Sample	Effects
Azagba, Langille, and Asbridge (2014)	-Self-reported GPA -Parental education level	Cross-sectional questionnaire	8210 students (grades 7, 9, 10, and 12) attending public schools in Canada	-GPA of ≥ 80% predictive of low energy drink use -Those with post-secondary parental education less likely to be moderate energy drink users
Martz, Patrick, and Schulenberg (2015)	-GPA	Cross-sectional questionnaire (two cohorts)	6498 12th-grade students (nationally representative samples)	-Low GPA associated with alcoholic energy drink use whilst controlling for sociodemographic, academic, and social factors -Effect disappeared after controlling for additional substance use
Pettit and DeBarr (2011)	-Self-reported GPA	Cross-sectional online questionnaire	136 US undergraduate students	-GPA negatively associated with largest number of energy drinks consumed on any occasion in past 30 days -Relationships between GPA and five other energy drink measures were not significant

Table 2.3. Findings from research on energy drink use and academic attainment.

association between energy drink use and low GPA as being indicative of students' propensity to procrastinate when preparing for stressful events such as exams.

The second study (Azagba et al., 2014) found that maintaining a (self-reported) GPA of 80% or higher was associated with lower occurrences of moderate (3-8 times per year) and high (more than once per month) energy drink use in a very large (N = 8210) sample of Canadian schoolchildren. However, this study also found that students whose parents received post-secondary education had a lower likelihood of being moderate energy drink consumers, which may potentially have confounded the relationship between energy drink use and their own GPA.

The third study (Martz, Patrick, & Schulenberg, 2015) reported findings from a very large (N = 6498) nationally representative sample of 12th-grade students from the US. It was observed that those who reported alcoholic energy drink use in the previous 12 months achieved significantly lower GPA than those who did not. Although this effect remained significant after controlling for sociodemographic characteristics and other academic and social factors, it disappeared once substance use was controlled for. However, though the results of this study are of interest to the current research, they are limited in that no data were reported to determine whether GPA was related to energy drink use in the absence of alcohol.

2.3.3.2 Discussion of Energy Drinks and Academic Attainment[3]

Although a number of studies were identified that examined energy drink use in relation to school/academic variables, only three directly investigated whether their consumption was associated with attainment. Findings from these papers suggest that the variables are negatively related, though the evidence presented so far is not strong. Furthermore, all three studies were cross-sectional, covariates were rarely controlled for, and a number of null-findings were reported. The current section has identified a gap in the literature, which research presented in this thesis will aim to address.

2.4 General Discussion

This chapter has presented findings from a review of the literature relating to energy drinks, mental health, and academic attainment. The next section will discuss potential ways in which these relationships might be explained.

2.4.1 Potential Mechanisms of Action

As caffeine consumption itself has been associated with a number of psychiatric disorders (Lara, 2010), as well as low academic attainment (Gilliland & Andress, 1981; James, Kristjánsson, & Sigfúsdóttir, 2011), the findings reported in the current review uphold the idea that effects observed in relation to energy drinks may be dependent on caffeine (e.g. McLellan & Lieberman, 2012). Although the lack of evidence for causality may be in accordance with the idea that caffeine use and mental health problems are simply correlated, the vast majority of studies identified here utilised cross-sectional designs. In most cases therefore, causality or direction of effect could not be determined. One possibility is that those with low wellbeing, or mental health problems such as depression and anxiety, self-medicate (see Khantzian,

[3] Since the literature review presented in the current chapter was conducted, a fourth paper of interest regarding energy drink usage and academic attainment has been published (Champlin, Pasch, & Perry, 2016). Using a sample of 844 first year undergraduates from the US, these authors reported that energy drink consumption quantity by frequency (i.e. number of days consumed in the past month multiplied by usual quantity of drinks consumed) and number of energy drinks used on the last occasion when they were consumed were both negatively associated with self-reported GPA. These effects remained significant after controlling for weekend and weekday sleep duration, sex, race, perceived stress, perceived stress management, and daily media usage. When past month alcohol intake was also controlled for, the number of energy drinks consumed in the last session remained negatively associated with GPA, though the effect relating to consumption quantity by frequency disappeared.

1997) by using energy drinks as a short-term ‘pick me up’. This usage pattern could therefore explain how the acute mood effects are often positive, whereas the long-term associations are not. Support for this idea is provided in that students are known to use caffeine as a coping strategy during stressful situations (Ríos et al., 2013).

Another possibility is that relationships observed between energy drink consumption, mental health problems and low academic attainment are mediated by dysregulated sleep. However, determining the direction of such relationships may be difficult. Sleep debt could, for instance, cause fatigue leading to increased use of energy drinks. Conversely, as caffeine is known to interfere with sleep, sleep loss could lead to inability to stay focused while studying, and symptoms associated with mental health problems. It may also be that the relationships are bidirectional. For instance, children are known to use caffeinated products to remain awake at night when using media-related technology (Calamaro, Mason, & Ratcliffe, 2009), and students have reported using energy drinks to combat the effects of insufficient sleep (Malinauskas et al., 2007). However, it should also be noted that, although those with a morning chronotype appear to have an advantage over those with an evening chronotype when it comes to academic attainment, the effect is ameliorated once three or more servings of caffeine are consumed each day (Cole, 2015). Therefore, though caffeine might have direct and/or indirect detrimental effects on academic outcomes, in certain circumstances beneficial effects may also be observed.

2.4.2 Limitations and Directions for Future Research

A limitation of the literature review of mental health presented here is that the search criteria did not address additional phenomena such as schizophrenia, personality disorder, and suicidality. Although some of the case reports identified suggest that energy drink use may be associated with such outcomes, it was deemed beyond the scope of the current chapter to examine them in greater detail. As this review aimed instead to focus more upon stress, anxiety, and depression, these phenomena may therefore be an area of interest for future research.

The majority of studies identified were conducted in young populations, potentially reflecting their comparatively high consumption of energy drinks. However, the disproportionately large number of studies utilising university students might be due to the relative ease in which such participants can be recruited. Studies into younger populations may therefore be important because children are both targeted by energy drinks advertisers and likely to be relatively naive caffeine consumers. In addition, research into older populations may be of interest. For instance, late adolescence and early adulthood are associated with the onset of psychiatric disorders and stress related to adjustment to many life changes, and also represent populations that are likely to report energy drink use. This is also a time at which one's level of academic success can have far-reaching consequences across the life-course. For these reasons, the question should be asked as to whether the relationships observed are unique to young persons or are also found in older populations.

2.5 Conclusions

The current chapter has aimed to provide a review of the literature relating to energy drink use, mental health, and academic attainment. Because most of the studies identified relating to mental health examined stress, anxiety, and depression, particular focus was placed on these areas. Though a number of studies investigating acute effects of energy drinks on mood reported benefits, only one such observation was made in relation to chronic use. Although null findings were also relatively common, most studies of chronic use provided evidence to suggest that energy drinks are associated with mental health problems. Few studies have so far been conducted to examine associations between energy drink use and academic attainment, though those identified here suggest the relationships to be negative. However, as almost all studies identified relating to either mental health or academic attainment were cross sectional, and some did not control for other relevant factors, such as sex, SES, and additional caffeine intake, the nature of the relationships uncovered is not yet fully understood. Therefore, to improve our understanding of such phenomena, longitudinal and intervention studies that take a multivariate approach to data analysis are required.

Based on observations made in the current chapter, the rest of this thesis will aim to further investigate energy drink use in relation to mental health and academic attainment in samples of undergraduate students and secondary school children.

Additionally, due to its higher prevalence in secondary schools compared to universities, problem behaviour will be examined in relation to energy drink consumption in schoolchildren. Although some research will be cross-sectional in nature, longitudinal analyses will also be presented in order to help determine whether the relationships observed are causal or correlational in nature. The next chapter will specifically aim to investigate associations between energy drink use and GPA, work efficiency, low wellbeing, course stress, and general health in British undergraduate students.

Chapter 3: An Overview of the Diet and Behaviour Scale (DABS), and a Cross-Sectional Investigation of Academic Performance and Mental Health in University Students

3.1 Introduction

3.1.1 Overview of the Diet and Behaviour Scale

A finding from the literature review presented in the previous chapter was that studies into the effects of energy drinks on mental health have rarely considered the influence of other dietary variables. The Diet and Behaviour Scale (DABS) was therefore developed so that the current research could take into account a number of different foods and drinks that may have effects on psychological outcomes. This new measure was designed to assess both the frequency and amount of consumption of common foods and drinks, though is not intended as a replacement for FFQs used to study other domains as it does not provide information on all important food groups (e.g. dairy products are not covered). The current chapter discusses the reasons and methodology used for developing the questionnaire, and presents data from a small-scale study of university students to provide an initial investigation of its underlying factor structure and associations with GPA, work efficiency, low wellbeing, and course stress. In addition to this, the chapter aims to identify demographic and lifestyle correlates of these academic performance and mental health outcomes. The identification of such variables is important because they can subsequently be controlled for in multivariate analyses, reducing the chances of the true nature of the results being masked by confounding factors.

3.1.2 Overview of Study 1[4]

Study 1 is an analysis of cross-sectional data taken from a longitudinal questionnaire survey, for which two cross-sections of data were collected 10 weeks apart. The first cross-section (Time 1; T1) was collected as part of an introductory event at the start of the academic year, and is comprised of a cohort of first year

[4] Longitudinal analyses from this dataset will be presented in Chapter 5.

undergraduate psychology students; the second cross-section (Time 2; T2) was collected from the same group of first year students, but also included participants from the previous year's cohort, whom at this point were in their second year of study. In order to provide a preliminary investigation of the DABS, and of dietary associations with academic and mental health outcomes, the current chapter will present cross-sectional findings from T2. The reasons for choosing this time-point are as follows: 1) the sample size was larger than that of T1, 2) the sample was less homogenous, consisting of second year students as well as first year students, and 3) demographic information, as well as the outcome measure of GPA, was unavailable at T1.

3.1.3 Functional Foods and the Need for a New Measure of Dietary Intake

Studies have shown that self-administered FFQs are able to produce similar results as food diaries (Rimm et al., 1992; Willett et al., 1985). However, many FFQs are also relatively long and time consuming to implement. Even scales such as The Youth/Adolescent Food Frequency Questionnaire (Rockett et al., 1997), which contains 131 items, could be problematic when administered to participants who struggle to sustain concentration for long periods of time (e.g. schoolchildren who exhibit behavioural problems and/or symptoms of attention deficit hyperactivity disorder; ADHD).

The main focus of many FFQs is the estimation of nutrient values (e.g. Willett et al., 1985; Willett, Reynolds, Cottrell-Hoehner, Sampson, & Brown, 1987), caloric consumption, and macronutrient composition (e.g. Martin-Moreno et al., 1993). However, Hu et al. (1999, p. 243) noted that, "people do not eat isolated nutrients. Instead, they eat meals consisting of a variety of foods with complex combinations of nutrients." In addition, certain foods and drinks contain very little of nutritional value, yet are known to have far reaching effects on psychological outcomes. Chewing gum for instance, has been associated with positive mood, faster reaction times, and increased alertness (Allen & Smith, 2011; Smith, 2009a, 2010). Another important example is caffeine, which, although contributing no nutritional value in itself, has become one of the most commonly consumed dietary ingredients (Heckman, Weil, & Gonzalez de Mejia, 2010). Due to the far-reaching effects of caffeine on mood, behaviour and cognitive function (see Smith, 2002 for a review), and considering that roasted coffee beans (*Coffea Arabica* and *Coffea robusta*) and tea leaves (*Camelia siniensis*) appear to be the primary sources of the substance (Barone & Roberts, 1996), it is considered important to record tea and coffee consumption when assessing diet.

In addition to tea and coffee, energy drinks are known to deliver high doses of caffeine. As illustrated in Chapter 2, these products have been associated with an array of psychological effects. Although McLellan and Lieberman (2012) consider there to be little evidence to ascribe such effects to ingredients other than caffeine, the fact that these products have also been associated with a number of serious health complaints (see Seifert et al., 2011), suggests that their inclusion in dietary questionnaires is both relevant and necessary. It is also further considered that the consumption of such products may be viewed as an outcome, rather than as a direct cause of behaviour in itself. If utilising the approach of administering an FFQ for the purpose of calculating nutrient profiles and subsequently assessing their relationships with behaviour, such subtleties might therefore be lost entirely.

Due to the reasons discussed above, it is desirable to have a measure of consumption of foods and drinks that may lead to changes in psychological outcomes. This topic has often been studied using single frequency or quantity questions, and such an approach does not allow one to control for other aspects of diet. There have been comprehensive reviews that have examined the dietary assessment methods in school age children; for example, McPherson, Hoelscher, Alexander, Scanlon, and Serdula (2002) concluded that the heterogeneity of the designs of the studies, study populations, and instruments used makes comparisons between methods, and often within methods, difficult. Another review (Livingstone & Robson, 2000) examined the issue of misreporting and the identification of misreporters. In general, correlations between reference methods and dietary assessment tools appear to be higher for food records and recall than for FFQs. Despite the superiority of measures based on food records or recall, these methods can be problematic for several reasons. If, for example, one is using weighed food records, data collection and analysis are often time consuming, expensive, and dropout rates for studies can be relatively high. Some of these problems can be addressed by using estimated food records, but again, this is not an ideal method for large sample sizes. Food recall also has problems in that the observations may be a poor measure of general intake and might show biases towards recall of certain types of product. Multi-pass recall removes some of these problems but is memory dependent, and data entry can be labour intensive. Due to these reasons, FFQs are often used as a more economical alternative.

3.1.4 Factor Analysis of FFQs

Factor analysis is a common method used to reduce a large number of dietary items to take into account the fact that consumption of different foods and drinks are often highly correlated. Not all studies use factor analysis; some classify the items on the basis of nutritional properties (e.g. Bertoli et al., 2005; Brunner, Stallone, Juneja, Bingham, & Marmot, 2001; Emmett, 2009; Rockett et al., 1997; Watson, Collins, Sibbritt, Dibley, & Garg, 2009). The results of factor analyses have also been very variable. For example, some studies report a two-factor solution (e.g. Ambrosini et al., 2011; Hu et al., 1999); however, this often leads to inclusion of items with a low weighting on the factor and/or exclusion of certain factors. These methods of factor analysis also often explain very little of the variance (e.g. 20%; Hu et al., 1999). Other studies (e.g. Speck, Bradley, Harrell, & Belyea, 2001) have identified 10 factors, though this can lead to several only containing a small number of items.

3.1.5 Energy Drink Use in Student Samples

Few published studies have investigated energy drink use in British university students, though a number of papers exist that examine the phenomenon in student populations from other countries. The prevalence of use appears to be relatively high. Miller (2008a), for example, reported that 39% of undergraduates at a public university in the US had consumed an energy drink in the previous month, and Malinauskas et al. (2007) observed 51% from a state university in the Central Atlantic region to have consumed more than one per month. Malinauskas et al. also identified that, although the majority of students reportedly only used one energy drink at a time, using three or more was common when mixed with alcohol (49%).

Energy drink use in university students has been found to increase in higher year groups (e.g. Arria et al., 2010; Pettit & DeBarr, 2011), with Pettit and DeBarr (2011) suggesting that the effect may be due to increased stress and susceptibility to unhealthy coping methods associated with higher workloads encountered in later stages of a degree course. Furthermore, consumption is higher in male university students (e.g. Lohsoonthorn et al., 2013; Miller, 2008a; Pettit & DeBarr, 2011; Poulos & Pasch, 2016). Of particular concern is the finding that risk-taking behaviour in undergraduates has been associated with using energy drinks (e.g. Miller, 2008b), and with combining them with alcohol (Brache & Stockwell, 2011). Miller (2008a) also found energy drink use to be associated with a 'toxic jock' identity, which consists of, amongst other things, sport-related identity, masculinity, and risk-taking.

3.1.6 Energy Drinks and Breakfast Omission

The pilot study discussed in Chapter 1 (Millward, as cited in Smith, 2014) reported that children who consume energy drinks and do not regularly eat breakfast are more prone to poor behaviour in school, and that those from higher socioeconomic backgrounds who eat good diets but also consume energy drinks exhibit more behavioural problems than similar children who do not consume energy drinks. Coupling these observations with the finding of Calamaro et al. (2009), that children sometimes use caffeinated products to remain awake at night whilst using media-related technology, it may therefore be that energy drinks are used to help stay up late, leading to insufficient sleep, and that in turn this causes difficulties in waking up the next morning. Furthermore, as skipping breakfast has been associated with other poor dietary behaviours, such as greater consumption of candies/chocolates, sweetened carbonated drinks, and deep-fried foods (So et al., 2011), it may be that waking up late leads to breakfast being skipped, and further energy drinks being consumed in order to help increase alertness. A survey reported in the mainstream media (Richardson, 2013) has worryingly claimed that approximately 5% of teenagers consume energy drinks as a substitute for breakfast. The article also provides support for Millward's claims, suggesting that such dietary habits may lead to subsequent hyperactivity and classroom disruption. Although the current chapter aims to examine energy drink use in a different population (i.e. university students), it is still considered important to investigate the effects of breakfast omission in conjunction with energy drink use here.

If energy drinks are consumed as a compensation for missing breakfast, then the behavioural effects of breakfast itself should be given some consideration. Eating breakfast has been associated with a number of acute benefits such as improved mood, calmness, short-term recognition, spatial memory, free recall, and auditory attention (Mahoney, Taylor, Kanarek, & Samuel, 2005; Smith, Clark, & Gallagher, 1999; Smith, Kendrick, & Maben, 1992; Smith, Kendrick, Maben, & Salmon, 1994). Furthermore, the benefits appear to extend beyond the short-term, with those who consume breakfast on a daily basis being found to be less depressed, less emotionally distressed, and to have lower levels of perceived stress than those who do not eat breakfast each day (Smith, 1998; for a review of the area, see Hoyland, Dye, & Lawton, 2009). Breakfast intervention programmes have also been demonstrated to improve academic performance (Rampersaud, Pereira, Girard, Adams, & Metzl, 2005), school attendance (Huang, Lee, & Shanklin, 2006; Powell, Walker, Chang, & Grantham-McGregor, 1998), and psychosocial functioning (Murphy et al., 1998).

3.1.7 Aims of Chapter 3

The current chapter presents data from a cross-sectional study of university students to fulfil four basic aims: 1) to introduce and examine the Diet and Behaviour Scale (DABS), a 29-item questionnaire used to record the frequency and amount of consumption of common foods and drinks, 2) to explore its underlying factor structure, 3) to identify demographic and lifestyle correlates of diet, GPA, work efficiency, low wellbeing, course stress, and general health, and 4) to preliminarily investigate dietary associations with academic and mental health outcomes. Due to observations made from the literature, four dietary variables will be given particular attention; these are: 1) total weekly caffeine intake (i.e. the sum of that obtained from energy drinks, cola, coffee, and tea), 2) the consumption of caffeine in combination with alcohol, 3) breakfast and energy drink consumption (both in isolation and in combination), and 4) energy drink consumption in combination with other dietary variables for which their usage is found to correlate.

3.2 Method

3.2.1 Participants

Two hundred and seventy-seven psychology undergraduate students took part in the current study, 268 of which completed the questionnaires. At this time-point, 142 (53%) were first year students and 126 (47%) were second year students. The sample consisted of 92.5% females, and an age range of 18-45 (M = 19.9, SD = 2.15) was observed. The majority of participants (78.7%) had attended state schools, relatively few (21.3%) had attended private/paid schools, and almost all (97.4%) were completing their first university degree at the time of data collection.

3.2.2 Apparatus/Materials

The Diet and Behaviour Scale (DABS) is a 29-item questionnaire developed for the purpose of assessing intake of common dietary variables with an onus on functional foods, and foods and drinks of current concern. The individual questions were selected to cover areas of eating and drinking for which there has been interest in possible effects on behaviour. Many of the items included in the scale had previously been used by other researchers to assess the behavioural effects of coffee, tea, caffeinated soft drinks, breakfast, chewing gum, fruit and vegetables, and junk food. Individual questions were also present in other FFQs, and have been compared with food recall or records. The advantage of the present approach over the use of single-items is that consumption of other foods and drinks can be statistically controlled for during analysis. The advantage over other FFQs is the length, as well as its relevance to foods and drinks with little or no nutritional value.

The first section of the DABS focuses on how frequently the respondent typically consumes foods and drinks. Frequency of consumption of 18 dietary variables is measured on a five-point scale (1 = never, 2 = once a month, 3 = once or twice a week, 4 = most days [3-6], 5 = every day). The second section of the DABS investigates the typical amounts consumed for 11 common foods and drinks. Eight of these items (energy drinks, cola, coffee, tea, crisps, chocolate, burgers/hot dogs, and chewing gum) require participants to state how much/many they typically consume per week, whereas three items (pieces of fruit, portions of vegetables, and water) require participants to state how much/many they typically consume per day. In addition to this, although not formerly a part of the DABS, an item was included to ask participants to list the brand names of the energy drinks that they consume. Because caffeine content is known to vary considerably between such products (Reissig, et al., 2009), this question was included to improve accuracy when estimating weekly caffeine consumption.

To measure certain aspects of mental health, 26 single-items from the Wellbeing Process Questionnaire (WPQ; Williams, 2014) were administered. These items were scored from 1 (least) to 10 (most). Single-item measures were chosen as they have been shown to be valid and reliable, allowing for the identification of overall risk whilst reducing the time costs associated with administering multi-item measures (see Williams, 2015; Williams & Smith, 2012). The items themselves (or those upon which they are based) have previously been validated against full measures, demonstrated to correlate well, and appear to be as sensitive as the full-length measures to which they were compared (Williams & Smith, 2012, 2013). In addition to wellbeing, single-item measures were also used to record students' work efficiency, course stress, and general health (all measured from 1 [low] to 10 [high]).

A number of questions were included to control for potentially confounding effects. Participants were asked to report whether or not they smoked, and to indicate their age, sex, height and weight, current year of education, the type of secondary school they attended (state or private/paid), whether they were currently completing their first or second university degree, their household income, and the subjects they studied for A-levels, along with the grades achieved.

As well as demography, a number of items were used to record certain aspects of lifestyle. Two items addressed the consumption of alcohol: participants were asked to state how many days per week they would typically drink (1 = 'never', 2 = '1 day', 3 = '2-3 days', 4 = '4-5 days', 5 = '6-7 days'), and to give an indication of how many units of alcohol they would consume during an average week. In addition, they were also asked to report whether or not they ever mixed alcohol with caffeine.

Twelve items were used to gauge the frequency, duration, and type of exercise in which they typically participated. Frequency of exercise was recorded as number of days per week, and amount of exercise was recorded in hours per week, with each measure being employed for the following types of activity: overall exercise, cardio, strength training, low intensity, medium intensity, and high intensity. Participants were also asked how many hours they typically spent asleep each night (1 = '5 hours or less', 2 = '6 hours', 3 = '7 hours', 4 = '8 hours', 5 = '9 hours or more'), and to report how often they achieved good quality sleep (1 = 'never', 2 = 'sometimes', 3 = 'often', 4 = 'always').

3.2.3 Design & Procedure

Data were collected using an online survey hosted by Qualtrics, as part of a larger project investigating wellbeing in undergraduate students (see Williams, 2014); participants received course credits as an incentive to participate. GPA was subsequently retrieved through Cardiff University's School Information Management System (SIMS), and was merged into the dataset by the School of Psychology. In order to protect participants' anonymity, the identifying variable was deleted before the dataset was returned to the researchers.

3.2.4 Statistical Analysis

Descriptive statistics are initially provided for the variables of interest. Factor analysis was used to reduce data for both the DABS and the WPQ. Subscales were then created for each of the factors extracted from the DABS, and their internal consistency was tested using standardised Cronbach's alpha. In order to identify covariates of diet, GPA, work efficiency, low wellbeing, course stress, and general health, relationships were examined using Pearson's correlations.

Analyses are presented which examine associations between dietary variables of interest and the mental health and academic outcomes. In each case, initial univariate effects were investigated using between-subjects t-tests and one-way between-subjects analysis of variance (ANOVA) when predictor variables were categorical (i.e. for breakfast frequency, energy drinks frequency, the combined effects of breakfast and energy drinks, and the co-consumption of caffeine and alcohol), and Pearson's correlations when variables were continuous (i.e. for total weekly caffeine intake, and for the DABS factor scores). Multivariate effects were then investigated using analysis of covariance (ANCOVA) when predictor variables were categorical, and multiple linear regressions when predictor variables were continuous. For all covariates entered into the multivariate analyses presented in this chapter, see Table 3.1.

GPA	Work efficiency	Low wellbeing	Course stress	General health
Covariates specific to each outcome variable that are included in all multivariate analyses presented in Chapter 3				
Smoker (dichotomous; yes or no)	Smoker (dichotomous; yes or no)	Smoker (dichotomous; yes or no)	Year of course (dichotomous; 1 or 2)	Smoker (dichotomous; yes or no)
Year of course (dichotomous; 1 or 2)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)
Age (continuous)	Social support (continuous; factor score)	Social support (continuous; factor score)	Negative coping (continuous; factor score)	Social support (continuous; factor score)
Student stressors (continuous; factor score)	Negative coping (continuous; factor score)	Negative coping (continuous; factor score)	Positive personality (continuous; factor score)	Negative coping (continuous; factor score)
Social support (continuous; factor score)	Positive personality (continuous; factor score)	Positive personality (continuous; factor score)	Sleep (continuous; factor score)	Positive personality (continuous; factor score)
Sleep (continuous; factor score)	Sleep (continuous; factor score)	Sleep (continuous; factor score)	Alcohol (continuous; factor score)	Sleep (continuous; factor score)
Mean A-level grade (continuous)	Alcohol (continuous; factor score)	Exercise (continuous; factor score)	Exercise (continuous; factor score)	Exercise (continuous; factor score)
BMI (continuous)	BMI (continuous)	Mean A-level grade (continuous)		
		BMI (continuous)		
Additional covariates entered when the predictor variable is total weekly caffeine intake				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Additional covariates entered when the predictor variable is frequency of breakfast consumption or co-consumption of caffeine and alcohol				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)
Additional covariates entered when the predictor variable is frequency of energy drink consumption or the combined effects of breakfast and energy drinks				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)
Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)
Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)

Table 3.1. List of covariates included in all multivariate analyses presented in Chapter 3.

Note. Covariates specific to each outcome variable were determined by correlational analyses presented in section 3.3.4.2.

3.3 Results

3.3.1 Demographic and Lifestyle Variance

In general the sample engaged in healthy lifestyles, with few claiming to smoke, and frequent exercise and high sleep hours being common. Alcohol intake however was relatively high, though this may be expected in undergraduate samples from the UK. The mean amount consumed per week was below the recommended upper limit (21 units for men, 14 units for women), but considering the large variance, and the fact that the majority of participants were female, alcohol intake is considered to have been relatively high. It was also concerning to find that nearly half of all participants reported that they consumed alcohol in combination with caffeine. For descriptive statistics and frequencies for lifestyle variables at T2, see Table 3.2.

In order to reduce data, the items used to measure exercise, sleep, and alcohol consumption were each factor analysed to provide single-factor solutions. For the exercise factor, however, the items measuring frequency and amount of low intensity exercise were excluded from the analysis because, on initial inspection, they were found to have very low factor loading scores (.16 and .232, respectively). For the factor loadings, initial eigenvalues, and percentages of variance explained by the exercise, alcohol, and sleep factors, see Table 3.3.

3.3.2 Dietary Intake and Factor Analysis of the DABS

3.3.2.1 Descriptive Statistics and Factor Analysis

Considerable variance in response to the DABS was observed (for frequency and descriptive statistics, see Table 3.4). To reduce data, and because the frequency and amount of consumption of many foods and drinks are known to be inter-correlated (Northstone et al., 2005), all 29 items were entered into an exploratory factor analysis. Varimax (orthogonal) rotation was used, and the number of factors extracted was determined by examining the scree plot. A four-factor solution emerged that explained 36.96% of variance, and the factors were labelled 'Junk Food', 'Healthy Foods', 'Energy Drinks & Coffee', and 'Tea'. For factor loading scores, initial eigenvalues, and percentages of variance explained, see Table 3.5.

		0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days	*M* (hours)	*SD*
Weekly exercise	Overall exercise	21 (8.1%)	14 (5.4%)	26 (10%)	49 (18.8%)	34 (13.1%)	54 (20.8%)	22 (8.5%)	40 (15.4%)	5.5	4.6
	Cardio	69 (26.7%)	51 (19.8%)	41 (15.9%)	43 (16.7%)	30 (11.6%)	14 (5.4%)	7 (2.7%)	3 (1.2%)	2.18	2.13
	Strength	135 (52.1%)	44 (17%)	24 (9.3%)	24 (9.3%)	15 (5.8%)	9 (3.5%)	2 (.8%)	6 (2.3%)	1.01	1.74
	Low intensity	43 (16.6%)	26 (10%)	14 (5.4%)	12 (4.6%)	13 (5%)	51 (19.7%)	19 (7.3%)	81 (31.3%)	3.87	3.6
	Medium intensity	157 (60.4%)	49 (18.8%)	20 (7.7%)	17 (6.5%)	8 (3.1%)	6 (2.3%)	0 (0%)	3 (1.2%)	.81	1.54
	High intensity	149 (57.5%)	34 (13.1%)	25 (9.7%)	20 (7.7%)	15 (5.8%)	7 (2.7%)	7 (2.7%)	2 (.8%)	1.21	2.23
		Never	**1 day**	**2-3 days**	**4-5 days**	**6-7 days**	***M* (units)**	***SD***			
Weekly alcohol	Days in week	36 (13.6%)	104 (39.4%)	120 (45.5%)	3 (1.1%)	1 (.4%)	9.07	8.71			
		5 hours or less	**6 hours**	**7 hours**	**8 hours**	**9+ hours**					
Sleep	Hours per night	14 (5.2%)	32 (11.9%)	100 (37.3%)	106 (39.6%)	16 (6%)					
		Never	**Sometimes**	**Often**	**Always**						
	Good quality sleep	10 (3.7%)	116 (43.4%)	128 (47.9%)	13 (4.9%)						
		Yes	**No**								
Smoking	Smoker	29 (10.9%)	238 (89.1%)								
		Yes	**No**								
Mix alcohol	With caffeine	123 (46.9%)	139 (53.1%)								

Table 3.2. Frequency data for lifestyle variables from Study 1.

	Factor loading	Initial eigenvalue	Cumulative % variance
Exercise			
Overall exercise frequency	.476	4.512	45.12%
Overall exercise amount	.707		
Cardio frequency	.797		
Cardio amount	.766		
Strength training frequency	.673		
Strength training amount	.683		
Medium intensity frequency	.467		
Medium intensity amount	.424		
High intensity frequency	.803		
High intensity amount	.776		
Sleep			
Sleep hours	.853	1.455	72.74%
Sleep quality	.853		
Alcohol			
Frequency per week	.897	1.61	80.49%
Units per week	.897		

Table 3.3. Factor loading scores, initial eigenvalues, and percentages of variance explained by the exercise, sleep, and alcohol factors from Study 1.

Frequency	***N***	**Never**	**Once a month**	**Once/twice a week**	**Most days (3-6)**	**Every day**
Breakfast	268	16 (6%)	12 (4.5%)	37 (13.8%)	79 (29.5%)	**124 (46.3%)**
Chocolate	267	6 (2.2%)	36 (13.5%)	**124 (46.4%)**	70 (26.2%)	31 (11.6%)
Crisps	268	25 (9.3%)	**96 (35.8%)**	94 (35.1%)	39 (14.6%)	14 (5.2%)
5+ fruit or veg	268	13 (4.9%)	30 (11.2%)	98 (36.6%)	**105 (39.2%)**	22 (8.2%)
Coffee	268	**123 (45.9%)**	39 (14.6%)	34 (12.7%)	30 (11.2%)	42 (15.7%)
Tea	268	61 (22.8%)	11 (4.1%)	35 (13.1%)	52 (19.4%)	**109 (40.7%)**
Cola	268	38 (14.2%)	82 (30.6%)	**97 (36.2%)**	36 (13.4%)	15 (5.6%)
Energy drinks	268	**158 (59%)**	81 (30.2%)	26 (9.7%)	3 (1.1%)	0 (0%)
Gum	268	61 (22.8%)	**82 (30.6%)**	63 (23.5%)	44 (16.4%)	18 (6.7%)
Sweets	268	28 (10.4%)	**107 (39.9%)**	**107 (39.9%)**	21 (7.8%)	5 (1.9%)
Fast-food	265	20 (7.5%)	**162 (61.1%)**	79 (29.8%)	4 (1.5%)	0 (0%)
Take-away	268	51 (19%)	**187 (69.8%)**	29 (10.8%)	1 (.4%)	0 (0%)
Pies or pasties	267	113 (42.3%)	**125 (46.8%)**	22 (8.2%)	7 (2.6%)	0 (0%)
Processed meat	268	**150 (56%)**	64 (23.9%)	38 (14.2%)	14 (5.2%)	2 (.7%)
Fried fish	265	101 (38.1%)	**122 (46%)**	38 (14.3%)	4 (1.5%)	0 (0%)
Oily fish	266	73 (27.4%)	80 (30.1%)	**81 (30.5%)**	31 (11.7%)	1 (.4%)
Chips	267	31 (11.6%)	**125 (46.8%)**	92 (34.5%)	19 (7.1%)	0 (0%)
Beans or peas	268	19 (7.1%)	35 (13.1%)	**117 (43.7%)**	91 (34%)	6 (2.2%)

Amount	***N***	**Min**	**Max**	***M***	***SD***
Energy drinks	267	0	4	.26	.65
Cola	267	0	18	1.62	2.73
Coffee	267	0	30	2.71	4.68
Tea	268	0	42	8.03	8.53
Crisps	267	0	14	1.76	2.21
Chocolate	267	0	20	2.55	2.35
Burgers/hot dogs	266	0	2	.38	.56
Gum	267	0	6	.69	.92
Fruit	268	0	10	2.04	1.31
Veg	268	0	10	2.28	1.23
Water	266	0	10	2.76	1.66

Table 3.4. Frequencies and descriptive statistics for all DABS items from Study 1.
Note. Modal values for frequency items are displayed in bold. All amount of consumption items were measured per week other than fruit, vegetables, and water, which were measured per day.

	Junk Food	Healthy Foods	Energy Drinks & Coffee	Tea
Q1. How often did you eat breakfast?	.078	.191	-.274	.187
Q2. How often did you eat chocolate?	**.496**	-.09	-.277	-.175
Q3. How often did you eat crisps?	**.677**	.105	-.103	-.129
Q4. How often did you eat five pieces of fruit or veg?	-.234	**.753**	.084	.047
Q5. How often did you drink coffee?	-.095	.169	**.669**	.273
Q6. How often did you drink tea?	-.007	-.033	.05	**.844**
Q7. How often did you drink cola?	.446	-.307	.386	-.314
Q8. How often did you drink energy drinks?	.213	.02	**.625**	-.169
Q9. How often did you chew gum?	.215	.03	.214	.095
Q10. How often did you eat sweets?	.388	-.158	.141	.158
Q11. How often did you eat fast-food?	**.626**	-.125	.005	.024
Q12. How often did you eat takeaway?	**.461**	.121	.114	.129
Q13. How often did you eat pies or pasties?	.409	.024	.058	.284
Q14. How often did you eat processed meat?	.373	-.187	.034	.042
Q15. How often did you eat fried fish?	.389	.256	.022	.044
Q16. How often did you eat oily fish?	.1	.382	.109	.112
Q17. How often did you eat chips?	**.514**	-.091	-.139	-.231
Q18. How often did you eat beans or peas?	.094	.429	-.101	-.119
Q19. Cans of energy drink per week	.029	.0	**.545**	-.161
Q20. Cans of cola per week	.341	-.344	.28	-.409
Q21. Cups of coffee per week	-.127	.105	**.692**	.129
Q22. Cups of tea per week	-.014	-.087	-.085	**.776**
Q23. Packets of crisps per week	**.652**	.066	.03	-.099
Q24. Bars of chocolate per week	**.562**	-.142	-.181	-.217
Q25. Burgers/hot dogs per week	**.544**	-.026	.079	-.012
Q26. Packs of chewing gum per week	.33	.063	.244	.017
Q27. Pieces of fruit per day	-.036	**.609**	.116	-.046
Q28. Portions of vegetables per day	-.077	**.694**	.194	-.032
Q29. Pints of water per day	-.056	**.457**	-.113	.029
Initial eigenvalue	4.222	2.563	2.039	1.894
Percentage of variance explained	13.28%	8.52%	7.96%	7.2%

Table 3.5. Exploratory factor analysis of DABS items from Study 1.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .45 are displayed in bold.

3.3.2.2 DABS Subscales

It is proposed that the DABS should be analysed using the extracted factor scores where possible. However, if investigating the effects of dietary change over time, this method is not appropriate, as, no matter how much the factor structures may resemble each other at different time-points, they cannot be considered to be exactly the same thing. Therefore, to analyse data in such a manner, dietary subscale scores for the four factors were calculated. It should be noted here that the use of DABS subscales when conducting change score analyses is a necessity; factor scores should be used instead whenever else possible as they take into account additional variance from the items that do not load strongly onto any one factor. However, in analyses where additional dietary predictor variables are used (e.g. caffeine, breakfast, energy drinks), the DABS subscale scores may be utilised in order to control for diet whilst avoiding the unnecessary inclusion of shared variance.

The DABS subscales are comprised of the individual items that load strongly onto each factor. In order to calculate the scores, the questionnaire data needed to be recoded so that the scoring systems were universal for the items that measured frequency of consumption as well as for those that measured amount of consumption. To do this, scores for all items were recoded into tertiles. However, in order to create three relatively equal sized groups, items 8, 10, 14, and 19 were recoded manually. In the current study, the cut-off point for an item to be considered part of a factor's subscale was set at a factor score of > .45.According to generally accepted criteria (Kline, 1999), standardised Cronbach's alpha values for each subscale were acceptable or better, and as follows: Junk Food (Q2, Q3, Q11, Q12, Q17, Q23, Q24, Q25), $\alpha = .721$; Healthy Foods (Q4, Q27, Q28, Q29), $\alpha = .631$; Energy Drinks & Coffee (Q5, Q8, Q19, Q21), $\alpha = .676$; Tea (Q6, Q22), $\alpha = .932$. In addition, each subscale was found to correlate strongly with its respective factor score: Junk food, $r(249) = .858$, $p < .001$; Healthy Foods, $r(249) = .84$, $p < .001$; Energy Drinks & Coffee, $r(249) = .83$, $p < .001$; Tea, $r(249) = .838$, $p < .001$.

3.3.3 Factor Analysis of the WPQ

Descriptive statistics for the 26 selected items from the WPQ are shown in Table 3.6. To reduce data, factor analyses were performed to derive variables labelled 'student stressors', 'social support', 'negative coping', 'positive personality', and 'low wellbeing'. These factors were determined based on how Williams (2014) grouped together the single-items included in the WPQ. However, some additions were made to two of the factors reported here: extraversion and emotional stability were added to the positive personality factor, and physical fatigue and mental fatigue were added to low wellbeing. For factor loading scores, initial eigenvalues, and percentages of variance explained by each of these factors, see Table 3.7.

WPQ single-item	Scoring system	*N*	Min	Max	*M*	*SD*
Challenges to development	1 = not at all part of my life; 10 = very much part of my life	266	1	10	7.17	2.14
Time pressures	1 = not at all part of my life; 10 = very much part of my life	266	2	10	7.66	1.93
Academic dissatisfaction	1 = not at all part of my life; 10 = very much part of my life	265	1	10	4.77	2.54
Romantic problems	1 = not at all part of my life; 10 = very much part of my life	266	1	10	4.89	2.84
Societal annoyances	1 = not at all part of my life; 10 = very much part of my life	266	1	10	4.14	2.47
Social mistreatment	1 = not at all part of my life; 10 = very much part of my life	265	1	10	3.88	2.59
Friendship problems	1 = not at all part of my life; 10 = very much part of my life	266	1	10	4.1	2.52
Tangible support	1 = strongly disagree; 10 = strongly agree	266	1	10	8.82	2.13
Belonging support	1 = strongly disagree; 10 = strongly agree	266	1	10	8.76	1.79
Emotional support	1 = strongly disagree; 10 = strongly agree	266	1	10	8.73	1.96
Depression	1 = not at all depressed; 10 = extremely depressed	265	1	9	3.99	2.28
Positive mood	1 = disagree strongly; 10 = agree strongly	265	1	10	6.26	2.05
Optimism	1 = disagree strongly; 10 = agree strongly	264	1	10	6.22	2.11
Self efficacy	1 = disagree strongly; 10 = agree strongly	264	2	10	6.55	1.78
Self esteem	1 = disagree strongly; 10 = agree strongly	263	1	10	5.88	2.22
Negative mood	1 = disagree strongly; 10 = agree strongly	262	1	10	4.15	2.28
Coping self blame	1 = disagree strongly; 10 = agree strongly	264	1	10	5.54	2.14
Coping wishful thinking	1 = disagree strongly; 10 = agree strongly	263	1	10	6.46	2.18
Coping avoidance	1 = disagree strongly; 10 = agree strongly	264	1	9	4.65	2.25
Extraversion	1 = disagree strongly; 10 = agree strongly	264	1	10	6.29	2.26
Emotional stability	1 = disagree strongly; 10 = agree strongly	264	1	10	7.05	1.81
Life satisfaction	1 = disagree strongly; 10 = agree strongly	263	1	10	6.75	1.96
Anxiety	1 = not at all anxious; 10 = extremely anxious	264	1	10	5.55	2.32
Life stress	1 = not at all stressful; 10 = very stressful	265	2	10	5.84	1.69
Physical fatigue	1 = not at all; 10 = very often	264	2	10	6.17	2.12
Mental fatigue	1 = not at all; 10 = very often	265	2	10	6.52	1.98

Table 3.6. Descriptive statistics for single-item measures from the WPQ from Study 1.

	Factor loading	Initial eigenvalue	Cumulative % variance
Student stressors			
Challenges to development	.509	2.716	38.8%
Time pressures	.497		
Academic dissatisfaction	.612		
Romantic problems	.464		
Societal annoyances	.707		
Social mistreatment	.757		
Friendship problems	.739		
Social support			
Tangible support	.785	2.154	71.8%
Belonging support	.889		
Emotional support	.865		
Negative coping			
Self blame	.678	1.612	53.73%
Wishful thinking	.759		
Avoidance	.76		
Positive personality			
Optimism	.867	3.166	63.31%
Self efficacy	.802		
Self esteem	.852		
Extraversion	.702		
Emotional stability	.744		
Low wellbeing			
Depression	.866	4.764	59.55%
Positive mood	-.829		
Negative mood	.871		
Life satisfaction	-.745		
Anxiety	.767		
Life stress	.64		
Physical fatigue	.654		
Mental fatigue	.766		

Table 3.7. Factor loading scores, initial eigenvalues, and percentages of variance explained for factors derived from the WPQ in Study 1.

3.3.4 Correlates of the DABS Factors and Outcome Variables

3.3.4.1 Correlates of the DABS Factors

Relationships between the DABS factor scores and control variables were investigated using between-subjects t-tests and Pearson's correlations. The significant and marginally significant relationships observed are discussed below. For outcomes of all t-tests and correlations, see Table 3.8.

	Junk Food		Healthy Foods		Energy Drinks & Coffee		Tea	
Differences	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Sex	2.534	.021	1.466	.144	2.03	.043	.102	.918
Smoker	.15	.881	.647	.518	4.106	< .001	.082	.935
Secondary school	-.576	.565	1.691	.092	-.178	.859	1.757	.082
Current year	.726	.468	.357	.721	1.179	.24	-1.059	.291
Correlations	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	-.072	.258	.056	.384	.163	.01	.107	.093
Household income	-.033	.682	.09	.26	.016	.841	-.039	.63
Student stressors	.059	.353	-.061	.341	.056	.383	.036	.568
Social support	-.122	.054	.032	.611	-.081	.2	-.013	.844
Negative coping	-.009	.894	-.084	.191	.056	.385	.083	.192
Positive personality	.042	.514	.132	.039	-.091	.158	.055	.395
Sleep factor	.075	.235	.077	.224	-.262	< .001	-.066	.299
Alcohol factor	.263	< .001	.234	< .001	.228	< .001	-.006	.921
Exercise factor	-.099	.14	.367	< .001	.037	.584	.024	.725
Mean A-level grade	-.087	.194	.021	.758	-.031	.644	.014	.829
BMI	-.036	.576	-.138	.032	.247	< .001	-.03	.648

Table 3.8. Relationships between DABS factors and control variables from Study 1.
Note. All correlations are Pearson's (two-tailed).

3.3.4.1.1 Junk Food

Males had higher scores than females for Junk Food consumption. In addition to this, Junk Food scores were found to correlate positively with alcohol factor scores, and negatively with social support, though the latter effect was only marginally significant.

3.3.4.1.2 Healthy Foods

Healthy Foods factor scores were marginally higher in those who attended private/paid schools compared to those who attended state schools. This dietary factor also correlated negatively with BMI, and positively with positive personality, alcohol, and exercise.

3.3.4.1.3 Energy Drinks & Coffee

Males and smokers had higher Energy Drinks & Coffee factor scores compared to females and non-smokers, respectively. In addition, this factor was found to correlate positively with age, alcohol, and BMI, and negatively with sleep.

3.3.4.1.4 Tea

Higher consumption of Tea was observed in those who had attended private/paid schools compared to those who had attended state schools, and Tea factor scores also correlated positively with age. Both effects were marginally significant.

3.3.4.2 Correlates of the Outcome Variables

Between-subjects t-tests and Pearson's correlations were conducted in order to examine relationships between the outcome variables and control variables. For *t*, *r*, and *p* values, see Table 3.9.

	GPA		**Work efficiency**		**Low wellbeing**		**Course stress**		**General health**	
Differences	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Sex	-.421	.674	-.081	.935	-1.464	.156	-1.516	.131	.119	.906
Smoker	-2.329	.021	-2.363	.019	3.78	< .001	1.17	.243	-2.913	.004
Secondary school	.514	.608	.641	.522	.567	.571	1.325	.186	.331	.741
Current year	3.684	< .001	.381	.703	.293	.77	-3.904	< .001	-.996	.32
Correlations	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	-.177	.004	-.081	.193	-.042	.504	.066	.285	.066	.288
Household income	.023	.77	.012	.882	.02	.803	.045	.563	.027	.733
Student stressors	-.159	.01	-.177	.004	.517	< .001	.403	< .001	-.285	< .001
Social support	.109	.077	.155	.011	-.282	< .001	-.048	.437	.152	.013
Negative coping	-.099	.111	-.279	< .001	.525	< .001	.208	.001	-.267	< .001
Positive personality	.043	.495	.263	< .001	-.782	< .001	-.278	< .001	.324	< .001
Sleep factor	.105	.086	.128	.037	-.448	< .001	-.221	< .001	.342	< .001
Alcohol factor	-.048	.442	-.225	< .001	-.059	.349	-.17	.006	-.009	.881
Exercise factor	-.028	.665	.098	.132	-.145	.027	-.136	.035	.158	.014
Mean A-level grade	.293	< .001	-.04	.533	.144	.028	.029	.652	-.021	.747
BMI	-.163	.009	-.188	.003	.19	.003	.021	.744	-.03	.639

Table 3.9. Relationships between outcome variables and control variables from Study 1.
Note. All correlations are Pearson's (two-tailed).

3.3.4.2.1 GPA

Smokers and second year students had lower GPA than non-smokers and first year students, respectively. GPA also correlated negatively with age, student stressors, and BMI, and positively with mean A-level grade, social support, and sleep, though the latter two effects were only marginally significant.

3.3.4.2.2 Work Efficiency

Smokers reported lower work efficiency compared to non-smokers. Work efficiency was also found to correlate positively with social support, positive personality, and sleep. In addition, negative correlations were observed with student stressors, negative coping, alcohol consumption, and BMI.

3.3.4.2.3 Low Wellbeing

Smokers had higher low wellbeing scores compared to non-smokers. Low wellbeing also correlated negatively with social support, positive personality, sleep and exercise; positive correlations were observed between low wellbeing and student stressors, negative coping, mean A-level grade, and BMI.

3.3.4.2.4 Course Stress

Second year students reported higher course stress than did first year students. Course stress was also found to correlate negatively with positive personality, sleep, alcohol, and exercise. Positive correlations were observed with student stressors and negative coping.

3.3.4.2.5 General Health

General health was lower in smokers than in non-smokers. In addition, general health correlated negatively with student stressors and negative coping, and positively with social support, positive personality, sleep, and exercise.

3.3.5 Weekly Caffeine Intake

3.3.5.1 Calculation of Weekly Caffeine Intake

The DABS items that record the weekly number of cans of cola and energy drinks and cups of tea and coffee were used to calculate estimates of caffeine intake (retrospective self-reporting of caffeine having been demonstrated to be reliable by James, Bruce, Lader, & Scott, 1989). Values of 133mg per can of energy drink, 25mg per can of cola, 80mg per cup of coffee, and 40mg per cup of tea were used. The values for cola, coffee, and tea were based on updated versions of those reported by

Brice and Smith (2002), which were themselves based on values provided by Barone and Roberts (1996) and Scott, Chakrabotry, and Marks (1989). The value used for energy drinks was the mean caffeine content of the three brands most commonly reported by the current sample (which together accounted for 77.5% of cases). A composite variable was then created for total weekly intake by adding together the individual values for energy drinks, cola, coffee, and tea. Caffeine consumed from energy drinks (M = 34.87mg/w, SD = 86.93) and cola (M = 40.54mg/w, SD = 68.19) was considerably lower than caffeine consumed from coffee (M = 216.93mg/w, SD = 374.04) and tea (M = 321.19mg/w, SD = 341.33). Total mean caffeine intake was 615.75mg/w (SD = 511.35).

3.3.5.2 Associations Between Total Weekly Caffeine Intake and Academic and Mental Health Outcomes

Pearson's correlations determined that total weekly caffeine intake was not associated with work efficiency, $r(263) = -.086$, $p = .161$, low wellbeing, $r(253) = .094$, $p = .135$, course stress, $r(263) = .04$, $p = .515$, or general health, $r(263) = -.024$, $p = .697$. However, a marginally significant negatively correlation was observed with GPA, $r(262) = -.113$, $p = .068$. To investigate the effects at the multivariate level, multiple linear regression analyses were conducted in which covariates were controlled for statistically. Although the model fit was significant for each outcome variable (GPA, $F[11, 201] = 4.767$, $p < .001$, $R^2_{\text{Adjusted}} = .163$; work efficiency, $F[11, 216] = 4.896$, $p < .001$, $R^2_{\text{Adjusted}} = .159$; low wellbeing, $F[12, 171] = 38.389$, $p < .001$, $R^2_{\text{Adjusted}} = .71$; course stress, $F[10, 201] = 6.126$, $p < .001$, $R^2_{\text{Adjusted}} = .195$; general health, $F[10, 205] = 4.932$, $p < .001$, $R^2_{\text{Adjusted}} = .155$), total weekly caffeine intake was not a significant predictor, of GPA, $\beta_{\text{Standardised}} = -.061$, $p = .367$, work efficiency, $\beta_{\text{Standardised}} = -.013$, $p = .832$, low wellbeing, $\beta_{\text{Standardised}} = .032$, $p = .451$, course stress, $\beta_{\text{Standardised}} = .014$, $p = .832$, or general health, $\beta_{\text{Standardised}} = .022$, $p = .734$.

3.3.6 Associations Between the Co-Consumption of Caffeine and Alcohol and Academic and Mental Health Outcomes

Between-subjects t-tests were conducted to determine whether GPA, work efficiency, low wellbeing, course stress, and general health differed between those who reportedly consumed alcohol with caffeine and those who did not. No differences were observed for GPA, $t(259) = -.302$, $p = .763$, low wellbeing, $t(252) = 1.301$, $p = .195$, or course stress, $t(260) = -.761$, $p = .447$. However, the group that consumed caffeine with alcohol was found to report significantly lower work efficiency, $t(260) = -4.237$, $p < .001$, and general health, $t(260) = -2.066$, $p = .04$. Multivariate analyses using ANCOVA revealed that the association with work efficiency remained significant, $F(1, 213) = 6.184$, $p = .014$, though that relating to general health did not, $F(1, 201) = 2.319$, $p = .129$. As with the univariate analyses, no effects were observed regarding GPA, $F(1, 198) = .399$, $p = .529$, low wellbeing, $F(1, 168) = .102$, $p = .75$, or course stress, $F(1, 198) = .101$, $p = .751$.

3.3.7 Associations Between DABS Factors and Academic and Mental Health Outcomes

Pearson's correlations determined that work efficiency was negatively correlated with Junk Food factor scores, and positively correlated with Healthy Foods factor scores, though both effects were only marginally significant. Factor scores for Energy Drinks & Coffee on the other hand, were significantly negatively correlated with GPA and work efficiency, and positively correlated with low wellbeing. General health was also positively correlated with consumption of the Healthy Foods factor, although the effect was only marginally significant. For all correlations between DABS factors and the outcome variables, see Table 3.10.

To investigate the above effects at the multivariate level, all four DABS factor scores were entered simultaneously into multiple linear regression models, along with covariates. However, none of the DABS factors remained a significant predictor of any of the outcome variables (for model fits, and β and *p* values, see Table 3.11).

	Junk Food		**Healthy Foods**		**Energy Drinks & Coffee**		**Tea**	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
GPA	-.077	.223	.004	.947	-.16	.011	-.055	.384
Work efficiency	-.117	.064	.112	.076	-.127	.044	-.002	.979
Low wellbeing	-.087	.178	-.1	.121	.166	.01	-.061	.347
Course stress	-.093	.141	-.097	.125	-.06	.341	-.006	.929
General health	-.032	.614	.122	.053	-.077	.222	.033	.607

Table 3.10. Correlations between DABS factor scores and academic and mental health outcomes from Study 1.

	Model fit			Junk Food		Healthy Foods		Energy Drinks & Coffee		Tea	
	F	*p*	R^2	β	*p*	β	*p*	β	*p*	β	*p*
GPA	4.325	< .001	.162	-.048	.471	-.057	.384	-.064	.373	-.061	.344
Work efficiency	4.54	< .001	.161	-.049	.448	.1	.121	-.035	.616	.018	.77
Low wellbeing	35.543	< .001	.714	-.065	.121	.004	.923	.053	.254	-.03	.474
Course stress	5.934	< .001	.208	-.105	.11	.009	.897	-.101	.127	-.027	.678
General health	4.522	< .001	.155	-.007	.912	.077	.266	.006	.931	.021	.742

Table 3.11. Multivariate associations between DABS factor scores and academic and mental health outcomes from Study 1.
Note. β values are standardised; R^2 values are adjusted.

3.3.8 Associations Between Breakfast and Energy Drink Consumption and Academic and Mental Health Outcomes

3.3.8.1 Individual Associations Between Breakfast and Energy Drink Consumption and Academic and Mental Health Outcomes

The DABS single-items for the frequency of breakfast and energy drink consumption were recoded into dichotomous variables. Breakfast was coded as ‘every day’ (answer 5) vs. ‘not every day’ (answers 1, 2, 3, and 4), whereas energy drink consumption was coded as ‘sometimes’ (answers 2, 3, 4, and 5) vs. ‘never’ (answer 1). This resulted in relatively similar numbers of participants in each group: breakfast every day (N = 124, 46.3%), breakfast not every day (N = 144, 53.7%); energy drinks sometimes (N = 110, 41%), energy drinks never (N = 158, 59%). Differences between these groups for GPA, work efficiency, low wellbeing, course stress, and general health were initially investigated using between-subjects t-tests. The frequency of breakfast consumption was not found to be associated with GPA, $t(265) = 1.445$, $p = .15$, work efficiency, $t(266) = .542$, $p = .588$, or course stress, $t(266) = -1.039$, $p = .3$. However, the group that did not consume breakfast every day was found to achieve higher low wellbeing scores, $t(255.94) = -2.88$, $p = .004$, and lower general health, $t(266) = 3.295$, $p = .001$.

No significant differences were detected between those who consumed energy drinks and those who did not for GPA, $t(265) = .362$, $p = .717$, work efficiency, $t(266) = 1.615$, $p = .108$, course stress, $t(266) = .175$, $p = .861$, or general health, $t(266) = -1.575$, $p = .116$. However, low wellbeing scores were higher in those who sometimes consumed energy drinks, $t(256) = -1.737$, $p = .084$, although the effect was only marginally significant.

In order to investigate the above effects at the multivariate level, ANCOVAs were conducted for each of the dependent variables. No significant effects were observed in relation to the frequency of consumption of breakfast: GPA, $F(1, 200) = .423$, $p = .516$; work efficiency, $F(1, 215) = .903$, $p = .343$; low wellbeing, $F(1, 170) = .025$, $p = .874$; course stress, $F(1, 200) = .034$, $p = .854$, general health, $F(1, 204) = 1.088$, $p = .298$. This was also the case for energy drinks: GPA, $F(1, 199) = .37$, $p = .544$; work efficiency, $F(1, 214) = .639$, $p = .425$; low wellbeing, $F(1, 169) = .248$, $p = .619$; course stress, $F(1, 199) = .767$, $p = .382$; general health, $F(1, 203) = .131$, $p = .718$.

3.3.8.2 Combined Effects of Breakfast and Energy Drinks

To examine their potential combined effects, the dichotomous variables for breakfast and energy drinks discussed in the previous section were combined to create to following four groups: 1) breakfast every day/energy drinks never, 2) breakfast every day/energy drinks sometimes, 3) breakfast not every day/energy drinks never, 4) breakfast not every day/energy drinks sometimes. This variable was investigated in relation to each of the outcome measures using one-way between-subjects ANOVAs. No effects were observed regarding GPA, $F(3, 263) = .838$, $p = .474$, or course stress, $F(3, 264) = .581$, $p = .628$. However, the association with work efficiency was significant, $F(3, 264) = 2.815$, $p = .04$. Post-hoc tests (Tukey, $p = .031$) determined that the breakfast not every day/energy drinks sometimes ($M = 5.55$, $SD = 1.985$) condition reported lower work efficiency than did the breakfast not every day/energy drinks never condition ($M = 6.42$, $SD = 1.714$).

A significant combined effect of breakfast and energy drinks was also observed in relation to low wellbeing, $F(3, 254) = 3.481$, $p = .017$. Post-hoc tests (Tukey, $p = .011$) determined that the breakfast not every day/energy drinks sometimes condition ($M = .276$, $SD = 1.129$) achieved higher low wellbeing scores than did the breakfast every day/energy drinks never condition ($M = -.251$, $SD = .929$). A further combined effect was observed in relation to general health, $F(3, 264) = 4.207$, $p = .006$. Tukey post hoc tests determined that general health was significantly higher in the breakfast every day/energy drinks never condition compared to breakfast not every day/energy drinks never ($p = .048$) and breakfast not every day/energy drinks sometimes ($p = .006$). However, at the multivariate level, the combined effect of breakfast and energy drinks was not predictive of any of the outcomes: GPA, $F(3, 197) = .434$, $p = .729$; work efficiency, $F(3, 212) = 1.48$, $p = .221$; low wellbeing, $F(3, 167) = .093$, $p = .964$; course stress, $F(3, 197) = .291$, $p = .832$; general health, $F(3, 201) = .371$, $p = .774$.

3.4 Discussion

The current chapter has introduced the Diet and Behaviour Scale (DABS), explored its underlying factor structure, and identified correlates of GPA, work efficiency, low wellbeing, course stress, and general health. In addition, relationships between a number of dietary predictors and academic and mental health outcomes were investigated. The current section will address each of these aims before discussing limitations of the study and directions for future research.

3.4.1 Factor Structure Associated With the DABS in Study 1

An exploratory factor analysis of all 29 items of the DABS revealed a four-factor solution, which consisted of Junk Food, Healthy Foods, Energy Drinks & Coffee, and Tea. Although previous analyses of FFQs have commonly produced two-factor solutions, which essentially represent healthy and unhealthy dietary patterns (e.g. Ambrosini et al., 2011; Akbaraly et al., 2009; Hu et al., 1999), such models may obscure the effects of foods and drinks that do not contribute appreciable nutritional value. As the Energy Drinks & Coffee factor, which was identified as being of particular importance to the current study, was comprised of such items, the factor structure presented here may be more relevant to answering the research questions at hand.

Subscales were derived for each of the dietary factor scores, and were found to have acceptable levels of internal consistency. This was of particular importance for two reasons. Firstly, the creation of subscales allows for DABS factors to be controlled for whilst avoiding shared variance with certain predictor variables (for example, shared variance can be avoided if each of the DABS subscales other than Energy Drinks & Coffee are entered as covariates when investigating the effects of energy drinks, whereas this would not be the case if using the original factor score variables). The second reason why the creation of reliable DABS subscales is of importance is that they can be used to ensure that the factors investigated do not vary across time-points when conducting longitudinal analyses. Although this is not relevant to the current chapter, it will be of considerable importance when change score analyses are presented further on in this thesis.

3.4.2 Identification of Covariates

Each DABS factor and outcome variable was associated with certain aspects of demography, lifestyle, and personality. In general, the effects observed were as expected: negative outcomes (i.e. low GPA, work efficiency, wellbeing, and general health, and high course stress) were consistently associated with other undesirable characteristics, such as smoking, poor sleep, the use of negative coping strategies, low positive personality scores etc. Although these findings may be of interest in themselves, the identification of such covariates was of particular importance to the current research because it provided reason to control for them statistically during multivariate analyses.

3.4.3 Dietary Patterns Associated With Undesirable Academic and Mental Health Outcomes

3.4.3.1 High Weekly Caffeine Intake

The first dietary indicator investigated was caffeine consumption. Its total weekly intake (i.e. the sum of that estimated from energy drinks, cola, coffee, and tea) was marginally negatively correlated with GPA at the univariate level. This effect is in accordance with James et al. (2011), who observed a negative relationship between GPA and caffeine intake in Icelandic schoolchildren. However, whereas the effect observed by James et al. remained significant after covariates had been controlled for, this was not the case in the current study. Furthermore, no relationships were observed here between caffeine intake and work efficiency, wellbeing, course stress, or general health. However, considering that previous research has reported associations between caffeine intake and mental health and academic performance (e.g. Gilliland & Andress, 1981; James et al., 2011; Kendler et al., 2006), it is likely that the relative lack of significant findings made by the current study is explainable by the generally low caffeine intake and small sample size.

3.4.3.2 Co-Consumption of Caffeine and Alcohol

When investigating the co-consumption of caffeine and alcohol, no effects were observed regarding GPA, low wellbeing, or course stress. However, those who did consume caffeine with alcohol reported significantly lower general health and work efficiency, with the latter effect remaining significant at the multivariate level. Although the finding is in line with that of Martz et al. (2015), who reported alcoholic energy drink consumption to be associated with low GPA, this effect itself was not replicated by the current study. However, the observation that co-consumption of caffeine and alcohol was associated with low work efficiency is in accordance with other studies that have reported similar undesirable outcomes (e.g. O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008). As both caffeine and alcohol intake were controlled for in the current study, it suggests these effects may not be entirely attributable to either substance, and that co-consumption represents a unique danger.

3.4.3.3 Consumption of the Energy Drinks & Coffee DABS Factor

Due to it being comprised of items measuring both the frequency and amount of consumption of energy drinks, the DABS factor labelled Energy Drinks & Coffee was identified as being of particular importance to the current study. It was therefore interesting to observe that consumption of this factor correlated negatively with GPA and work efficiency, and positively with low wellbeing. Although these effects did not remain significant at the multivariate level, they echo similar findings relating to energy drinks reported in the literature reviewed in Chapter 2 (e.g. Azagba et al., 2014; Pettit & DeBarr, 2011; Trapp et al., 2014). However, considering that the relationships reported here related to factor scores, it is not possible to state with conviction that they relied upon energy drinks, or whether they were explainable by the consumption of coffee or caffeine in general. The next section will therefore discuss analyses that attempted to isolate such effects to two dietary practices: the consumption of energy drinks, and the omission of breakfast.

3.4.3.4 Breakfast Omission and Frequent Energy Drink Consumption

Due to reports in the mainstream media suggesting that energy drinks may be consumed as a substitute for breakfast (e.g. Richardson, 2013), and that this pattern may itself be associated with undesirable outcomes, breakfast omission and energy drink consumption were investigated, both in isolation, and in combination. Neither breakfast nor energy drinks alone were related to GPA, work efficiency, or course stress. However, breakfast omission was associated with low wellbeing and low general health. Energy drink consumption was also associated with low wellbeing, though the effect was only marginally significant. As these effects did not remain significant at the multivariate level, it was considered that a combination of the two practices might be of greater predictive value. At the univariate level, significant combined effects of breakfast omission and energy drink consumption were observed in relation to work efficiency, low wellbeing, and low general health. The effects relating to work efficiency and wellbeing appeared to reflect undesirable outcomes being associated with the group that did not eat breakfast every day and did consume energy drinks, whereas low general health was more broadly associated with breakfast omission. However, as with most previously discussed analyses, these effects did not remain significant once covariates had been controlled for.

3.4.4 Limitations and Directions for Further Research

Although a number of dietary effects were observed at the univariate level, only one (the association between co-consumption of caffeine and alcohol and low work efficiency) remained significant at the multivariate level. Though this could be because the relationships are explained by the control variables, this is perhaps unlikely considering that similar dietary effects have been shown to remain significant after adjusting for covariates. For example, Stasio et al. (2011) observed associations between energy drink use and anxiety after controlling for sleep quality and additional caffeinated drink consumption; Vilija and Romualdas (2014) reported associations between energy drink use and PTSD symptoms after controlling for sex, index trauma, physical activity, smoking, and sense of coherence. For this reason it is likely that the current study simply lacked the statistical power required for the effects to remain significant at the multivariate level.

Although the sample investigated was of moderate size, it was also relatively homogenous in that it only included first and second year undergraduate psychology students, a demographic group that is unrepresentative of the wider population in a number of regards (e.g. strong female bias, specific age range, relatively high educational attainment, increased likelihood of coming from a high socioeconomic background etc.) The proportion of participants who consumed large amounts of caffeine or frequently used energy drinks was also comparatively low. This observation might, at least in part, explain why relatively few dietary effects were observed, as they may be more likely to occur towards the high end of the distribution. Two potential methods of addressing this problem were considered: 1) acquiring a considerably larger sample size, and 2) purposefully collecting data from individuals who consume large amounts of caffeine and energy drinks. Initially the latter option was chosen, and the next chapter will present findings from a second cross-sectional study, for which frequent users of energy drinks were recruited.

Chapter 4: A Cross-Sectional Investigation of Diet, Academic Performance and Mental Health in a Student Sample of Frequent Energy Drink Consumers

4.1 Introduction

Chapter 3 aimed to provide a preliminary investigation of associations between diet, academic performance, and mental health in university students. A considerable issue with the study was that comparatively few participants were high consumers of either caffeine or energy drinks. As the study made relatively few findings relating to diet, and because all but one did not remain statistically significant after controlling for covariates, it was considered likely that such effects lie towards the ends of the continuum regarding caffeine and energy drink consumption.

4.1.1 Overview of Study 2

In attempt to overcome some of the challenges faced in Study 1, a cross-sectional online questionnaire survey of students who claimed to be frequent (twice a week or more) users of energy drinks was carried out. The current study therefore aimed to further investigate dietary associations with work efficiency, low wellbeing, course stress, and general health in a population that consumed greater amounts of caffeine and energy drinks. GPA was not used as a dependent variable in this study because the relevant information was not available.

4.1.2 Aims of Chapter 4

The current chapter proceeds with similar aims to that of Chapter 3, although the effects are examined in a slightly different population. Essentially, Chapter 4 aims to investigate cross-sectional associations between three dietary patterns: 1) total weekly caffeine intake, 2) energy drinks in combination with their natural correlates, and 3) breakfast and energy drinks (both in isolation and in combination), and four outcome variables: 1) work efficiency, 2) low wellbeing, 3) course stress, and 4) general health. In addition to this, the current chapter aims to further inspect the underlying factor structure associated with the DABS, and to examine similarities and differences with that which were observed in the sample of undergraduate psychology students presented in the previous chapter.

4.2 Method

4.2.1 Participants

Two hundred and eighty-four students from Cardiff University took part in Study 2. The majority of participants (62.9%) were female, though the sex ratio was still more balanced than that observed in Study 1. This is likely to have been because the participants in Study 2 did not specifically study psychology, which is a discipline known to have a strong female bias at undergraduate level. Most respondents were undergraduates (first year = 20.4%, second year = 31.3%, third year = 25%, fourth year = 6%), a considerable minority (13.7%) were postgraduates, and 3.5% listed themselves as 'other'. A likely reason for this last option being chosen is that some respondents may have been taking part in exchange programmes, such as Erasmus, and so, might not have belonged to a specific year group. Ages ranged from 18 to 44 (M = 22.02, SD = 3.52), and the majority of respondents (84.3%) were studying for their first academic degree. Most participants (79.2%) reported that they had attended state schools, with a minority (20.8%) having attended private/paid schools.

4.2.2 Apparatus/Materials

As with Study 1, the DABS was used to measure dietary intake, and the same 26 single-items from the WPQ were used to assess certain aspects of mental health. In addition, the same items from Study 1 were also administered to measure course stress, work efficiency, general health, sex, age, height and weight, first/second degree, current year group, household income, smoking, type of secondary school attended, and A-level subjects and grades.

The questions used to record exercise frequency and duration were different to those administered in Study 1. Three questions were used to measure the frequency of taking part in mild, moderate, and vigorous exercise (1 = 3 times a week or more, 2 = once or twice a week, 3 = about once to three times a month, 4 = never/hardly ever), and three further questions were used to record the average number of hours per week for which they were performed. Different items were also used to record frequency and amount of alcohol consumption. Whereas Study 1 did not differentiate between weekdays and weekend days, the current study did. The number of days drinking on weekdays was reported on a four-point scale (1 = never, 2 = 1-2 days, 3 = 3 days, 4 = 4 days), and the number of days drinking on weekend days was measured on a three-point scale (1 = never, 2 = 1-2 days, 3 = all 3 days). Separate items were included to record the average number of units consumed on weekdays and weekend days.

The single-item measure used to record sleep duration in Study 1 was also administered here. The item used to record the frequency of achieving good quality sleep, however, was changed from a four-point scale to a five-point scale (1 = not at all, 2 = rarely, 3 = sometimes, 4 = frequently, 5 = very frequently) in order to increase its sensitivity. In addition, another single-item, which utilised this same five-point scale, was included to record the frequency by which daytime sleepiness occurred.

4.2.3 Design & Procedure

Data were collected through an online survey hosted by Qualtrics, and informed consent was obtained from all participants prior to beginning. In order to acquire participants who frequently consumed energy drinks, an advert was placed on the Cardiff University Noticeboard, which was accessible to all students registered at the institution. The advert specified that respondents should be regular energy drink users (consuming two or more per week), and three prize draws of £50 were offered as an incentive to take part.

4.2.4 Statistical Analysis

In general, the current chapter utilised the same analytical procedures as Chapter 3. Frequency and descriptive statistics are provided for demographic, dietary, and personality variables, and single-factor score solutions were derived for sleep, alcohol consumption, and exercise, so that a large amount of variance could be controlled for without unnecessarily limiting the statistical power of the multivariate analyses. All 29 items of the DABS were once again factor analysed using varimax rotation. On this occasion a four-factor structure emerged, which consisted of Junk Food, Energy Drinks & Cola, Hot Caffeinated Beverages, and Fish, Beans & Peas.

Subscales were created for each factor, and their internal consistency was tested using standardised Cronbach's alpha. The same factor-analytic approach to the WPQ used in Chapter 3 was also again utilised here (i.e. factors were derived for student stressors, social support, negative coping, positive personality, and low wellbeing). Associations between these factors, as well as those derived from the DABS, were then investigated using between-subjects t-tests and Pearson's correlations.

Caffeine intake from individual sources was calculated using the same method presented in Chapter 3 (i.e. 133mg per can of energy drink, 25mg per can of cola, 80mg per cup of coffee, 40mg per cup of tea), and the sum of these values was as an estimate of total weekly consumption. Pearson's correlations were then used to assess associations between total caffeine intake and the (continuous) outcome variables of work efficiency, low wellbeing, course stress, and general health. At the multivariate level, multiple linear regression analyses were conducted so that additional variance from covariates could be controlled for statistically. The same approach to analysis (i.e. Pearson's correlations followed by multiple linear regression) was also used when investigating the DABS factor scores. For a description of all covariates included in each multivariate analysis presented in this chapter, see Table 4.1. Essentially, each of the control variables that were significantly or marginally significantly associated (i.e. $p < .1$) with the outcome variable in question was entered as a covariate. In addition, subscale scores for the DABS factors that were not comprised of caffeinated products (i.e. Junk Food and Fish, Beans & Peas), and caffeine (either total weekly intake, or that consumed from cola, coffee, and tea) were also entered, depending on which predictor variable was being investigated.

When examining the effects of the frequency of breakfast and energy drink consumption, breakfast was dichotomised in the same manner as in Chapter 3 (i.e. every day vs. not every day). However, due to the frequency of energy drink consumption being considerably higher in the current study, rather than dichotomising as 'sometimes' vs. 'never', it was instead dichotomised as 'three times a week or more' vs. 'less than three times a week'. Between-subjects t-tests were then used to determine whether these groups differed in work efficiency, low wellbeing, course stress, and general health. After this, the effects were investigated at the multivariate level using ANCOVAs. In addition, the dichotomous breakfast and energy drinks

Work efficiency	Low wellbeing	Course stress	General health
Covariates specific to each outcome variable that are included in all multivariate analyses presented from Study 2			
School (dichotomous; private/paid or state)	Sex (dichotomous; male or female)	Sex (dichotomous; male or female)	Sex (dichotomous; male or female)
Age (continuous)	School (dichotomous; private/paid or state)	School (dichotomous; private/paid or state)	Student stressors (continuous; factor score)
Student stressors (continuous; factor score)	Household income (continuous)	Household income (continuous)	Social support (continuous; factor score)
Positive personality (continuous; factor score)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)	Negative coping (continuous; factor score)
Sleep (continuous; factor score)	Social support (continuous; factor score)	Negative coping (continuous; factor score)	Positive personality (continuous; factor score)
Alcohol (continuous; factor score)	Negative coping (continuous; factor score)	Positive personality (continuous; factor score)	Sleep (continuous; factor score)
Exercise (continuous; factor score)	Positive personality (continuous; factor score)	Sleep (continuous; factor score)	
Mean A-level grade (continuous)	Sleep (continuous; factor score)	Exercise (continuous; factor score)	
BMI (continuous)	BMI (continuous)		
Additional covariates when the predictor variable is total weekly caffeine intake			
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Additional covariates when the predictor variable is frequency of breakfast consumption			
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)
Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)
Additional covariates when the predictor variable is frequency of energy drink consumption or the combined effects of breakfast and energy drinks			
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)	Fish, Beans & Peas DABS subscale score (continuous)
Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)
Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)
Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)

Table 4.1. List of covariates included in multivariate analyses presented from Study 2.

Note. Covariates specific to each outcome variable were determined by correlational analyses presented in section 4.3.4.2.

variables were used to categorise participants into one of four potential combinations of frequent/infrequent consumption. These groups were then examined in relation to the outcome variables by using one-way between-subjects ANOVAs at the univariate level, and ANCOVAs at the multivariate level.

4.3 Results

4.3.1 Demography and Lifestyle Variance

Although the items used to measure exercise participation were different from those of Study 1, the current sample appeared to report more hours per week for mild, moderate, and vigorous activity. In addition to this, the percentage of participants who claimed to be smokers in the current study was higher (Study 1 = 10.9%; Study 2 = 15.9%), and the consumption of alcoholic units also appeared to be higher. However, this latter observation is difficult to quantify considering that the current study used different measures of alcohol consumption compared to Study 1 (i.e. Study 2 differentiated between week days and weekend days, whereas Study 1 did not). Sleep hours also appeared to differ between the two samples. Interestingly though, the percentage of participants who reported sleeping for seven hours per night (Study 1 = 37.3%; Study 2 = 36.4%), five or fewer hours (Study 1 = 5.2%; Study 2 = 6.1%), or nine or more hours (Study 1 = 6%; Study 2 = 6.8%) did not differ substantially. However, compared to Study 1, a higher percentage of participants in the current study reported sleeping for six hours per night (Study 1 = 11.9%; Study 2 = 22.9%), and a lower percentage reported sleeping for eight hours per night (Study 1 = 39.6%; Study 2 = 27.9%). Due to differences in the scales used it was difficult to determine whether sleep quality differed between the two samples, although daytime sleepiness in the current study was found to be common, with just over half of all respondents claiming that they 'frequently' or 'very frequently' experienced the problem.

Frequency data relating to lifestyle (exercise, sleep, alcohol consumption, BMI, and smoking) are presented in Table 4.2. Factor analyses were conducted to reduce data for exercise, sleep and alcohol into single-factor solutions. Unlike the analysis presented from Study 1, the low intensity exercise variables were entered here because their factor loading scores were relatively high. For factor loadings, initial eigenvalues, and percentages of variance explained, see Table 4.3.

		Three times a week or more	Once or twice a week	About once to three times a month	Never/ hardly ever	*M* (hours)	*SD*
Exercise	Mild exercise	209 (77.1%)	39 (14.4%)	19 (7%)	4 (1.5%)	8.2	7.403
	Moderate exercise	80 (29.6%)	104 (38.5%)	44 (16.3%)	42 (15.6%)	3.5	3.777
	Vigorous exercise	80 (29.4%)	68 (25%)	61 (22.4%)	63 (23.2%)	3.16	3.921
		Never	**1-2 days**	**3 days**	**4 days**	***M*** **(units)**	***SD***
Alcohol	Week days	110 (40.6%)	131 (48.3%)	23 (8.5%)	7 (2.6%)	6.1	9.956
		Never	**1-2 days**	**All 3 days**	***M*** **(units)**	***SD***	
	Weekend days	68 (24.9%)	195 (71.4%)	10 (3.7%)	7.73	7.946	
		5 hours or less	**6 hours**	**7 hours**	**8 hours**	**9+ hours**	
Sleep	Hours per night	17 (6.1%)	64 (22.9%)	102 (36.4%)	78 (27.9%)	19 (6.8%)	
		Not at all	**Rarely**	**Sometimes**	**Frequently**	**Very frequently**	
	Good quality sleep	3 (1.1%)	45 (16.1%)	112 (40%)	90 (32.1%)	30 (10.7%)	
	Daytime sleepiness	13 (4.6%)	37 (13.2%)	87 (31.1%)	110 (39.3%)	33 (11.8%)	
	Underweight	**Normal weight**	**Overweight**	***M***	***SD***		
BMI	15 (5.6%)	183 (68%)	71 (26.4%)	23.57	4.47		
	Yes	**No**					
Smoking	44 (15.9%)	233 (84.1%)					

Table 4.2. Frequency data for lifestyle variables from Study 2.

	Factor loading	Initial eigenvalue	Cumulative % variance
Exercise			
Mildly energetic frequency	.521	2.669	44.48%
Mildly energetic amount	.582		
Moderate exercise frequency	.754		
Moderate exercise amount	.792		
Vigorous exercise frequency	.665		
Vigorous exercise amount	.648		
Sleep			
Sleep hours	.639	1.504	50.13%
Sleep quality	.808		
Daytime sleepiness	.665		
Alcohol			
Week days frequency	.812	2.564	64.1%
Week days units	.828		
Weekend days frequency	.716		
Weekend days units	.84		

Table 4.3. Factor loading scores, initial eigenvalues, and percentages of variance explained by factor analyses of exercise, sleep, and alcohol consumption variables from Study 2.

4.3.2 Dietary Intake and Factor Analysis of the DABS

As with Study 1, considerable variance was observed for responses to the DABS items (for descriptive statistics, see Table 4.4). Although it is difficult to compare the results to those of Study 1 due to the differences in the samples investigated, an obvious disparity, as expected, was that the current sample used energy drinks in greater frequency (Study 1 mode [59%] = 'never'; Study 2 mode [40.4%] = 'once or twice a week') and amount (Study 1 M = .26 cans per week, SD = .65; Study 2 M = 2.62 cans per week, SD = 2.53). However, though the advert used for recruitment specified that respondents should consume energy drinks at least twice per week, 15.3% claimed only to use the products once a month, and 10.9% claimed not to use them at all. A possible reason for this is that some participants may have only taken part in order to enter the prize-draw.

The 29 DABS items were factor analysed (using Varimax rotation), and produced a four-factor structure consisting of Junk Food, Energy Drinks & Cola, Hot Caffeinated Beverages, & Fish, Beans & Peas, which explained 38.11% of variance. As with Study 1, the cut-off point for being considered part of a factor/derived subscale was set at a factor loading of > .45. For factor loading scores, initial eigenvalues, and percentages of variance explained by each DABS factor from Study 2, see Table 4.5.

As with Study 1, subscale scores were created for each of the four factors extracted, and standardised Cronbach's alpha values were calculated. The internal consistency for the following scales was acceptable: Junk Food (Q2, Q3, Q10, Q11, Q13, Q17, Q23) α = .734; Energy Drinks & Cola (Q7, Q8, Q19, Q20) α = .754; Hot Caffeinated Beverages (Q5, Q6, Q21, Q22) α = .762. For Fish, Beans & Peas (Q15, Q16, Q18), the internal consistency was unacceptable, α = .447. Strong positive correlations were observed between each subscale and its respective factor score: Junk Food, $r(252) = .908$, $p < .001$; Energy Drinks & Cola, $r(252) = .839$, $p < .001$; Hot Caffeinated Beverages, $r(252) = .822$, $p < .001$; Fish, Beans & Peas, $r(252) = .703$, $p < .001$.

Frequency	*N*	Never	Once a month	Once/twice a week	Most days (3-6)	Every day
Breakfast	275	27 (9.8%)	15 (5.5%)	43 (15.6%)	78 (28.4%)	**112 (40.7%)**
Chocolate	274	7 (2.6%)	42 (15.3%)	**126 (46%)**	72 (26.3%)	27 (9.9%)
Crisps	275	27 (9.8%)	82 (29.8%)	**112 (40.7%)**	47 (17.1%)	7 (2.5%)
5+ fruit or veg	275	21 (7.6%)	34 (12.4%)	90 (32.7%)	**93 (33.8%)**	37 (13.5%)
Coffee	274	**91 (33.2%)**	31 (11.3%)	46 (16.8%)	42 (15.3%)	64 (23.4%)
Tea	275	72 (26.2%)	17 (6.2%)	43 (15.6%)	48 (17.5%)	**95 (34.5%)**
Cola	274	47 (17.2%)	51 (18.6%)	**111 (40.5%)**	48 (17.5%)	17 (6.2%)
Energy drinks	275	30 (10.9%)	42 (15.3%)	**111 (40.4%)**	77 (28%)	15 (5.5%)
Gum	275	74 (26.9%)	**80 (29.1%)**	54 (19.6%)	46 (16.7%)	21 (7.6%)
Sweets	275	25 (9.1%)	93 (33.8%)	**104 (37.8%)**	45 (16.4%)	8 (2.9%)
Fast-food	275	16 (5.8%)	**135 (49.1%)**	101 (36.7%)	19 (6.9%)	4 (1.5%)
Take-away	275	52 (18.9%)	**184 (66.9%)**	31 (11.3%)	7 (2.5%)	1 (.4%)
Pies or pasties	274	91 (33.2%)	**131 (47.8%)**	39 (14.2%)	11 (4%)	2 (.7%)
Processed meat	272	**145 (53.3%)**	70 (25.7%)	38 (14%)	15 (5.5%)	4 (1.5%)
Fried fish	273	93 (34.1%)	**127 (46.5%)**	44 (16.1%)	9 (3.3%)	0 (0%)
Oily fish	274	**90 (32.8%)**	77 (28.1%)	78 (28.5%)	27 (9.9%)	2 (.7%)
Chips	275	16 (5.8%)	**128 (46.5%)**	94 (34.2%)	35 (12.7%)	2 (.7%)
Beans or peas	274	13 (4.7%)	49 (17.9%)	**120 (43.8%)**	85 (31%)	7 (2.6%)

Amount	*N*	Min	Max	*M*	*SD*
Energy drinks	274	0	18	2.62	2.53
Cola	271	0	24	2.07	3.28
Coffee	274	0	45	4.26	6.32
Tea	274	0	74	7.4	9.66
Crisps	275	0	20	2.16	2.47
Chocolate	274	0	28	2.64	2.77
Burgers/hot dogs	275	0	6	.65	1.03
Gum	275	0	6	.75	1.15
Fruit	275	0	25	2.21	2.1
Veg	274	0	7.5	2.26	1.3
Water	273	0	10	3.07	1.82

Table 4.4. Frequencies and descriptive statistics for all DABS items from Study 2.
Note. Modal values for frequency items are displayed in bold. All amount of consumption items were measured per week other than fruit, vegetables, and water, which were measured per day.

	Junk Food	Energy Drinks & Cola	Hot Caffeinated Beverages	Fish, Beans & Peas
Q1. How often did you eat breakfast?	-.175	-.396	.108	.134
Q2. How often did you eat chocolate?	**.484**	.051	-.026	-.312
Q3. How often did you eat crisps?	**.725**	-.012	.207	.022
Q4. How often did you eat five pieces of fruit or veg?	-.253	-.412	.314	.207
Q5. How often did you drink coffee?	.066	.121	**.651**	-.048
Q6. How often did you drink tea?	.1	-.128	**.612**	-.011
Q7. How often did you drink cola?	.295	**.58**	.089	-.104
Q8. How often did you drink energy drinks?	-.137	**.765**	.123	.11
Q9. How often did you chew gum?	.061	.157	.5	.371
Q10. How often did you eat sweets?	**.642**	.042	-.071	.039
Q11. How often did you eat fast-food?	**.487**	.355	-.271	.221
Q12. How often did you eat takeaway?	.406	.065	.005	.129
Q13. How often did you eat pies or pasties?	**.467**	.033	-.094	.388
Q14. How often did you eat processed meat?	.284	.102	-.098	.44
Q15. How often did you eat fried fish?	.079	.161	-.209	**.589**
Q16. How often did you eat oily fish?	-.045	-.088	.145	**.476**
Q17. How often did you eat chips?	**.573**	.279	-.223	.231
Q18. How often did you eat beans or peas?	.068	-.078	.276	**.469**
Q19. Cans of energy drink per week	-.128	**.702**	.061	.176
Q20. Cans of cola per week	.165	**.537**	-.035	-.207
Q21. Cups of coffee per week	-.013	.177	**.601**	-.039
Q22. Cups of tea per week	-.036	-.149	**.578**	-.012
Q23. Packets of crisps per week	**.695**	.0	.228	-.029
Q24. Bars of chocolate per week	.401	.182	-.004	-.347
Q25. Burgers/hot dogs per week	.329	.417	-.296	.204
Q26. Packs of chewing gum per week	.08	.263	.418	.413
Q27. Pieces of fruit per day	-.089	-.163	.237	.016
Q28. Portions of vegetables per day	-.328	-.271	.389	.08
Q29. Pints of water per day	-.007	-.159	-.04	.404
Initial eigenvalue	4.306	2.784	1.998	1.964
Percentage of variance explained	11.56%	9.67%	9.44%	7.44%

Table 4.5. Exploratory factor analysis of DABS items from Study 2.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .45 are displayed in bold.

4.3.3 Factor Analysis of the WPQ

Descriptive statistics for responses to all single-item measures included from the WPQ are shown in Table 4.6. Factor scores for ‘student stressors’, ‘social support’, ‘negative coping’, ‘positive personality’, and ‘low wellbeing’ were then derived using the same methodology described in Study 1 (see Chapter 3, section 3.3.3). For factor loading scores, initial eigenvalues, and percentages of variance explained by each of these factors, see Table 4.7.

WPQ single-item	**Scoring system**	***N***	**Min**	**Max**	***M***	***SD***
Challenges to development	1 = not at all part of my life; 10 = very much part of my life	263	1	10	6.95	2.42
Time pressures	1 = not at all part of my life; 10 = very much part of my life	263	1	10	7.63	2.13
Academic dissatisfaction	1 = not at all part of my life; 10 = very much part of my life	263	1	10	4.98	2.73
Romantic problems	1 = not at all part of my life; 10 = very much part of my life	261	1	10	4.82	2.93
Societal annoyances	1 = not at all part of my life; 10 = very much part of my life	263	1	10	4.1	2.67
Social mistreatment	1 = not at all part of my life; 10 = very much part of my life	262	1	10	3.87	2.78
Friendship problems	1 = not at all part of my life; 10 = very much part of my life	263	1	10	3.69	2.53
Tangible support	1 = strongly disagree; 10 = strongly agree	264	1	10	8.15	2.67
Belonging support	1 = strongly disagree; 10 = strongly agree	264	1	10	8.32	2.21
Emotional support	1 = strongly disagree; 10 = strongly agree	264	1	10	8.22	2.43
Depression	1 = not at all depressed; 10 = extremely depressed	261	1	10	4.45	2.27
Positive mood	1 = disagree strongly; 10 = agree strongly	258	1	10	5.95	1.96
Optimism	1 = disagree strongly; 10 = agree strongly	260	1	10	6.12	2.19
Self efficacy	1 = disagree strongly; 10 = agree strongly	261	1	10	7.03	1.83
Self esteem	1 = disagree strongly; 10 = agree strongly	259	1	10	5.97	2.29
Negative mood	1 = disagree strongly; 10 = agree strongly	262	1	10	4.35	2.2
Coping self blame	1 = disagree strongly; 10 = agree strongly	261	1	10	5.78	2.3
Coping wishful thinking	1 = disagree strongly; 10 = agree strongly	260	1	10	6.07	2.52
Coping avoidance	1 = disagree strongly; 10 = agree strongly	262	1	9	4.74	2.29
Extraversion	1 = disagree strongly; 10 = agree strongly	259	1	10	6.36	2.25
Emotional stability	1 = disagree strongly; 10 = agree strongly	259	1	10	7.03	1.88
Life satisfaction	1 = disagree strongly; 10 = agree strongly	258	1	10	6.55	2
Anxiety	1 = not at all anxious; 10 = extremely anxious	259	1	10	5.56	2.31
Life stress	1 = not at all stressful; 10 = very stressful	257	1	10	6.26	2
Physical fatigue	1 = not at all; 10 = very often	259	1	10	6.11	2.3
Mental fatigue	1 = not at all; 10 = very often	259	1	10	6.71	2.13

Table 4.6. Descriptive statistics for single-item measures from the WPQ from Study 2.

	Factor loading	Initial eigenvalue	Cumulative % variance
Student stressors			
Challenges to development	.447	2.482	35.45%
Time pressures	.488		
Academic dissatisfaction	.628		
Romantic problems	.364		
Societal annoyances	.711		
Social mistreatment	.73		
Friendship problems	.692		
Social support			
Tangible support	.753	2.099	69.96%
Belonging support	.875		
Emotional support	.876		
Negative coping			
Self blame	.677	1.48	49.33%
Wishful thinking	.714		
Avoidance	.716		
Positive personality			
Optimism	.763	2.917	58.33%
Self efficacy	.747		
Self esteem	.832		
Extraversion	.741		
Emotional stability	.732		
Low wellbeing			
Depression	.802	4.043	50.54%
Positive mood	-.771		
Negative mood	.787		
Life satisfaction	-.739		
Anxiety	.655		
Life stress	.653		
Physical fatigue	.59		
Mental fatigue	.662		

Table 4.7. Factor loading scores, initial eigenvalues, and percentages of variance explained for factors derived from the WPQ for Study 2.

4.3.4 Correlates of the DABS Factors and Outcome Variables

4.3.4.1 Correlates of the DABS Factors

Each of the DABS factor scores was investigated in relation to the demographic, lifestyle, and personality control variables using between-subjects t-tests and Pearson's correlations. The significant (and marginally significant) relationships are discussed below; for the outcome of all t-tests and correlations, see Table 4.8.

	Junk Food		Energy Drinks & Cola		Hot Caffeinated Beverages		Fish, Beans & Peas	
Differences	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Sex	1.156	.249	3.665	< .001	-3.542	< .001	4.559	< .001
Smoker	1.132	.259	.742	.459	2.992	.003	.387	.699
Secondary school	1.073	.284	-1.047	.296	-.783	.434	.803	.423
Correlations	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	-.038	.553	.002	.975	.053	.404	-.15	.018
Household income	.084	.246	-.11	.131	.006	.938	-.049	.5
Student stressors	.081	.214	.031	.628	.022	.739	-.11	.089
Social support	-.003	.965	-.133	.038	.012	.85	.143	.025
Negative coping	.062	.34	.071	.277	.09	.165	-.046	.481
Positive personality	.061	.348	-.186	.004	-.035	.588	.128	.049
Sleep factor	-.023	.717	-.226	< .001	-.126	.045	-.089	.157
Alcohol factor	.094	.158	.132	.047	.052	.435	.25	< .001
Exercise factor	-.153	.017	-.014	.834	-.006	.92	.2	.002
Mean A-level grade	.131	.054	-.086	.206	.133	.05	-.008	.906
BMI	.02	.752	.182	.004	-.042	.51	-.006	.928

Table 4.8. Relationships between DABS factors and control variables from Study 2.
Note. All correlations are Pearson's (two-tailed).

4.3.4.1.1 Junk Food

Junk Food consumption was negatively correlated with exercise frequency. A positive association with mean A-level grades was also observed, though it was only marginally significant.

4.3.4.1.2 Energy Drinks & Cola

Males achieved significantly higher scores for Energy Drinks & Cola than did females. This factor also correlated negatively with social support, positive personality, and sleep. In addition, Energy Drinks & Cola consumption was positively correlated with alcohol factor scores and BMI.

4.3.4.1.3 Hot Caffeinated Beverages

Females and smokers achieved higher scores for the Hot Caffeinated Beverages factor than did males and non-smokers, respectively. In addition to this, Hot Caffeinated Beverage factor scores were negatively correlated with sleep, and positively correlated with mean A-level scores (though this latter effect was only marginally significant).

4.3.4.1.4 Fish, Beans & Peas

Males achieved higher scores than females for Fish, Beans & Peas. Consumption of this factor was also negatively associated with age and student stressors, though the latter effect was only marginally significant. In addition, consumption of Fish, Beans & Peas was positively correlated with social support, positive personality, alcohol consumption, and exercise participation.

4.3.4.2 Correlates of the Outcome Variables

As with the DABS factors, each of the outcomes was examined in relation to the control variables using between-subjects t-tests and Pearson's correlations. The significant and marginally significant relationships observed are discussed below; for outcomes from the t-tests and correlations, see Table 4.9.

	Work efficiency		**Low wellbeing**		**Course stress**		**General health**	
Differences	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Sex	-1.148	.252	-2.343	.02	-2.085	.038	2.555	.011
Smoker	.985	.326	.122	.903	-1.046	.3	-1.483	.139
Secondary school	-2.298	.022	-2.647	.009	-1.808	.072	1.556	.121
Correlations	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Age	.101	.093	-.042	.506	.08	.182	.038	.529
Household income	-.008	.91	-.228	.001	-.12	.091	.01	.889
Student stressors	-.129	.038	.457	< .001	.252	< .001	-.146	.019
Social support	.041	.513	-.343	< .001	-.066	.285	.12	.051
Negative coping	-.094	.131	.538	< .001	.168	.007	-.16	.01
Positive personality	.201	.001	-.731	< .001	-.252	< .001	.216	.001
Sleep factor	.103	.085	-.5	< .001	-.247	< .001	.326	< .001
Alcohol factor	-.147	.021	.008	.907	-.013	.838	-.011	.859
Exercise factor	.107	.086	-.036	.574	-.11	.077	.101	.104
Mean A-level grade	.125	.052	.014	.833	.096	.136	-.004	.956
BMI	-.151	.013	.135	.035	.069	.259	-.071	.242

Table 4.9. Relationships between outcome variables and control variables from Study 2.
Note. All correlations are Pearson's (two-tailed).

4.3.4.2.1 Work Efficiency

Those who had attended state schools reported significantly higher work efficiency than did those who had attended private/paid schools. Work efficiency was also positively correlated with positive personality. In addition, marginally significant positive correlations were observed with age, sleep, exercise, and mean A-level grade, and significant negative correlations were observed with student stressors, alcohol, and BMI.

4.3.4.2.2 Low Wellbeing

Females reported higher scores for the low wellbeing factor than did males. This was also the case for those who had attended state schools compared to those who had attended private/paid schools. Low wellbeing was further negatively correlated with household income, social support, positive personality, and sleep. In addition, low wellbeing was positively associated with student stressors, negative coping, and BMI.

4.3.4.2.3 Course Stress

Females reported significantly higher course stress scores than did males. Those who had attended state schools also reported higher course stress compared to those who had attended paid/private schools, though the effect was only marginally significant. In addition, course stress was positively correlated with student stressors and negative coping, and negatively correlated with positive personality, sleep, household income, and exercise (though the last two effects were only marginally statistically significant).

4.3.4.2.4 General Health

General health was higher in males compared to females, and correlated negatively with student stressors and negative coping. In addition, positive correlations were observed with positive personality, sleep, and social support, although this last relationship was only marginally significant.

4.3.5 Associations Between Weekly Caffeine Intake and Academic and Mental Health Outcomes

Weekly caffeine intake was calculated using the same method described in Chapter 3 (see section 3.3.5.1). The largest sources were energy drinks (range = 0-

2394mg/w, M = 348.8, SD = 336.59) and coffee (range = 0-3600mg/w, M = 340.88, SD = 505.56). Caffeine intake from tea was also relatively high (range = 0-2957.6mg/w, M = 296.2, SD = 386.46), and that consumed from cola was relatively low (range = 0-600mg/w, M = 51.85, SD = 82.11). Although caffeine intake from tea was slightly lower in the current study (Study 1 M = 321.19mg/w, SD = 341.33; Study 2 M = 296.2mg/w, SD = 386.46), consumption was considerably higher for energy drinks (Study 1 M = 34.87mg/w, SD = 86.93; Study 2 M = 348.8mg/w, SD = 336.59), cola (Study 1 M = 40.54mg/w, SD = 68.19; Study 2 M = 51.85mg/w, SD = 82.11), and coffee (Study 1 M = 216.93mg/w, SD = 374.04; Study 2 M = 340.88mg/w, SD = 505.56). Total weekly consumption was also therefore higher in the current study (Study 1 M = 615.75mg/w, SD = 511.35; Study 2 M = 1027.37mg/w, SD = 766.92).

Pearson's correlations determined that total weekly caffeine intake was positively associated with work efficiency, $r(266) = .181$, $p = .003$, low wellbeing, $r(246) = .228$, $p < .001$, and course stress, $r(266) = .2$, $p = .001$, though no relationship with general health was observed, $r(267) = -.039$, $p = .528$. In order to control for the covariates identified in the previous section, multiple linear regression analyses were conducted. The overall model fit for each outcome variable was significant: work efficiency, $F(12, 165) = 3.112$, $p = .001$, $R^2_{\text{Adjusted}} = .125$; low wellbeing, $F(12, 169) = 31.435$, $p < .001$, $R^2_{\text{Adjusted}} = .669$; course stress, $F(11, 166) = 3.775$, $p < .001$, $R^2_{\text{Adjusted}} = .147$; general health, $F(9, 230) = 5.051$, $p < .001$, $R^2_{\text{Adjusted}} = .132$. Total weekly caffeine intake remained positively associated with work efficiency, $\beta_{\text{Standardised}} = .294$, $p < .001$, and course stress, though the latter effect was now only marginally significant, $\beta_{\text{Standardised}} = .145$, $p = .052$. However, the association with low wellbeing disappeared, $\beta_{\text{Standardised}} = .054$, $p = .243$, and, as with the univariate analysis, no relationship was observed with general health, $\beta_{\text{Standardised}} = .056$, $p = .375$.

4.3.6 Associations Between the DABS Factors and Academic and Mental Health Outcomes

Associations between the four DABS factors and work efficiency, low wellbeing, course stress, and general health were initially investigated using Pearson's correlations. Factor scores for Energy Drinks & Cola and Hot Caffeinated Beverages were both positively correlated with low wellbeing and course stress. In addition, consumption of Hot Caffeinated Beverages was also positively correlated with work efficiency, and Energy Drinks & Cola was negatively correlated with general health (though this last relationship was only marginally significant). Junk Food consumption was also negatively correlated with general health, and Fish, Beans & Peas was not associated with any of the outcome measures. For all *r* and *p* values, see Table 4.10.

In order to investigate effects of the DABS factors further, all four of the factor scores were entered simultaneously into multiple linear regression models upon the outcomes of work efficiency, low wellbeing, and course stress. The same covariates as used in the previous multivariate analyses were again used here. Only three significant effects were observed: a negative correlation between Junk Food and general health, a positive correlation between Hot Caffeinated Beverages and work efficiency, and a positive correlation between Energy Drinks & Cola and course stress. For model fit, β and *p* values, see Table 4.11.

	Junk Food		**Energy Drinks & Cola**		**Hot Caffeinated Beverages**		**Fish, Beans & Peas**	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Work efficiency	-.022	.731	-.063	.315	.207	.001	-.038	.546
Low wellbeing	-.024	.716	.194	.003	.133	.042	-.104	.111
Course stress	.083	.186	.171	.007	.141	.025	-.01	.88
General health	-.15	.016	-.115	.068	.007	.907	.036	.563

Table 4.10. Correlations between DABS factor scores and academic and mental health outcomes from Study 2.
Note. All correlations are Pearson's (two-tailed).

	Model fit			**Junk Food**		**Energy Drinks & Cola**		**Hot Caffeinated Beverages**		**Fish, Beans & Peas**	
	F	*p*	R^2	β	*p*	β	*p*	β	*p*	β	*p*
Work efficiency	2.879	.001	.123	.094	.208	.045	.556	.276	< .001	-.026	.731
Low wellbeing	28.856	< .001	.672	-.045	.309	-.011	.816	.065	.151	-.008	.868
Course stress	3.341	< .001	.14	.024	.75	.157	.046	.089	.23	-.017	.834
General health	4.595	< .001	.135	-.148	.019	-.029	.669	.076	.236	.024	.709

Table 4.11. Multivariate associations between DABS factor scores and academic and mental health outcomes from Study 2.
Note. β values are standardised; R^2 *values are adjusted.*

4.3.7 Associations Between Breakfast and Energy Drink Consumption and Academic and Mental Health Outcomes

4.3.7.1 Individual Effects of Breakfast and Energy Drinks

As with Study 1, breakfast consumption was dicotomised as 'every day' vs. 'not every day' (answer 5 vs. answers 1, 2, 3, and 4). However, due to higher consumption in the current study, energy drink use was dicotomised as 'three times a week or more' vs. 'less than three times a week' (answers 4 and 5 vs. answers 1, 2, and 3). No differences were observed between those who ate breakfast every day and those who did not regarding work efficiency, $t(272) = -1.092$, $p = .276$, low wellbeing, $t(250) = 1.062$, $p = .289$, or course stress, $t(272) = 1.372$, $p = .171$. However, general health was marginally higher in those who consumed breakfast every day compared to those who did not, $t(273) = -1.815$, $p = .071$.

No differences were observed between those who consumed energy drinks three times a week or more and those who consumed them less than three times a week in relation to work efficiency, $t(272) = -.715$, $p = .475$, low wellbeing, $t(250) = -1.196$, $p = .233$, or general health, $t(273) = .171$, $p = .864$. However, those who consumed energy drinks three times a week or more did report significantly higher course stress, $t(272) = -2.023$, $p = .044$.

After controlling for covariates, energy drink use remained not associated with work efficiency, $F(1, 162) = .419$, $p = .518$, low wellbeing, $F(1, 166) = 1.266$, $p = .262$, and general health, $F(1, 228) = 1.282$, $p = .259$, and the effect relating to course stress disappeared, $F(1, 163) = 2.534$, $p = .113$. Likewise, breakfast consumption was not associated with work efficiency, $F(1, 164) = .957$, $p = .329$, course stress, $F(1, 165) = .596$, $p = .441$, or general health, $F(1, 229) = .199$, $p = .656$. Interestingly, those who did not eat breakfast every day achieved marginally higher low wellbeing scores than those who did eat breakfast every day, $F(1, 168) = 3.233$, $p = .074$.

4.3.7.2 Combined Effects of Breakfast and Energy Drinks

The dichotomous breakfast and energy drinks variables described in the previous section were combined to create the following groups: 1) breakfast every day/energy drinks less than three times a week, 2) breakfast every day/energy drinks three times a week or more, 3) breakfast not every day/energy drinks less than three times a week, 4) breakfast not every day/energy drinks three times a week or more. This variable was investigated in relation to the outcomes using one-way between-subjects ANOVAs. Breakfast and energy drink combinations were not associated with work efficiency, $F(3, 270) = .649$, $p = .584$, or general health, $F(3, 271) = 1.096$, $p = .351$, but marginally significant effects were observed for low wellbeing, $F(3, 248) = 2.146$, $p = .095$, and course stress, $F(3, 270) = 2.294$, $p = .078$. Although it would be inappropriate to use post-hoc tests because the effects were not statistically significant, it appeared that high scores for low wellbeing and course stress were associated with the infrequent breakfast/frequent energy drinks condition.

At the multivariate level the combined breakfast/energy drinks variable was not associated with work efficiency, $F(3, 160) = .318$, $p = .812$, low wellbeing, $F(3, 164) = 1.731$, $p = .163$, or general health, $F(3, 226) = .973$, $p = .406$. Though the association with course stress remained marginally significant, $F(3, 161) = 2.32$, $p = .077$, this, as in the univariate analysis, precluded the use of post hoc testing.

4.4 Discussion

Because the sample utilised in Study 1 contained relatively few high caffeine and energy drink consumers, Study 2 attempted to investigate dietary effects in a sample of students who claimed to be frequent users of energy drinks. The idea behind this was that, although the sample size was comparable to that of Study 1, the effects observed would be larger in high caffeine and energy drink users compared to a more general student sample, and so, would be easier to detect. This study therefore aimed, like Study 1, to examine the underlying factor structure of the DABS, and to investigate the effects of a number of dietary variables on work efficiency, low wellbeing, course stress, and general health. However, unlike Study 1, GPA was not used as an outcome variable here because the relevant information was not available.

4.4.1 Factor Structure Associated With the DABS in Study 2

Although the structure observed in the current study (i.e. Junk Food, Energy Drinks & Cola, Hot Caffeinated Beverages, and Fish, Beans & Peas) was clearly different from that of Study 1 (i.e. Junk Food, Healthy Foods, Energy Drinks & Coffee, and Tea), there were also some similarities. The first factor extracted in both studies was very similar, and generally represented a pattern of unhealthy eating. In relation to the other factors, the obvious difference was that caffeinated products loaded differently between the two studies; in Study 1 tea loaded onto its own factor, cola did not load strongly onto any one particular factor, and energy drinks and coffee went together, whereas in Study 2 energy drinks and cola went together, and tea and coffee went together. The factor labelled Fish, Beans & Peas in the current study, though consisting of different food types, can be seen to be similar to that named Healthy Foods in Study 1, as both factors essentially appeared to represent patterns of healthy eating.

A potential reason for the differences in factor structures observed between Study 1 and Study 2 is that the populations investigated were considerably different. Firstly, the participants in the current study were recruited due to claims of being frequent energy drink users, whereas those of Study 1 were not. As consumption of many foods and drinks are heavily inter-correlated (e.g. Northstone et al., 2005), this deliberate oversampling of energy drink users may have led to artificially increased/decreased correlations between certain dietary variables, potentially altering the nature of the factors extracted. In addition, though the participants in both studies were students at Cardiff University, those in Study 1 were all first or second year undergraduates studying psychology, whereas this was not the case in Study 2. However, another possible explanation for the considerable differences observed is that neither sample from Study 1 nor Study 2 was large enough to produce a consistent and verifiable factor structure.

Although the subscales for three of the four factors extracted in the current study were observed to have acceptable levels of internal consistency, that relating to the factor labelled Fish, Beans & Peas did not. However, as the subscale scores were only used here as control variables, this was deemed not to have been of major importance. Along with the observation that the four-factor models differed considerably between Study 1 and Study 2, this finding does nevertheless indicate that further examination of the underlying structure of the DABS in university students is required.

4.4.2 Dietary Patterns Associated With Academic and Mental Health Outcomes

4.4.2.1 Caffeine Consumption

Total weekly caffeine consumption correlated positively with work efficiency, and the effect remained significant at the multivariate level. This finding was unexpected because GPA, which is known to be strongly associated with work efficiency, has previously been reported to correlate negatively with caffeine intake (Gilliland & Andress, 1981; James et al., 2011).

Although caffeine was not associated with low wellbeing in Study 1, its total weekly intake correlated positively with this variable in the current study. However, when covariates were controlled for, this effect disappeared, suggesting that it might have been explainable by personality factors or variations in demography and lifestyle. In a similar manner to the effects observed with low wellbeing, caffeine was positively associated with course stress in the current study (the effect remaining marginally significant at the multivariate level), although no such observation had been made in Study 1. General health, as in Study 1, was not associated with caffeine intake at either the univariate or multivariate level.

Taken together, the findings discussed in this section are considerably different from those of Study 1, which observed very little evidence of relationships between caffeine intake and academic and mental health outcomes. The findings reported here also support the idea that such effects may occur at high levels of consumption, and therefore justify having collected data specifically from frequent users of energy drinks. Of particular interest was the finding that caffeine was associated with both beneficial (high work efficiency) and unfavourable (low wellbeing and high course stress) outcomes in this population.

4.4.2.2 DABS Factor Scores

Although consumption of Fish, Beans & Peas was unrelated to any of the outcome variables investigated, relationships were observed with each of the other three factors. As might be expected, Junk Food consumption was negatively correlated with general health, and the effect remained significant at the multivariate level. Initial positive correlations were also observed between Hot Caffeinated Beverages and work efficiency, low wellbeing, and course stress, and between Energy Drinks & Cola and low wellbeing, course stress, and general health (though this last effect was only marginally significant). These relationships are therefore similar to those observed in Study 1, where the factor labelled Energy Drinks & Coffee correlated negatively with GPA and work efficiency, and positively with low wellbeing. However, whereas none of the relationships observed in Study 1 retained statistical significance at the multivariate level, some of those in the current study did: work efficiency remained positively associated with consumption of Hot Caffeinated Beverages, which likely reflects similar relationships between caffeine consumed from coffee and tea discussed in the previous section, and consumption of Energy Drinks & Cola remained positively associated with course stress. This latter effect is similar to a number of studies (e.g. Hofmeister et al, 2010; Pettit & DeBarr, 2011; Trapp et al., 2014), which have reported energy drink use to be associated with high stress levels, and may reflect the observation that students sometimes use caffeinated products as a coping strategy (e.g. Ríos et al., 2013). However, in the context of a cross-sectional analysis, it is not possible to infer whether such relationships are causal, and if so, in which direction the effects lie.

4.4.2.3 Breakfast Omission and Frequent Energy Drink Consumption

Consuming energy drinks three times a week or more was related to high course stress in the current study. Although this association did not remain significant at the multivariate level, it was of interest as no such effect was observed in Study 1. In addition, Study 1 reported associations between the frequency of breakfast and energy drink consumption and low wellbeing, whereas no such univariate level effects were observed here. However, though those effects in Study 1 did not remain significant after controlling for covariates, the multivariate analysis presented for the current study observed marginally higher low wellbeing scores in those who did not eat breakfast every day compared to those who did. Therefore, although the effects observed differed somewhat between studies, they were broadly comparable to each other. In addition, lower general health was associated with breakfast omission in both studies, though the effect reported in the current chapter was only marginally significant, and neither remained significant at the multivariate level.

Whereas Study 1 observed a significant univariate level effect in which a combination of breakfast omission and frequent energy drink consumption predicted low work efficiency, this effect was not replicated in the current study. Furthermore, Study 1 also made a similar finding in relation to low wellbeing; though a comparable effect was observed in the current study, it did not achieve statistical significance. In addition, the current study observed a marginally significant effect (which remained marginally significant after controlling for covariates) in which a combination of frequent breakfast omission and energy drink consumption was related to high course stress. Study 1, however, did not observe such an effect. Furthermore, Study 1 reported a combined effect in which the breakfast not every day/energy drinks never condition reported lower general health than did the breakfast every day/energy drinks never condition: no comparable effect was detected in Study 2.

Taken together, though the effects observed differed considerably between studies, and none remained statistically significant at the multivariate level, the findings from Study 1 and Study 2 broadly point towards a combination of breakfast omission and energy drink consumption being associated with undesirable academic and mental health outcomes. This is therefore considered to be a dietary pattern that warrants further investigation.

4.4.3 Limitations and Directions for Further Research

Whereas Study 1 investigated a population of undergraduate psychology students, Study 2 specifically recruited frequent users of energy drinks with the idea that doing so would make observing effects relating to caffeine and energy drinks more likely. However, this method was also a limitation in that the participants came from a very specific demographic group. Furthermore, the use of energy drinks was made explicit in the advert used to recruit participants, whereas this was not the case for Study 1: this may therefore have influenced responses. In addition, due to having included a prize-draw, Study 2 is likely to have attracted participants who would not otherwise have taken part. These limitations therefore make it difficult to reliably compare the findings from Study 2 to those of Study 1, and also limit generalisability to wider student populations.

Another issue with the methodology of Study 2 is that, unlike Study 1, it was not possible to investigate dietary associations with GPA. Although work efficiency is known to be strongly associated with GPA, a direct measure of academic attainment is clearly more desirable, and so, findings relating to work efficiency should be interpreted with caution. However, due to recruiting participants from the university as a whole, rather than from a specific course, participants' GPA may have differed depending on the grading systems utilised by their respective departments. Combined with the need for such a measure to also rely upon self-report, this would likely have reduced its reliability.

A major methodological issue encountered in both Study 1 and Study 2 is that they were only cross-sectional, and so, cause and effect could not be determined. For instance, although high caffeine intake might be a cause of low wellbeing, low wellbeing might also lead to the use of caffeinated products as a coping strategy. It is also quite possible that such relationships are bidirectional. In an attempt to address these issues, Chapter 5 will present findings from a longitudinal study of undergraduate students, for which change score analyses were conducted, and GPA was once again used as an outcome variable.

Chapter 5: A Longitudinal Analysis of Dietary Effects on Academic Performance and Mental Health in University Students

5.1 Introduction

Chapters 3 and 4 provided evidence to suggest that certain dietary patterns, which involve the consumption of energy drinks, may be associated with both academic and mental health outcomes in British university students. However, an issue with the studies so far presented is that they were cross-sectional, and so, causation could not be inferred. For this reason the current chapter presents findings from a longitudinal study of first year undergraduate psychology students.

As with the previous two chapters, this chapter aims to investigate the underlying structure of the DABS. In addition, it aims to determine whether caffeine intake, breakfast and energy drink consumption (both in isolation and in combination), and the DABS factor scores are able to predict variance in GPA, work efficiency, low wellbeing, course stress, and general health at 10-week follow-up. The final aim of the current chapter was to determine whether changing caffeine intake between the two time-points was predictive of these outcome measures.

5.2 Method

Data presented in the current chapter came from a longitudinal study comprised of two cross-sections. Data from Time 1 (T1) were collected from a new cohort of first year undergraduate psychology students at Cardiff University during an introduction to research workshop held in the first week of the academic term. Data from Time 2 (T2) were collected 10 weeks later; as T2 has already been analysed cross-sectionally in Chapter 3, only a limited description of the sample will be provided here. For ease of reporting, the study described in this chapter will be referred to as 'Study 3'.

5.2.1 Participants

At T1, 189 participants completed the questionnaires. Although demographic information was not collected at this time-point, data from T2 could be used for the

130 participants who completed the study at both time-points. Of these 130, information relating to sex was available for 129; 14 (10.9%) were male, and 115 (89.1%) were female. Information relating to age was available for 125, and the sample ranged from 18 to 45 (M = 19.59, SD = 2.47). It should however be noted that, as data collection at T2 occurred 10 weeks after that of T1, the mean age reported at T1 for these participants would have been slightly inflated. Although the vast majority (N = 124, 95.4%) taking part at T1 were in their first year, six (4.6%) were second year students. The likely reason for this is that some second year students who had not taken part in the introduction to research event during their own first year attended in their second year instead.

5.2.2 Apparatus/Materials

As in previous chapters, the Diet and Behaviour Scale (DABS) was used as an assessment of diet over the previous six months, and this measure was administered at both time-points. All other measures (wellbeing, demographic, and lifestyle) were collected at T2, and have already been described in detail in Chapter 3.

5.2.3 Design & Procedure

Data from T1 were acquired by administering pen and paper questionnaires during an introductory event held in the first week of the autumn semester. The second cross-section (T2) was collected using an online survey, hosted by Qualtrics, for which participants received course credits for taking part. Participants' GPA was acquired from Cardiff University SIMS.

5.2.4 Statistical Analysis

As cross-sectional analyses from T2 have already been presented in Chapter 3, no such cross-sectional analyses are presented here. Demographic and lifestyle information relating to those who took part at the first time-point are provided from a combination of data collected at both T1 and T2, and a factor analysis of the DABS from T1 is explored. Cross-lag analyses were then conducted in order to determine whether dietary consumption (i.e. caffeine intake, consumption of breakfast and energy drinks, and variance in the DABS factors) from T1 could predict variance in the outcome measures (i.e. GPA, work efficiency, low wellbeing, course stress, and general health) at T2. This was then followed up with a change-score analysis of caffeine, in order to determine whether increasing in consumption between the two time-points was related to variance in the outcome measures at T2. No change-score analyses of the DABS factors were conducted because the factor structures were not consistent across the two time-points. In multivariate analyses, the same covariates were used as identified in Chapter 3, section 3.3.4.2 (from T2; see Table 5.1).

5.3 Results

5.3.1 Demography and Lifestyle

Exercise participation was relatively common, with the majority claiming to perform low intensity exercise three times a week or more, and moderate intensity exercise once or twice a week; nearly half of participants took part in vigorous exercise at least once per week. As with previously reported data, few participants were smokers, alcohol consumption was relatively high, and most achieved seven or eight hours of sleep per night. For frequency and descriptive statistics from T1, see Table 5.2.

As data relating to a number of demographic variables were not collected at T1, those from T2 are used where available. These data showed that the majority (75.4%) attended state secondary schools, with 24.6% having attended private/paid schools. Average household income was relatively high, though varied considerably between participants (M = £48,036.84, SD = 37907.28), and a mean BMI of 22.06 (SD = 3.99) was observed. Frequency and descriptive statistics for each of the other lifestyle variables collected at T2 are displayed for the participants present at T1 in Table 5.3.

5.3.2 Dietary Intake and Factor Analysis

As with the previously reported studies, dietary intake was found to vary considerably (for frequencies and descriptive statistics relating to each of the single-item measures included in the DABS at T1, see Table 5.4). All 29 items from the DABS at T1 were then entered into an exploratory factor analysis. This produced

Covariates specific to each outcome variable that are included in all multivariate analyses presented in Chapter 5				
GPA	**Work efficiency**	**Low wellbeing**	**Course stress**	**General health**
Smoker (dichotomous; yes or no)	Smoker (dichotomous; yes or no)	Smoker (dichotomous; yes or no)	Year of course (dichotomous; 1 or 2)	Smoker (dichotomous; yes or no)
Year of course (dichotomous; 1 or 2)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)	Student stressors (continuous; factor score)
Age (continuous)	Social support (continuous; factor score)	Social support (continuous; factor score)	Negative coping (continuous; factor score)	Social support (continuous; factor score)
Student stressors (continuous; factor score)	Negative coping (continuous; factor score)	Negative coping (continuous; factor score)	Positive personality (continuous; factor score)	Negative coping (continuous; factor score)
Social support (continuous; factor score)	Positive personality (continuous; factor score)	Positive personality (continuous; factor score)	Sleep (continuous; factor score)	Positive personality (continuous; factor score)
Sleep (continuous; factor score)	Sleep (continuous; factor score)	Sleep (continuous; factor score)	Alcohol (continuous; factor score)	Sleep (continuous; factor score)
Mean A-level grade (continuous)	Alcohol (continuous; factor score)	Exercise (continuous; factor score)	Exercise (continuous; factor score)	Exercise (continuous; factor score)
BMI (continuous)	BMI (continuous)	Mean A-level grade (continuous)		
		BMI (continuous)		
Additional covariates entered when the predictor variable is total weekly caffeine intake at T1 or changes in total weekly caffeine consumption between T1 and T2.				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Additional covariates entered when the predictor variable is frequency of breakfast consumption at T1				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)	Total weekly caffeine intake (continuous)
Additional covariates entered when the predictor variable is frequency of energy drink consumption at T1 or the combined effects of breakfast and energy drinks at T1				
Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)	Junk Food DABS subscale score (continuous)
Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)	Healthy Foods DABS subscale score (continuous)
Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)	Caffeine from cola (continuous)
Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)	Caffeine from coffee (continuous)
Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)	Caffeine from tea (continuous)

Table 5.1. List of covariates included in all multivariate analyses presented in Chapter 5.

Note. Covariates specific to each outcome variable were determined by correlational analyses presented in Chapter 3, section 3.3.4.2; all covariates are from T2.

		Never/ hardly ever	About once to three times a month	Once or twice a week	Three times a week or more	*M* (hours per week)	*SD*
Exercise	Mildly energetic	1 (.5%)	2 (1.1%)	29 (15.3%)	157 (83.1%)	8.72	7.94
	Moderately energetic	5 (2.8%)	33 (18.4%)	97 (54.2%)	44 (24.6%)	3.59	3.66
	Vigorous	49 (26.3%)	48 (25.8%)	57 (30.6%)	32 (17.2%)	2.39	3
		Never	**1-2 days**	**3 days**	**4 days**	***M* (units)**	***SD***
Alcohol	Weekdays	55 (29.1%)	114 (60.3%)	16 (8.5%)	4 (2.1%)	5.45	4.92
		Never	**1-2 days**	**3 days**	***M* (units)**	***SD***	
	Weekend days	23 (12.4%)	162 (87.1%)	1 (.5%)	6.64	4.6	
		5 hours or less	**6 hours**	**7 hours**	**8 hours**	**9+ hours**	
Sleep	Hours per night	5 (2.7%)	32 (17%)	68 (36.2%)	72 (38.3%)	11 (5.9%)	
		Yes	**No**	**Manufactured**	**Hand-rolled**		
				M	*SD*	*M*	*SD*
Smoking	Smoker	19 (10.1%)	170 (89.9%)	.68	1.92	.28	1.42

Table 5.2. Frequency data for lifestyle variables from Study 3 at T1.

a four-factor model, which explained 38.1% of variance. The factors extracted were labelled 'Junk Food & Absence of Coffee', 'Energy Drinks, Cola & Absence of Breakfast', 'Fruit, Veg & Gum', and 'Tea, Sweets & Chocolate', and, although some resembled those observed at T2 (i.e. Junk Food, Healthy Foods, Energy Drinks & Coffee, and Tea), there were also some obvious differences. For factor loading scores, initial eigenvalues, and percentages of variance explained by each of the factors extracted at T1, see Table 5.5. As with previous analyses, subscales were created for each factor score by recoding the single-items into tertiles, and then adding the relevant values together. In this case however, items that loaded negatively (i.e. breakfast and coffee) were reverse-coded before the subscales were computed so that a high number indicated low consumption. Standardised Cronbach's alpha values were acceptable or better for each subscale (other than for Fruit, Veg & Gum, for which the value was considered poor by conventional standards; e.g. Kline, 1999): Junk Food & Absence of Coffee (Q3, Q5, Q11, Q17, Q21, Q23, Q25) $\alpha = .723$, Energy Drinks, Cola & Absence of Breakfast (Q1, Q7, Q8, Q19, Q20) $\alpha = .727$, Fruit, Veg & Gum (Q4, Q9, Q26, Q27, Q28) = $\alpha = .563$, Tea, Sweets & Chocolate (Q2, Q6, Q10, Q22, Q24) $\alpha = .663$. Pearson's correlations were then used to determine whether the subscales measured similar concepts as the factor scores. Strong positive correlations were observed between each subscale and its respective factor score: Junk Food & Absence of Coffee, $r(173) = .9$, $p < .001$; Energy Drinks, Cola & Absence of Breakfast, $r(173) = .878$, $p < .001$, Fruit, Veg & Gum, $r(173) = .804$, $p < .001$; Tea, Sweets & Chocolate, $r(173) = .883$, $p < .001$.

		0 days	**1 day**	**2 days**	**3 days**	**4 days**	**5 days**	**6 days**	**7 days**	***M* (hours)**	***SD***
Weekly exercise	Overall exercise	9 (7.1%)	6 (4.7%)	14 (11%)	21 (16.5%)	15 (11.8%)	28 (22%)	10 (7.9%)	24 (18.9%)	5.77	5.1
	Cardio	41 (32.5%)	22 (17.5%)	23 (18.3%)	17 (13.5%)	15 (11.9%)	4 (3.2%)	3 (2.4%)	1 (.8%)	2.13	2.23
	Strength	72 (56.7%)	19 (15%)	13 (10.2%)	7 (5.5%)	7 (5.5%)	4 (3.1%)	0 (0%)	5 (3.9%)	.92	1.61
	Low intensity	17 (13.4%)	9 (7.1%)	5 (3.9%)	4 (3.1%)	6 (4.7%)	29 (22.8%)	7 (5.5%)	50 (39.4%)	4.28	3.48
	Medium intensity	79 (62.2%)	22 (17.3%)	11 (8.7%)	8 (6.3%)	3 (2.4%)	2 (1.6%)	0 (0%)	2 (1.6%)	.7	1.14
	High intensity	75 (59.1%)	17 (13.4%)	14 (11%)	6 (4.7%)	8 (6.3%)	4 (3.1%)	1 (.8%)	2 (1.6%)	1.13	1.95
		Never	**1 day**	**2-3 days**	**4-5 days**	**6-7 days**	***M* (units)**	***SD***			
Weekly alcohol	Days in week	17 (13.3%)	37 (28.9%)	71 (55.5%)	2 (1.6%)	1 (.8%)	9.57	8.52			
		5 hours or less	**6 hours**	**7 hours**	**8 hours**	**9+ hours**					
Sleep	Hours per night	10 (7.7%)	21 (16.2%)	50 (38.5%)	45 (34.6%)	4 (3.1%)					
		Never	**Sometimes**	**Often**	**Always**						
	Good quality sleep	1 (.8%)	64 (49.2%)	62 (47.7%)	3 (2.3%)						
		Yes	**No**								
Smoking	Smoker	14 (10.8%)	116 (89.2%)								
		Yes	**No**								
Mix alcohol	With caffeine	59 (46.8%)	67 (53.2%)								

Table 5.3. Frequency data for lifestyle variables for participants that took part in Study 3 at T1 (from data collected at T2).

Frequency	***N***	**Never**	**Once a month**	**Once/twice a week**	**Most days (3-6)**	**Every day**
Breakfast	189	9 (4.8%)	4 (2.1%)	22 (11.6%)	64 (33.9%)	**90 (47.6%)**
Chocolate	189	2 (1.1%)	27 (14.3%)	**91 (48.1%)**	54 (28.6%)	15 (7.9%)
Crisps	189	12 (6.3%)	60 (31.7%)	**74 (39.2%)**	35 (18.5%)	8 (4.2%)
5+ fruit or veg	189	6 (3.2%)	15 (7.9%)	68 (36%)	**83 (43.9%)**	17 (9%)
Coffee	189	**79 (41.8%)**	37 (19.6%)	32 (16.9%)	21 (11.1%)	20 (10.6%)
Tea	189	45 (23.8%)	12 (6.3%)	28 (14.8%)	45 (23.8%)	**59 (31.2%)**
Cola	189	30 (15.9%)	44 (23.3%)	**77 (40.7%)**	32 (16.9%)	6 (3.2%)
Energy drinks	189	**104 (55%)**	56 (29.6%)	26 (13.8%)	3 (1.6%)	0 (0%)
Gum	189	41 (21.7%)	48 (25.4%)	**49 (25.9%)**	37 (19.6%)	14 (7.4%)
Sweets	187	8 (4.3%)	66 (35.3%)	**95 (50.8%)**	15 (8%)	3 (1.6%)
Fast-food	189	16 (8.5%)	**106 (56.1%)**	64 (33.9%)	3 (1.6%)	0 (0%)
Take-away	189	31 (16.4%)	**131 (69.3%)**	23 (12.2%)	4 (2.1%)	0 (0%)
Pies or pasties	189	68 (36%)	**90 (47.6%)**	30 (15.9%)	1 (.5%)	0 (0%)
Processed meat	188	**83 (44.1%)**	58 (30.9%)	35 (18.6%)	11 (5.9%)	1 (.5%)
Fried fish	189	54 (28.6%)	**102 (54%)**	29 (15.3%)	4 (2.1%)	0 (0%)
Oily fish	189	41 (21.7%)	58 (30.7%)	**77 (40.7%)**	13 (6.9%)	0 (0%)
Chips	188	14 (7.4%)	**90 (47.9%)**	79 (42%)	5 (2.7%)	0 (0%)
Beans or peas	189	11 (5.8%)	23 (12.2%)	**113 (59.8%)**	40 (21.2%)	2 (1.1%)

Amount	***N***	**Min**	**Max**	***M***	***SD***
Energy drinks	189	0	6	.4	.95
Cola	189	0	14	1.77	2.17
Coffee	189	0	30	2.59	4.72
Tea	188	0	50	7.13	8.49
Crisps	189	0	8.5	2.1	1.97
Chocolate	188	0	10	2.6	2.13
Burgers/hot dogs	187	0	3	.48	.62
Gum	188	0	10	.92	1.24
Fruit	187	0	10	2.28	1.39
Veg	187	0	7	2.28	1.13
Water	183	0	10	2.74	1.61

Table 5.4. Frequencies and descriptive statistics for all DABS items from T1.
Note. Modal values for frequency items are displayed in bold. All amount of consumption items were measured per week other than fruit, vegetables, and water, which were measured per day.

	Junk Food & Absence of Coffee	Energy Drinks, Cola & Absence of Breakfast	Fruit, Veg & Gum	Tea, Sweets & Chocolate
Q1. How often did you eat breakfast?	.041	**-.474**	.031	.155
Q2. How often did you eat chocolate?	.368	-.07	-.057	**.535**
Q3. How often did you eat crisps?	**.672**	.019	-.031	.14
Q4. How often did you eat five pieces of fruit or veg?	-.165	-.385	**.545**	.054
Q5. How often did you drink coffee?	**-.591**	.282	-.063	.291
Q6. How often did you drink tea?	-.21	-.13	.165	**.68**
Q7. How often did you drink cola?	.16	**.661**	-.25	.17
Q8. How often did you drink energy drinks?	.075	**.723**	.139	-.103
Q9. How often did you chew gum?	-.034	.367	**.456**	.149
Q10. How often did you eat sweets?	.167	.11	-.014	**.545**
Q11. How often did you eat fast-food?	**.544**	.313	-.026	.137
Q12. How often did you eat takeaway?	.229	.049	.245	-.027
Q13. How often did you eat pies or pasties?	.258	-.024	-.08	.388
Q14. How often did you eat processed meat?	.293	.079	-.131	.057
Q15. How often did you eat fried fish?	.347	.26	.139	.203
Q16. How often did you eat oily fish?	-.062	.008	.417	.028
Q17. How often did you eat chips?	**.57**	.232	-.101	.19
Q18. How often did you eat beans or peas?	.106	-.039	.382	-.137
Q19. Cans of energy drink per week	.07	**.63**	.166	-.157
Q20. Cans of cola per week	.134	**.687**	-.231	.027
Q21. Cups of coffee per week	**-.589**	.258	-.15	.286
Q22. Cups of tea per week	-.146	-.165	.05	**.659**
Q23. Packets of crisps per week	**.665**	-.003	-.022	.058
Q24. Bars of chocolate per week	.406	-.007	-.159	**.483**
Q25. Burgers/hot dogs per week	**.537**	.178	-.018	.017
Q26. Packs of chewing gum per week	-.094	.359	**.582**	.114
Q27. Pieces of fruit per day	-.001	-.12	**.564**	.05
Q28. Portions of vegetables per day	-.03	-.038	**.685**	-.106
Q29. Pints of water per day	-.087	-.254	.269	-.026
Initial eigenvalue	3.946	2.65	2.29	2.164
Percentage of variance explained	11.5%	10.39%	8.23%	7.98%

Table 5.5. Exploratory factor analysis of DABS items from T1.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .45 (and < -.45) are displayed in bold.

Table 5.6 displays the correlations and differences between each of the single-item DABS measures between the two time-points. In each case, significant positive correlations were observed: however, although it was predicted that diet would change noticeably between T1 and T2, few differences were observed, and no significant increases in consumption occurred. The frequency of consuming sweets and processed meat decreased, and so did the amount (but not the frequency) of consuming crisps. The amount of energy drinks consumed also decreased, though the frequency of their consumption did not change significantly. There were also trends for the frequency of consuming chips, and pies/pasties, as well as the amount of fruit, to decrease.

	Correlation		Difference	
	rho	*p*	*t*	*p*
Q1. How often did you eat breakfast?	.587	< .001	-.38	.704
Q2. How often did you eat chocolate?	.514	< .001	-1.435	.154
Q3. How often did you eat crisps?	.5	< .001	1.106	.271
Q4. How often did you eat five pieces of fruit or veg?	.586	< .001	1.574	.118
Q5. How often did you drink coffee?	.833	< .001	-.923	.358
Q6. How often did you drink tea?	.849	< .001	-.628	.531
Q7. How often did you drink cola?	.592	< .001	.886	.377
Q8. How often did you drink energy drinks?	.517	< .001	1.469	.144
Q9. How often did you chew gum?	.742	< .001	.682	.497
Q10. How often did you eat sweets?	.568	< .001	2.227	.028
Q11. How often did you eat fast-food?	.523	< .001	.848	.398
Q12. How often did you eat takeaway?	.468	< .001	.744	.458
Q13. How often did you eat pies or pasties?	.52	< .001	1.795	.075
Q14. How often did you eat processed meat?	.531	< .001	2.555	.012
Q15. How often did you eat fried fish?	.578	< .001	1.348	.18
Q16. How often did you eat oily fish?	.761	< .001	.507	.613
Q17. How often did you eat chips?	.468	< .001	1.961	.052
Q18. How often did you eat beans or peas?	.551	< .001	-1.451	.149
Q19. Cans of energy drink per week	.492	< .001	1.975	.05
Q20. Cans of cola per week	.47	< .001	1.225	.223
Q21. Cups of coffee per week	.819	< .001	-.442	.659
Q22. Cups of tea per week	.877	< .001	.119	.905
Q23. Packets of crisps per week	.602	< .001	2.691	.008
Q24. Bars of chocolate per week	.676	< .001	-.143	.887
Q25. Burgers/hot dogs per week	.364	< .001	.726	.469
Q26. Packs of chewing gum per week	.723	< .001	1.509	.134
Q27. Pieces of fruit per day	.372	< .001	1.854	.066
Q28. Portions of vegetables per day	.489	< .001	-.277	.783
Q29. Pints of water per day	.546	< .001	.213	.832

Table 5.6. Correlations and differences between DABS single-items at T1 and T2.
Note. All correlations are Spearman's (two-tailed).

5.3.3 Correlates of the DABS Factors

Pearson's and Spearman's correlations and between-subjects t-tests were used to investigate relationships between the DABS factor scores from T1 and the control variables that were also collected at that time-point. Compared to non-smokers, smokers achieved higher scores on Energy Drinks, Cola, & Absence of Breakfast. Smokers also achieved higher scores than non-smokers for Junk Food & Absence of Coffee, and Tea, Sweets & Chocolate, though both of these effects were only marginally statistically significant. Fruit, Veg & Gum consumption was positively correlated with sleep hours, alcohol consumption, and exercise frequency. Consumption of Energy Drinks, Cola & Absence of Breakfast and Tea, Sweets & Chocolate were both negatively correlated with sleep hours. For outcomes from all t-tests and correlations, see Table 5.7.

	Junk Food & Absence of Coffee		Energy Drinks, Cola & Absence of Breakfast		Fruit, Veg & Gum		Tea, Sweets & Chocolate	
Differences	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*
Smoker	-1.938	.054	2.617	.01	.91	.364	-1.906	.058
Correlations	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Sleep hours	.082	.284	-.271	< .001	.19	.012	-.165	.029
Alcohol factor	.067	.414	.063	.445	.164	.045	-.033	.688
Exercise factor	-.057	.477	-.097	.224	.259	.001	-.059	.46

Table 5.7. Relationships between DABS factors and control variables from T1.
Note. All correlations reported are Pearson's, except for those relating to sleep hours, which are Spearman's.

5.3.4 Longitudinal Associations Between Caffeine Intake and Academic and Mental Health Outcomes

5.3.4.1 Cross-Lag Associations Between Caffeine Intake and Academic and Mental Health Outcomes

In order to determine whether caffeine intake at T1 was associated with subsequent variance in the outcome variables at T2, Pearson's correlations were conducted. This analysis found that total weekly caffeine intake at T1 was positively associated with low wellbeing, $r(123) = .225$, $p = .011$, and course stress at T2, $r(127) = .271$, $p = .002$, though no significant relationships were observed with GPA, $r(133) = -.099$, $p = .253$, work efficiency, $r(127) = -.139$, $p = .117$, or general health, $r(127) = -.11$, $p = .214$.

In order to control for variance from the covariates at T2 identified in Chapter 3, multiple linear regression analyses were conducted. The model fit was significant for each of the analyses: GPA, $F(11, 90) = 2.571$, $p = .007$, $R^2_{\text{Adjusted}} = .146$; work efficiency, $F(11, 98) = 3.852$, $p < .001$, $R^2_{\text{Adjusted}} = .223$; low wellbeing, $F(12, 83) = 20.068$, $p < .001$, $R^2_{\text{Adjusted}} = .707$; course stress, $F(10, 97) = 3.252$, $p = .001$, $R^2_{\text{Adjusted}} = .174$; general health, $F(10, 100) = 4.784$, $p < .001$, $R^2_{\text{Adjusted}} = .256$. A marginally significant positive association between total weekly caffeine intake at T1 and course stress at T2 was detected, $\beta_{\text{Adjusted}} = .159$, $p = .093$, though no relationships were observed with the other outcome variables: GPA, $\beta_{\text{Adjusted}} = .027$, $p = .808$; work efficiency, $\beta_{Adjusted}$ = -.134, p = .161; low wellbeing, $\beta_{Adjusted}$ = .015, p = .808; general health, $\beta_{Adjusted}$ = .104, p = .246.

5.3.4.2 Associations Between Changes in Caffeine Intake and Academic and Mental Health Outcomes

Pearson's correlations determined that total weekly caffeine intake at T1 was positively correlated with total weekly caffeine intake at T2, $r(126) = .81$, $p < .001$. The same was also true for each source of the substance: energy drinks, $r(128) = .463$, $p < .001$; cola, $r(127) = .363$, $p < .001$; coffee, $r(128) = .85$, $p < .001$; tea, $r(127) = .773$, $p < .001$. A within-subjects t-test determined that caffeine consumed from energy drinks was marginally lower at T2 compared to T1, $t(129) = -1.975$, $p = .05$. However, no differences between time-points were detected for total weekly caffeine intake, $t(127) = .609$, $p = .543$, or caffeine consumed from cola, $t(128) = 1.225$, $p = .223$, coffee, $t(129) = .442$, $p = .659$, or tea, $t(128) = .119$, $p = .905$.

A percentage change score for total weekly caffeine consumption was calculated in the following manner: (T2 total caffeine − T1 total caffeine) ⁄ T1 total caffeine × 100. This variable was then recoded into three groups: 'increase' (N = 56; 43.8%), 'decrease' (N = 62; 48.4%), and 'no change' (N = 10; 7.8%). The 'decrease' and 'no change' groups were then collapsed and compared to the 'increase' group using between-subjects t-tests. The analysis found no significant differences between the two groups regarding T2 scores for GPA, $t(126) = -.808$, $p = .421$, work efficiency, $t(126) = -1.065$, $p = .289$, low wellbeing, $t(122) = 1.645$, $p = .103$, course stress, $t(126) = 1.492$, $p = .138$, or general health, $t(126) = -1.158$, $p = .249$.

When ANCOVAs were run, the model fit was significant for each outcome variable: GPA: $F(11, 90) = 2.564$, $p = .007$, $R^2_{Adjusted} = .146$; work efficiency, $F(11, 97) = 3.587$, $p < .001$, $R^2_{Adjusted} = .209$; low wellbeing, $F(12, 83) = 20.126$, $p < .001$, $R^2_{Adjusted} = .707$; course stress, $F(10, 96) = 3.102$, $p = .002$, $R^2_{Adjusted} = .165$; general health, $F(10, 99) = 4.606$, $p < .001$, $R^2_{Adjusted} = .249$. However, as with the univariate level analysis, no differences were observed between the increase and no increase groups for any of the outcome variables: GPA, $F(1, 90) = .001$, $p = .97$; work efficiency, $F(1, 97) = .029$, $p = .864$; low wellbeing, $F(1, 83) = .238$, $p = .627$; course stress, $F(1, 96) = 1.329$, $p = .252$; general health, $F(1, 99) = .5$, $p = .481$.

5.3.5 Cross-Lag Associations Between Breakfast and Energy Drink Consumption and Academic and Mental Heath Outcomes

As with the cross-sectional analyses presented in Chapter 3, breakfast was coded as 'every day' vs. 'not every day', energy drink consumption was coded as 'sometimes' vs. 'never', and associations were investigated using between-subjects t-tests. Energy drink consumption at T1 was not associated with any of the outcome variables at T2: GPA, $t(134) = .419$, $p = .676$; work efficiency, $t(128) = -.446$, $p = .656$; low wellbeing, $t(124) = -1.103$, $p = .272$; course stress, $t(128) = -1.482$, $p = .141$; general health, $t(128) = 1.553$, $p = .123$. Likewise, breakfast consumption at T1 was not associated with later outcomes for GPA, $t(134) = 1.024$, $p = .308$, work efficiency $t(128) = -1.256$, $p = .211$, course stress, $t(128) = -1.552$, $p = .123$, or general health, $t(128) = 1.478$, $p = .142$. However, those who did not eat breakfast every day at T1 were found to report higher low wellbeing scores at T2, $t(124) = -2.543$, $p = .012$.

As with Chapter 3, breakfast and energy drinks were combined into the following four groups: 1) breakfast every day/energy drinks never, 2) breakfast every day/energy drinks sometimes, 3) breakfast not every day/energy drinks never, 4) breakfast not every day/energy drinks sometimes. This variable was then investigated in relation to the outcomes using one-way ANOVAs. These groups were not significantly associated with any of the outcome variables at T2: GPA, $F(3, 132) = .738$, $p = .531$; work efficiency, $F(3, 126) = .61$, $p = .61$; low wellbeing, $F(3, 122) = 2.19$, $p = .093$; course stress, $F(3, 126) = 1.369$, $p = .255$; general health, $F(3, 126) = 1.387$, $p = .25$ (though it should be noted that a marginally significant effect was observed in relation to low wellbeing).

ANCOVAs were used to examine the effects of breakfast and energy drinks at the multivariate level. When investigating breakfast, each model fit was significant: GPA, $F(12, 90) = 2.558$, $p = .006$, $R^2_{\text{Adjusted}} = .155$; work efficiency, $F(12, 97) = 4.62$, $p < .001$, $R^2_{\text{Adjusted}} = .285$; low wellbeing, $F(13, 83) = 18.969$, $p < .001$, $R^2_{\text{Adjusted}} = .709$; course stress, $F(11, 96) = 2.932$, $p = .002$, $R^2_{\text{Adjusted}} = .166$; general health, $F(11, 99) = 4.638$, $p < .001$, $R^2_{\text{Adjusted}} = .267$. The breakfast every day and breakfast not every day conditions at T1 did not differ regarding later outcomes for GPA, $F(1, 90)$

= 2.227, p = .139, low wellbeing, $F(1, 83) = .209$, p = .649, course stress, $F(1, 96)$ = .117, p = .733, or general health, $F(1, 99) = 1.552$, p = .216.

When investigating energy drinks, the model fit was significant for each outcome variable: GPA, $F(14, 88) = 2.009$, $p = .026$, $R^2_{\text{Adjusted}} = .122$; work efficiency, $F(14, 95) = 3.66$, $p < .001$, $R^2_{\text{Adjusted}} = .255$; low wellbeing, $F(15, 81) = 16.43$, $p < .001$, $R^2_{\text{Adjusted}} = .707$; course stress, $F(13, 94) = 2.703$, $p = .003$, $R^2_{\text{Adjusted}} = .171$; general health, $F(13, 97) = 3.91$, $p < .001$, $R^2_{\text{Adjusted}} = .256$. The energy drinks sometimes and never conditions at T1 did not differ regarding later outcomes for GPA, $F(1, 88) = .087$, $p = .769$, low wellbeing, $F(1, 81) = .582$, $p = .448$, course stress, $F(1, 94) = .487$, $p = .487$, or general health, $F(1, 97) = .365$, $p = .547$.

When investigating the combined effects of breakfast and energy drinks, the model fit was significant for each outcome: GPA, $F(16, 86) = 1.941$, $p = .027$, $R^2_{\text{Adjusted}} = .129$; work efficiency, $F(16, 93) = 3.821$, $p < .001$, $R^2_{\text{Adjusted}} = .293$; low wellbeing, $F(17, 79) = 14.278$, $p < .001$, $R^2_{\text{Adjusted}} = .702$; course stress, $F(15, 92) = 2.324$, $p = .007$, $R^2_{\text{Adjusted}} = .157$; general health, $F(15, 95) = 3.661$, $p < .001$, $R^2_{\text{Adjusted}} = .266$. No combined effects of breakfast and energy drinks at T1 were observed regarding later outcomes for GPA, $F(3, 86) = .931$, $p = .429$, low wellbeing, $F(3, 79) = .385$, $p = .764$, course stress, $F(3, 92) = .273$, $p = .845$, or general health, $F(3, 95) = 1.247$, $p = .297$.

Although no multivariate level effects were observed regarding GPA, low wellbeing, course stress, or general health, higher work efficiency at T2 was observed in the T1 breakfast not every day condition compared to the breakfast every day condition, $F(1, 97) = 8.862$, $p = .004$, and in the T1 energy drinks sometimes condition compared to the energy drinks never condition, $F(1, 95) = 5.244$, $p = .024$, at. A combined effect was also observed, $F(3, 93) = 4.221$, $p = .008$; Bonferroni post hoc tests determined that work efficiency was significantly higher in the breakfast not every day/energy drinks sometimes condition ($M = 6.941$) compared to the breakfast every day/energy drinks never condition ($M = 5.287$), $p = .004$.

No change score analyses were conducted for frequency of breakfast and energy drink consumption due to certain groups being comprised of very few participants. For breakfast, the majority did not change between the two time-points, with similar numbers increasing and decreasing (no change N = 77, 59.2%; decrease N = 24, 18.5%, increase N = 29, 22.3%). Comparable observations were made regarding energy drinks, though in this case the number who increased in consumption was even smaller (no change N = 89, 68.5%, decrease N = 27, 20.8%, increase N = 14, 10.8%).

5.3.6 Cross-Lag Associations Between DABS Factors and Academic and Mental Health Outcomes

The DABS factor scores from T1 were investigated in relation to the outcome variables at T2 using Pearson's correlations. Consumption of Junk Food & Absence of Coffee at T1 was negatively correlated with low wellbeing scores, and, interestingly, consumption of Fruit, Veg & Gum at T1 was positively associated with course stress at T2. Consumption of Energy Drinks & Cola at T1 was negatively associated with GPA and general health, and positively associated with low wellbeing at T2, whereas consumption of Tea, Sweets & Chocolate at T1 was not associated with any of the outcome variables at T2. For r and p values, see Table 5.8. At the multivariate level Fruit, Veg & Gum consumption at T1 remained positively associated with course stress at T2, although the relationship at this point was only marginally significant. A marginally significant positive relationship between Fruit, Veg & Gum consumption at T1 and work efficiency at T2 was also observed, an effect that had not been detected at the univariate level. No other findings of note were made in these analyses. For all β and p values, see Table 5.9.

	Junk Food & Absence of Coffee		**Energy Drinks & Cola**		**Fruit, Veg & Gum**		**Tea, Sweets & Chocolate**	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*
GPA	-.002	.985	-.181	.042	-.136	.127	-.041	.645
Work efficiency	.108	.236	-.065	.476	.13	.155	-.008	.93
Low wellbeing	-.214	.02	.215	.02	.0	.998	-.059	.526
Course stress	-.119	.194	.128	.163	.198	.029	.072	.429
General health	.079	.39	-.294	.001	-.076	.408	.01	.913

Table 5.8. Correlations between DABS factors at T1 and academic and mental health outcomes at T2.
Note. All correlations are Pearson's (two-tailed).

	Model fit			Junk Food & Absence of Coffee		Energy Drinks & Cola		Fruit, Veg & Gum		Tea, Sweets & Chocolate	
	F	*p*	R^2	β	*p*	β	*p*	β	*p*	β	*p*
GPA	2.238	.017	.133	-.076	.462	-.017	.881	-.123	.232	.011	.911
Work efficiency	3.984	< .001	.258	.12	.183	.142	.175	.175	.063	-.044	.622
Low wellbeing	16.279	< .001	.688	-.086	.166	.045	.542	-.06	.367	-.071	.269
Course stress	2.708	.005	.154	-.071	.443	.001	.996	.173	.082	.014	.883
General health	4.112	< .001	.244	-.017	.844	-.158	.115	-.036	.696	.064	.472

Table 5.9. Multivariate associations between DABS factor scores at T1 and academic and mental health outcomes at T2.
Note. β values are standardised; R^2 values are adjusted.

5.4 Discussion

The current chapter aimed to investigate dietary effects over time. More specifically it aimed to determine whether caffeine intake, breakfast omission, energy drink use, and consumption of the DABS factors at T1 were predictive of academic and mental health outcomes at T2. In addition, change in caffeine consumption between the two time-points was also investigated in relation to these outcome variables.

5.4.1 Factor Structures Associated With the DABS in the Student Studies[5]

Four-factor structures to the DABS emerged in each of the three cross-sections of student data. However, though there were strong similarities regarding some of the factors extracted, others showed marked differences. The first factor to emerge in each analysis was similar, and generally reflected a high consumption of unhealthy food items. This factor was labelled 'Junk Food' in Study 1 and Study 2. However, in Study 3 it was labelled 'Junk Food & Absence of Coffee'. Although there were small differences between the factors regarding which items loaded at which values, the main difference of note was this negative loading of coffee in the factor extracted in Study 3. In general though, these factors appeared to measure a very similar construct to each other.

In each dataset a factor emerged that generally related to healthy food items. In Study 1 this factor was comprised of items measuring fruit, vegetable, and water

[5] In the current context 'Study 1' refers to the second cross-section (T2) from the longitudinal student study, 'Study 2' refers to the survey of frequent energy drink consumers, and 'Study 3' refers to the first cross-section (T1) from the longitudinal student study.

intake, and was labelled ‘Healthy Foods’. In Study 3, the factor was comprised of fruit, vegetable, and chewing gum consumption, and so was labelled ‘Fruit, Veg & Gum’. In Study 2, the relevant factor was comprised of items measuring the consumption of fish, beans and peas. This latter factor, although similar in representing a pattern of healthy eating, was therefore markedly different from those observed in the cross-sections of psychology students, and was labelled ‘Fish, Beans & Peas’ to avoid any potential confusion.

No consistent pattern was observed regarding tea and coffee consumption. As previously mentioned, coffee loaded negatively onto the factor labelled ‘Junk Food & Absence of Coffee’ in Study 3. Tea, however, loaded onto a factor labelled ‘Tea, Sweets & Chocolate’. In Study 1, tea consumption comprised its own unique factor (‘Tea’), whereas coffee loaded onto a factor comprised of itself and energy drinks (‘Energy Drinks & Coffee’). In Study 2, tea and coffee loaded onto the same factor, which was labelled ‘Hot Caffeinated Beverages’.

The factors upon which energy drink consumption loaded strongly were of particular interest to the current research. However, like tea and coffee, energy drink consumption was found to load onto different factors in each analysis. In Study 2 the relevant factor was labelled ‘Energy Drinks & Cola’, and was very similar to that labelled ‘Energy Drinks, Cola & Absence of Breakfast’ observed in Study 3. The only noticeable difference between these factors was that the absence of breakfast loaded strongly enough to be considered a part of the factor in Study 3, whereas this was not the case in Study 2 (though it did still load in a negative direction). The factor observed in Study 1, however, was noticeably different, and was labelled ‘Energy Drinks & Coffee’.

Although there were similarities between the factor structures observed between each of the studies presented, there were also a number of considerable differences. These disparities may reflect differences in demography and sample size, as well as the fact that participants in Study 2 were specifically selected because of their frequent use of energy drinks. A further difference was that this sample was not restricted to psychology students or to those from particular year groups. The differences in factor structures observed between the two time-points in the longitudinal study may be explained by two observations: 1) the sample at T1 (i.e.

Study 3) was considerably smaller than that of T2 (i.e. Study 1), and 2) the sample at T2 was comprised of first and second year students, whereas the sample at T1 included first year students only. However, this latter possibility is only a partial explanation, as when the second year students were excluded a different structure from that of T1 was found to emerge (for factor loading scores, initial eigenvalues, and percentages of variance explained by this alternative analysis, see Appendix A).

Due to the marked differences in dietary factors observed between the samples examined, it is difficult to conclude with much certainty what is the structure of the DABS within a student population. Although differences between these samples might account for some of this, it is also likely that much of this variation can be explained by the relatively small sample sizes investigated. For the purpose of examining dietary effects on academic performance and mental health, however, the differences in factor structures are not considered to be a problem because each analysis can be taken on its own merit.

5.4.2 Longitudinal Dietary Effects

5.4.2.1 Caffeine

Total weekly caffeine intake at T1 was positively correlated with low wellbeing and course stress at T2. Once covariates had been controlled for, however, the relationship with course stress became only marginally significant, and that relating to low wellbeing disappeared altogether. In addition, increasing or not increasing in caffeine intake between the two time-points was not associated with any of the outcome variables.

5.4.2.2 Breakfast Omission and Energy Drink Consumption

Not eating breakfast every day at T1 was associated with higher low wellbeing scores at T2, though the effect did not remain significant at the multivariate level. However, although no such effects were observed at the univariate level, high work efficiency at T2 was associated with consuming energy drinks, not eating breakfast every day, and a combination of the two at T1. Based on the previous findings, these effects appear somewhat counterintuitive. However, a potential explanation would be that students who spent a lot of time studying late at night might consider themselves to be efficient workers, although such behaviour may also result in higher consumption of energy drinks to counter the effects of sleepiness, and reduced likelihood of eating breakfast the following morning due to waking up late.

Taken together, the effects of breakfast and energy drinks observed in this chapter were not entirely consistent. Few significant effects were observed, and those that did appear were not always in the predicted direction. A possible reason for this is that by differentiating participants into four groups, each consisting of relatively low numbers, the statistical power of the analyses was compromised. Taking this into consideration, it is possible that Type 1 and/or Type 2 errors were made here.

5.4.2.3 DABS Factors

Few effects of note were observed between the DABS factors and outcome variables. At the univariate level, consumption of Junk Food & Absence of Coffee at T1 was negatively associated with low wellbeing at T2. In addition, consumption of Fruit, Veg & Gum at T1 was positively associated with course stress at T2. Although this might initially appear counterintuitive, it may reflect the observation that chewing gum is often used for the purpose of combatting stress (Princeton Review & Wrigley, 2005).

Consumption of Energy Drinks & Cola at T1 was negatively related to GPA and general health, and positively related to low wellbeing at T2. These findings are consistent with those that have previously associated energy drink use to high stress (e.g. Hofmeister et al., 2010; Pettit & DeBarr, 2011), and low GPA (Azagba et al., 2014; Pettit & DeBarr, 2011) in university students. However, the only findings of note once additional covariates had been controlled for related to Fruit, Veg & Gum: consumption of this factor at T1 was positively associated with work efficiency and course stress at T2, though the effects were only marginally significant.

5.4.3 Limitations

Although the past month consumption of energy drinks in this longitudinal study (45% at T1, 41% at T2) was comparable to those reported in the literature (e.g.

Malinauskas et al., 2007; Miller, 2008a), few participants consumed the products once a week or more (15.4% at T1, 10.8% at T2), and none claimed to use them every day. The study was also further compromised in that the number of participants who completed both time-points was relatively small, reducing the statistical power of longitudinal analyses. In addition to this, the two cross-sections were collected only 10 weeks apart, and it was not feasible to conduct change score analyses for most of the variables investigated.

5.4.4 Summary of the Student Studies

Chapters 3, 4, and 5 have presented three studies of dietary associations with academic and mental health outcomes in university students. Studies 1 and 2 investigated effects cross-sectionally in a cohort of undergraduate psychology students, and a sample of frequent energy drink users, respectively, whereas Study 3 provided longitudinal analyses from a sample of first year undergraduate psychology students. These three studies have together helped identify factor structures associated with the DABS, covariates that are related to these factors, as well as to academic and mental health outcomes, and have provided preliminary investigations into the effects of diet on GPA, work efficiency, low wellbeing, course stress, and general health. However, each study had considerable limitations.

Arguably the greatest limitation for Study 1 was that the sample investigated generally reported low consumption of caffeine and energy drinks. Although Study 2 attempted to address this issue by specifically collecting data from frequent energy drink users, this was also itself a limitation because such a group is unlikely to be representative of students in general, or indeed of society as a whole. In addition, specific knowledge that the study was about energy drink use might have affected responses, and the use of a prize-draw may have led to sampling bias. However, it should be noted that participants in Studies 1 and 3 received course credits, so could also have had ulterior motives for taking part.

A further issue is that both Study 1 and Study 2 were cross-sectional, and so cause and effect could not be determined. Study 3 therefore investigated effects longitudinally, though also incurred a number of limitations itself. In particular, the relatively low consumption of caffeine and energy drinks, and impossibility of computing change scores for many of the variables of interest were problematic.

The majority of student studies investigating associations between energy drinks, mental health, and academic attainment discussed in Chapter 2 had larger sample sizes than those presented here. This may potentially therefore explain some of the inconsistencies/null findings observed. In addition, as reports in the mainstream media have tended to focus on younger populations, it is possible that university students are not the ideal demographic group to have examined in the first place. As each of the studies reported so far observed a number of relationships between diet and demography, this may be of particular importance to the current research. For instance, university students are more likely to come from privileged socioeconomic backgrounds. Shepherd (2007, as cited in Reay, Crozier, & Clayton, 2010) reported statistics from the UK Universities and Colleges Administrations Service (UCAS), which showed that in 2005 only 24.72% of students accepted to university were from the four lowest socio-economic groups. This is a trend that appears to be further exacerbated in the Russell Group Universities (of which Cardiff University, from which the participants were sourced, is one). Reay et al. (2010) reported that in 2000 only 16% of students admitted by the Russell Group universities came from the three social classes covering the most disadvantaged groups. This difference in socioeconomic background is important to take into account, particularly when considering that lower levels of education and socioeconomic position are both associated with poor quality diet (Galobardes, Morabia, & Bernstein, 2001).

Another way in which an undergraduate sample may not be representative is that the occurrence of special educational needs (SEN) will be particularly low, and there may be relatively little variability in terms of academic ability. It also appears that variables such as low SES and the presence of SEN are related both to diet, and to academic and mental health outcomes. Therefore, dietary effects may be larger and more easily identifiable in populations that are more representative in these regards. For these reasons, the rest of this thesis will present findings from a large-scale study of secondary school children from the South West of England.

Chapter 6: Identification of Demographic and Lifestyle Covariates of Diet, School Performance, and Mental Health in Secondary School Children

6.1 Introduction

6.1.1 Overview of the Cornish Academies Project

The three studies so far presented in this thesis used university students as participants due to them being readily obtainable, and because it was thought that dietary change could be effectively investigated over the first 10 weeks of study. However, the general lack of consistent and significant findings suggested that the samples were too small, and/or that university students were not the ideal demographic group to examine. For these reasons it was considered important to investigate dietary effects in a much larger sample comprised of secondary school children with more varied demographic backgrounds.

The Cornish Academies Project was a large-scale longitudinal research programme funded by The Waterloo Foundation, which was initially conceived from the pilot study discussed in Chapter 1. After developing and testing the DABS in the three student studies, data were collected from three academies in the South West of England at two separate time-points spaced six months apart. The initial intentions of the project were to better establish the DABS as a measure of food and drink consumption, and to investigate associations between diet, mental health, school performance, and problem behaviour in adolescents. The current chapter aims to investigate the factor structure associated with the DABS in this cohort, and to identify demographic and lifestyle correlates of diet, mental health, and school performance.

6.1.2 Mental Health in Adolescents

Due to the complexity of relationships between mental health variables, it is considered important for research to take a multidimensional approach (e.g. Galvin & Smith, 2015). Not only does this allow for interactions between variables to be assessed, and for the influence of confounding factors to be controlled for statistically, it is also more likely to reflect real-world processes. In order to utilise such methods when investigating the effects of diet, it is therefore necessary to determine risk factors associated with poor mental health. Although a number of covariates have been identified in adults, including female sex, low social class, low income and education, unemployment, not being married, and having a poor somatic health status (e.g. Andrade et al., 2000; Eisenberg, Gollust, Golberstein, & Heffner, 2007; Jacobi et al., 2004), such effects have been less commonly investigated in adolescents. Certain aspects of lifestyle have also been associated with mental health. For instance, aerobic exercise has been found to have antidepressant and anxiolytic effects in adults, and can protect against the harmful consequences of stress (Salmon, 2001). Although similar effects have been reported in younger populations, Biddle and Asare (2011) claimed that the evidence is not extensive, and that methodological limitations have often been present in the research so far conducted.

Considering the seriousness of the effects of mental health problems on society as a whole, it is surprising to find that few data have been published that relate to such phenomena in British adolescents. A population-based sample of British children and adolescents aged 5-15 (Ford, Goodman, & Meltzer, 2003) did, however, identify the prevalence rate of DSM-IV disorders to be 9.5%. Furthermore, a longitudinal assessment of prevalence rates from age 9 to 16 (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003) determined that 36.7% of participants had at least one psychiatric disorder at some point during the study period. However, to be able to effectively address these issues, more recent data are required. For this reason, the Cornish Academies Project was used to collect data relating to stress, anxiety, depression, and general health in secondary school children.

6.1.3 School Performance in Adolescents

In addition to mental health, the degree to which a child achieves at school can have a considerable impact on a range of later-life outcomes (Currie & Thomas, 1999). In particular, low school attendance has been a concern in the UK for a number of years. According to Taylor (2012), there were 57 million days of school missed in 2009/2010, and of children who miss 50% of school, only 3% achieve the government target of five or more GCSEs with grades A*-C including English and maths. In addition, children with low attendance are less likely to be in employment, further education or training once leaving school (Taylor, 2012). Although unemployment can be a major problem in itself, it is also associated with a number of harmful outcomes, such as criminal behaviour (Verbruggen, Blokland, & van der Geest, 2012), and poor health and suicide (Dorling, 2009). Furthermore, it can have considerable knock-on effects at the societal level (Trades Union Congress, 2010).

In addition to the above, low school attendance is a strong predictor of low educational attainment (Morris & Rutt, 2004). This is of particular concern considering that attainment is known to predict future outcomes, such as career prospects and earning potential (Cheeseman Day & Newburger, 2002). Poor attendance and attainment are also known to co-occur with a range of parental variables (see Desforges & Abouchaar, 2003). Moreover, research has shown that family circumstances, and parental interest and attitudes towards education are stronger predictors of a child's school attainment than are school factors, such as extra resources being made available in areas of high need (Mortimore & Whitty, 2000).

A further concern is that low academic attainment is associated with antisocial behaviour and delinquency (Hinshaw, 1992). Disruptive behaviour in school is a problem for several reasons. Firstly, it can be distracting, making it difficult for teachers to teach, as well as for other students to learn. This can cause collateral harm to students' academic achievement, and damage the reputation of the school. Problem behaviour is also associated with future criminality (Pajer, 1998), making it a variable of particular societal interest. Due to such concerns, data were collected that relate to school attendance, Key Stage 3/Key Stage 4 English and maths attainment, and the occurrence of problem behaviour throughout the school year.

6.1.4 Aims of Chapter 6

The current chapter presents cross-sectional data from the Cornish Academies Project to fulfil two basic aims: 1) to examine the factor structure associated with the DABS in secondary school children, and 2) to identify demographic and lifestyle correlates of diet, mental health, and school performance. The findings presented here will therefore inform approaches to analysis taken when examining associations between diet, mental health, and school performance in subsequent chapters.

6.2 Method[6]

6.2.1 Participants

Three thousand and seventy one pupils from three academies (secondary schools) in the South West of England (Academy 1 N = 954, Academy 2 N = 1363, Academy 3 N = 754) were asked to take part in the current study. Two thousand six hundred and ten (85%) agreed. At Time 1 (T1) approximately 20% of the sample came from each of the five year-groups present in UK secondary education, 2030 completed the questionnaires, an age range of 11-16 years (M = 13.83, SD = 1.46) was observed, and the sex ratio was relatively balanced (51.1% males, 48.9% females). Almost all participants were white (97.3%), and the majority spoke English as their first language (98.3%). Thirteen per cent met the eligibility requirements to receive free school meals (FSM; a proxy indication of low SES; Shuttleworth, 1995), and the prevalence of SEN was relatively high (21.8%). At six-month follow-up (Time 2; T2), the cohort consisted of 3323 children, 2307 of whom completed the questionnaires. Similarly to T1, there was a relatively balanced sex ratio (48.5% male, 51.5% female), and an age range of 11-17 (M = 13.6, SD = 1.49) was observed.

6.2.2 Apparatus/Materials

As with the student studies presented in previous chapters, the Diet and Behaviour Scale (DABS) was used at both time-points to record the frequency and amount of consumption of foods and drinks. Alongside the DABS, five questions were administered to measure certain aspects of lifestyle. Three items were used to gauge the frequency by which subjects participated in exercise (mildly energetic, moderately energetic, and vigorous), with answers being given on a four-point scale (1 = three times a week or more, 2 = once or twice a week, 3 = about once to three times a month, 4 = never/hardly ever). Finally, participants were asked to state how many hours per night they typically spent sleeping, and to indicate how good they considered their general health to have been over the previous six months (1 = very good, 2 = good, 3 = fair, 4 = bad, 5 = very bad). This last question was chosen

[6] Because the participants and apparatus/materials used in the Cornish Academies Project are described in detail here, they will not be discussed again in method sections of later chapters (i.e. Chapters 7, 8, and 9) that report analyses from the same dataset.

because it has been suggested that health status, when examined as an outcome variable, may be best operationalized by using a global single-item (Fayers & Hand, 2002). Furthermore, single-item measures of self-reported health status have been used in population studies for over half a century, can reduce time-costs associated with multi-item measures, and have been shown to be significantly and independently predictive of a number of specific health problems, mortality, use of health services, changes in functional status, and recovery from ill health (Bowling, 2005).

At T2 three additional questions were administered, which related to mental health: these were taken from the Wellbeing Process Questionnaire (WPQ; Williams, 2014). Subjects were asked how frequently they had experienced feelings of stress, anxiety, and depression over the previous six months, on a five-point scale (1 = not at all, 2 = rarely, 3 = sometimes, 4 = frequently, 5 = very frequently). Single-items were chosen to save time compared with administering multi-item scales. Self-assessment of mental health has been shown to be a valid way of measuring depression, anxiety, and stress (Antony, Bieling, Cox, Enns, & Swinson, 1998; Henry & Crawford, 2005), and may lead to more truthful reporting than face-to-face assessments.

6.2.3 Design & Procedure

Schoolteachers administered the DABS, along with the aforementioned lifestyle and mental health questions, in the classroom to pupils from their respective academies. Two cross-sections of data were collected, with T2 occurring six months after T1. Demographic information was acquired (at both time-points) through SIMS and stored within a confidential database at Cardiff University. This information included age, sex, school attendance, number of detentions/behavioural points received, school year, ethnicity, presence/absence of a SEN status, eligibility/ineligibility to receive FSM, whether or not English was spoken as an additional language, and whether the child was cared for by a non-parental guardian. All questionnaire and demographic data were fully anonymised before being merged.

6.2.4 Statistical Analysis

Descriptive statistics for demographic, lifestyle, school performance, and mental health variables are provided, and cross-tabulations for data acquired through

SIMS (i.e. not from the questionnaires) were then examined to determine how representative the samples were of the schools from which they came. This was followed by exploratory factor analysis of the DABS using varimax (orthogonal) rotation; four factors were extracted: Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, and Hot Caffeinated Beverages. Based on the items that loaded strongly onto each factor, subscales were created using the same methods outlined in Chapter 3, section 3.3.2.2, and their internal consistency was tested using standardised Cronbach's alpha. Pearson's correlations were then used to test how strongly the factor scores and subscale scores correlated, and also to determine how strongly the subscale scores correlated between the two time-points.

Total weekly caffeine intake was calculated using the same method outlined in Chapter 3 (section 3.3.5.1), and each of the dietary variables of interest (i.e. the DABS factors, frequency of breakfast and energy drink consumption, and total weekly caffeine intake) were investigated in relation to demographic and lifestyle variables using Pearson's correlations, between-subjects t-tests, one-way ANOVAs, Chi-square, and Chi-square tests for linear association. Because the single-item measures of mental health (i.e. general health, stress, anxiety, and depression) related to ordered categorical data, they were dichotomised to create an above average group and a below average group for each outcome. Between-subjects t-tests, Chi-square, and Chi-square tests of linear association were then used to identify their demographic and lifestyle correlates. Due to different grading and disciplinary systems existing between the three academies examined, the same approach was taken for English attainment, maths attainment, and behavioural sanctions. School attendance was also dichotomised, in this case using a median split, to remain consistent with the other outcome variables, and also because the data were considerably skewed.

6.3 Results & Discussion

6.3.1 Descriptive Statistics and Representativeness of the Sample

6.3.1.1 Demographic Variance

The demographics of the sample varied considerably at both T1 and T2. Table 6.1 presents the frequency data for the academy and school year that participants came from, their sex, ethnicity, whether they were considered to have a SEN status, were eligible to receive FSM, spoke English as an additional language, and whether or not they were looked after by a non-parental guardian. Specific information is also provided in this table for those participants who completed the questionnaires only at T1, only at T2, both times, or neither time.

Although the samples were generally similar across the two cross-sections, it should be noted that the considerably lower numbers reported for both males and females at T2 is a reflection of differences in the data collection techniques employed: at T1 data relating to sex were collected through SIMS, whereas at T2 they were collected directly from the questionnaires. It is also interesting to note that the percentage of pupils with a SEN status was considerably higher at T2 (29.2%) compared to T1 (21.8%). This specifically reflects increases in the percentages of children with a SEN status present in Academies 2 and 3: Academy 2 T1 SEN = 17.1%, T2 SEN = 25.5%; Academy 3 T1 SEN = 26.1%, T2 SEN = 40.8% (the proportion of pupils with a SEN status at Academy 1 being 25.2% at both time-points). The large increase in percentage of participants with a SEN status from Academy 3 may also reflect the observation that the number of pupils from this academy who were present in the sample increased by 223 between the two time-points. This was in stark contrast to Academies 1 and 2, which gained only 17 and 12 pupils, respectively. A likely explanation for this is that teachers at Academy 3 did not administer questionnaires to all classes at T1.

6.3.1.2 Lifestyle Variance

Participation in mildly energetic exercise was common, with the majority of respondents taking part three times a week or more. Moderately energetic, and vigorous exercise were less common, though the majority of participants still engaged in such activities once per week or more. On average, participants slept for around 8.5 hours per night at both time-points. For frequency data and descriptive statistics for lifestyle variables at T1 and T2 see Table 6.2.

The three items relating to exercise frequency (mildly energetic, moderately energetic, and vigorous) were factor analysed to provide a single-factor solution. The purpose of this was so that a single covariate could be entered into subsequent

		T1		T2		T1 only (T1)		T2 only (T2)		Both (T1)		Neither (T1)	
		N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Academy	1	954	31.1%	971	29.2%	109	29.5%	51	7.9%	574	34.6%	229	52%
	2	1363	44.4%	1375	41.4%	164	44.3%	327	50.5%	829	49.9%	63	14.3%
	3	754	24.6%	977	29.4%	97	26.2%	269	41.6%	257	15.5%	148	33.6%
Year	7	576	18.9%	573	18.8%	29	8.1%	130	21.5%	327	19.9%	90	20.6%
	8	601	19.8%	602	19.7%	66	18.5%	142	23.5%	327	19.9%	66	15.1%
	9	613	20.2%	618	20.3%	75	21%	100	16.6%	363	22.1%	77	17.6%
	10	613	20.2%	616	20.2%	98	27.5%	118	19.5%	300	18.2%	97	22.2%
	11	637	21%	640	21%	89	24.9%	114	18.9%	328	19.9%	107	24.5%
Sex	Male	1554	51.1%	1018	48.5%	179	50.1%	274	47.3%	822	50%	250	57.2%
	Female	1486	48.9%	1079	51.5%	178	49.9%	305	52.7%	823	50%	187	42.8%
SEN	Yes	669	21.8%	899	29.2%	85	23%	190	30.5%	308	18.6%	156	35.7%
	No	2399	78.2%	2184	70.8%	285	77%	433	69.5%	1352	81.4%	281	64.3%
FSM	Yes	396	13%	398	13.1%	59	16.5%	67	11.1%	186	11.3%	85	19.5%
	No	2644	87%	2651	86.9%	298	83.5%	537	88.9%	1459	88.7%	352	80.5%
Ethnicity	White	2938	97.3%	2946	97.2%	345	97.2%	594	98.7%	1592	97.5%	411	94.3%
	Not white	83	2.7%	84	2.8%	10	2.8%	8	1.3%	40	2.5%	25	5.7%
EAL	Yes	52	1.7%	51	1.7%	2	.5%	7	1.3%	34	2%	9	2.1%
	No	3016	98.3%	2868	98.3%	368	99.5%	545	98.7%	1626	98%	428	97.9%
NPG	Yes	17	.6%	17	.6%	3	.8%	1	.2%	9	.5%	4	.9%
	No	3051	99.4%	2909	99.4%	367	99.2%	563	99.8%	1651	99.5%	433	99.1%

Table 6.1. Frequency information for demographic variables at T1 and T2.
Note. 'SEN' refers to special educational needs status, 'FSM' refers to eligibility to receive free school meals, 'EAL' refers to whether English is spoken as an additional language, and 'NPG' refers to whether the child was looked after by a non-parental guardian.

	Three times a week or more		**Once or twice a week**		**About once to three times a month**		**Never/hardly ever**			
	T1	T2	T1	T2	T1	T2	T1	T2		
Mild exercise	**1397 (73%)**	**1675 (76.7%)**	329 (17.2%)	371 (17%)	105 (5.5%)	91 (4.2%)	84 (4.4%)	48 (2.2%)		
Moderate exercise	522 (27.3%)	564 (25.8%)	**755 (39.5%)**	**873 (40%)**	414 (21.7%)	503 (23%)	220 (11.5%)	243 (11.1%)		
Vigorous exercise	521 (27.3%)	579 (26.5%)	**557 (29.2%)**	**667 (30.6%)**	451 (23.6%)	544 (24.9%)	381 (19.9%)	393 (18%)		
	N		**Min**		**Max**		***M***		***SD***	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Sleep hours per night	1948	2198	3	3	14	13	8.64	8.41	1.551	1.542

Table 6.2. Frequency data and descriptive statistics for lifestyle variables at T1 and T2.
Note. Modal values for the exercise frequency variables are displayed in bold.

multivariate analyses, thus allowing for all three levels of intensity to be controlled for without unnecessarily reducing statistical power. At T1 the (un-rotated) factor loadings were as follows: moderate exercise, .796, vigorous exercise, .765, mild exercise, .534. The initial eigenvalue was 1.503, and the factor extracted explained 50.12% of variance. At T2, the following (un-rotated) factor loadings were observed: vigorous exercise, .778, moderate exercise, .765, mild exercise, .56. The initial eigenvalue was 1.504, and the factor was found to explain 50.13% of the variance.

6.3.1.3 School Performance and Mental Health Outcomes

Considerable variance was observed in relation to the school performance and mental health outcomes. For descriptive statistics relating to these variables, see Table 6.3.

6.3.1.4 Representativeness of the Sample

Response rates for completion of the questionnaires were relatively high (T1 = 77.8%, T2 = 88.4%), and an attrition rate of 18.23% was observed. In order to investigate whether this sample was representative of the academies from which it came, Chi-square tests were used to determine if the SIMS data for those who completed the DABS differed from that of those who did not. These analyses were performed at both time-points.

When Chi-square analyses are conducted, cross-tabulation tables may be presented. Cross-tabulations show the number of participants that fall into specific categories of two different variables, with the dependent variable being plotted on the y-axis, and the independent variable on the x-axis. The number of participants that fall into a particular group (‘count’) can then be compared to the number predicted assuming a random distribution (‘expected count’). The percentages of participants within each level of the dependent variable who are present in each level of the independent variable (‘row %’ or ‘column %’) are also provided, and so individual cells can be compared with one another. The adjusted residual determines the probability of the number of participants falling into each cell having occurred randomly, with values of > 2 and < -2 indicating that the distribution is unlikely to have occurred by chance effects alone (i.e. $p < .05$). In 2x2 cross-tabulations (i.e.

			N		Min		Max		*M*		*SD*	
			T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
School attendance		Total	3040	3019	0%	0%	100%	100%	93.08%	90.73%	9.66	10.46
		Academy 1	948	928	0%	0%	100%	99.13%	94.78%	88.35%	7.49	11.95
		Academy 2	1346	1336	0%	0%	98.5%	99.37%	91.83%	91.46%	10.19	9.67
		Academy 3	746	755	0%	0%	100%	100%	93.16%	92.38%	10.73	9.27
English attainment	KS3	Academy 1	364	400	9	7	23	22	13.88	12.39	2.32	2.45
		Academy 2	1049	799	6	1	24	20	11.63	9.98	2.97	2.88
		Academy 3	395	408	4	4	21	18	12.43	10.61	2.66	2.86
	KS4	Academy 1	552	558	1	1	22	22	11.17	9.92	4.2	4.12
		Academy 2	259	524	1	1	8	8	3.34	3.51	1.09	1.18
		Academy 3	322	336	6	1	25	25	16.49	10.6	4.99	3.74
Maths attainment	KS3	Academy 1	373	401	4	2	24	21	12.53	10.71	3.12	3.57
		Academy 2	534	802	2	1	22	24	10.59	9.89	3.45	3.77
		Academy 3	391	409	1	1	21	18	11.65	10.25	3.77	3.98
	KS4	Academy 1	551	556	1	1	22	22	13.1	10.25	4.99	5.06
		Academy 2	780	524	1	1	9	8	4.17	3.96	1.68	1.44
		Academy 3	331	324	4	1	25	24	11.27	12.62	3.6	4.81
Behavioural sanctions	Detentions	Academy 1	954	938	0	0	37	38	0.62	0.66	2.16	2.24
	Detentions	Academy 2	1346	1336	0	0	6	17	0.14	0.69	0.55	1.89
	Behavioural points	Academy 3	740	926	0	0	135	166	6.82	7	15.27	17.66
		Very good		**Good**		**Fair**		**Bad**		**Very bad**		
Mental health	General health	387 (20.1%)	432 (19.2%)	**1004 (52.2%)**	**1157 (51.4%)**	447 (23.2%)	547 (24.3%)	68 (3.5%)	101 (4.5%)	18 (.9%)	14 (.6%)	
		Not at all	**Rarely**	**Sometimes**	**Frequently**	**Very frequently**						
	Stress	216 (9.6%)	606 (26.9%)	**842 (37.4%)**	393 (17.5%)	192 (8.5%)						
	Anxiety	430 (19.2%)	**856 (38.2%)**	625 (27.9%)	225 (10%)	103 (4.6%)						
	Depression	**808 (36.1%)**	653 (29.2%)	481 (21.5%)	187 (8.4%)	108 (4.8%)						

Table 6.3. Descriptive statistics and frequencies for school performance and mental health outcomes at T1 and T2.
Note. Stress, anxiety, and depression data were collected at T2 only; modal values for mental health variables are displayed in bold.

when both the independent and dependent variables consist of two levels), the Chi-square ($\chi 2$) and p values are given to provide an indication of the level of statistical significance of an effect. When more than two levels are present for either the independent or dependent variable (or indeed both), Chi-square tests for linear association may be reported instead, in order to provide an indication as to whether the observed effect is linear in nature (though note that this statistic is not meaningful when variables are nominal, and so in such instances will not be reported). For cross-tabulations, $\chi 2$, and p values for associations between completing the questionnaires and the categorical control variables at both time-points, see Table 6.4.

At T1 males were marginally less likely to complete the DABS, although such an analysis at T2 was not possible because the data relating to sex from this time-point were obtained from the questionnaires rather than from SIMS. The academy that a pupil came from was also related to their likelihood of completing the questionnaires, though the effect differed between time-points. At T1, more respondents than expected came from Academy 1 and Academy 2, and fewer than expected came from Academy 3; at T2, more respondents than expected came from Academy 2, and fewer than expected came from Academy 1 and Academy 3.

The school year that a participant came from was associated with their likelihood of completing the questionnaires. A significant linear trend was observed at T2, in which the likelihood of answering the questionnaires was negatively related to school year, $\chi 2$ (1, N = 3049) = 30.245, $p < .001$. However, no such trend was observed at T1, $\chi 2$ (1, N = 3040) = 1.102, $p = .294$, where instead fewer respondents than expected came from Year 7, and more respondents than expected came from Year 9. Furthermore, children with a SEN status were less likely to answer the questionnaires at both time-points. This was also the case for pupils who were eligible to receive FSM, although the effect was only marginally significant at T1. In addition, those who achieved above average school attendance were significantly more likely to complete the questionnaires at T2, though no such effect was observed at T1.

			Sex		Academy			School year					SEN status		FSM		School attendance	
			Male	Female	Academy 1	Academy 2	Academy 3	Year 7	Year 8	Year 9	Year 10	Year 11	Yes	No	Yes	No	High	Low
Completed DABS T1	Yes	Count	1001	1001	683	993	354	356	393	438	398	417	393	1637	245	1757	1012	990
		Expected count	1023.4	978.6	630.6	901	498.4	379.3	395.8	403.7	403.7	419.5	442.7	1587.3	260.8	1741.2	1000.3	1001.7
		Row %	50%	50%	33.6%	48.9%	17.4%	17.8%	19.6%	21.9%	19.9%	20.8%	19.4%	80.6%	12.2%	87.8%	50.5%	49.5%
		Adjusted residual	-1.7	1.7	4.3	7.1	-12.8	-2.3	-.3	3.3	-.5	-.2	-4.6	4.6	-1.8	1.8	.9	-.9
	No	Count	553	485	271	370	400	220	208	175	215	220	276	762	151	887	507	531
		Expected count	530.6	507.4	323.4	462	255.6	196.7	205.2	209.3	209.3	217.5	226.3	811.7	135.2	902.8	518.7	519.3
		Row %	53.3%	46.7%	26%	35.5%	38.4%	21.2%	20%	16.9%	20.7%	21.2%	26.6%	73.4%	14.5%	85.5%	48.8%	51.2%
		Adjusted residual	1.7	-1.7	-4.3	-7.1	12.8	2.3	.3	-3.3	.5	.2	4.6	-4.6	1.8	-1.8	-.9	.9
		$\chi 2$	2.935, *p* = .087		164.003, *p* < .001			13.076, *p* = .011					21.056, *p* < .001		3.218, *p* = .073		.795, *p* = .372	
Completed DABS T2	Yes	Count	-	-	626	1148	533	456	469	466	418	442	610	1665	253	1999	1213	1041
		Expected count	-	-	674.1	954.6	678.3	423	444.4	456.3	454.8	472.5	663.4	1611.6	294	1958	1122.1	1131.9
		Row %	-	-	27.1%	49.8%	23.1%	20.3%	20.8%	20.7%	18.6%	19.6%	26.8%	73.2%	11.2%	88.8%	53.8%	46.2%
		Adjusted residual	-	-	-4	14.8	-12	3.5	2.5	1	-3.8	-3.1	-4.8	4.8	-5	5	7.6	-7.6
	No	Count	-	-	345	227	444	117	133	152	198	198	289	519	145	652	290	475
		Expected count	-	-	296.9	420.4	298.7	150	157.6	161.7	161.2	167.5	235.6	572.4	104	693	380.9	384.1
		Row %	-	-	34%	22.3%	43.7%	14.7%	16.7%	19%	24.8%	24.8%	35.8%	64.2%	18.2%	81.8%	37.9%	62.1%
		Adjusted residual	-	-	4	-14.8	12	-3.5	-2.5	-1	3.8	3.1	4.8	-4.8	5	-5	-7.6	7.6
		$\chi 2$	-		241.172, *p* < .001			34.681, *p* < .001					23.142, *p* < .001		25.116, *p* < .001		57.809, *p* < .001	

Table 6.4. $\chi 2$ values and cross-tabulations between completion of the DABS and categorical control variables.

Note. No cross-tabulation is provided for sex at T2 because this variable was collected via questionnaire response at this time-point.

6.3.1.5 Discussion of Descriptive Statistics and Representativeness of the Sample

This section has shown that there was large variability in the sample studied in relation to demography, lifestyle, school performance, and mental health. More importantly, participants who completed the questionnaires were found to not be entirely representative of the schools that they came from in a number of ways. This therefore highlights the need to use multivariate approaches to analysis in which such variables can be controlled for statistically. The next section will report data relating to dietary consumption, and present a four-factor structure associated with the DABS.

6.3.2 Dietary Questionnaire Data and Exploratory Factor Analysis

6.3.2.1 Frequency and Amount of Dietary Consumption As Assessed by the DABS

As with the university student data presented in previous chapters, considerable variance in responding to the DABS was observed in both cross-sections of the current study. For frequencies and descriptive statistics, see Table 6.5. The amount of missing data was generally low (the greatest amount for frequency items being 1.2% at T1 and 1.8% at T2; the highest for amount items being 2.4% at T1 and 2.8% at T2) and probably reflects slight difficulties in understanding the questions (e.g. some children may not have known what processed meat refers to, or might use metric units rather than pints).

6.3.2.2 Exploratory Factor Analysis of the DABS

As with the methodology used in Chapter 3, all 29 items of the DABS were factor analysed using varimax rotation. In this case, a four-factor solution with eigenvalues > 1.5 was extracted, which accounted for 38.02% of variance within the dataset at T1 and 37.74% at T2. Due to high loadings from crisps, chocolate, chips, and sweets, factor 1 was labelled ‘Junk Food’. Factor 2 was labelled ‘Caffeinated Soft Drinks/Gum’ due to high loadings from energy drinks, chewing gum, and cola. Factor 3 was labelled ‘Healthy Foods’, due to high loadings from items measuring fruit and vegetable consumption, and factor 4 was labelled ‘Hot Caffeinated Beverages’ due to high loadings from tea and coffee. For factor loading scores, initial eigenvalues, and percentages of variance explained at T1 and T2, see Table 6.6.

	N		**Never**		**Once a month**		**Once/twice a week**		**Most days (3-6)**		**Every day**	
Frequency	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Breakfast	2022	2306	8.6%	8.2%	4.7%	5.1%	15.7%	15.6%	20.6%	23.1%	**50.4%**	**48%**
Chocolate	2019	2294	1.7%	1.7%	11.4%	12%	**43.5%**	**45.4%**	29.8%	30%	13.5%	10.9%
Crisps	2019	2298	4.3%	5.6%	10%	11.1%	30%	30.7%	**36.5%**	**36.6%**	18.6%	15.9%
5+ fruit or veg	2011	2295	6.2%	6.4%	9.3%	7.9%	27.5%	29.6%	**42.7%**	**42.7%**	14.3%	13.3%
Coffee	2025	2301	**63.8%**	**65.3%**	10.3%	9.7%	10.7%	11.4%	7.8%	6.7%	7.5%	6.9%
Tea	2024	2303	**35.6%**	**35.8%**	11.8%	11%	17.2%	18.5%	16.4%	14.8%	19.1%	20%
Cola	2025	2298	11.4%	10.4%	25.9%	26.6%	**37.8%**	**41.4%**	18.3%	16.8%	6.7%	4.8%
Energy drinks	2004	2291	**44.1%**	**44.9%**	28.9%	30.6%	16.3%	16%	7.8%	6.1%	2.8%	2.5%
Gum	2006	2291	15.8%	16.1%	25.9%	25.3%	**29.3%**	**30.6%**	19.9%	20.4%	9.1%	7.6%
Sweets	2003	2283	3.7%	4.2%	19.9%	23.3%	**50%**	**53.1%**	21.8%	16.5%	4.6%	2.8%
Fast-food	2001	2285	8.3%	8.3%	**61.6%**	**61.8%**	24.8%	26.7%	4.5%	2.6%	.8%	.6%
Take-away	2007	2293	23.4%	25.1%	**62.9%**	**64.2%**	11.9%	10%	1.3%	.3%	.5%	.3%
Pies or pasties	2005	2292	13.9%	14.4%	**50.6%**	**53.2%**	28.8%	27.7%	5.9%	3.8%	.7%	1%
Processed meat	1999	2281	**44.9%**	**46.6%**	22.5%	25.7%	20.1%	17.8%	10%	7.9%	2.6%	2%
Fried fish	2012	2289	29.5%	29.4%	**41.5%**	**43.3%**	24.5%	23.4%	4.2%	3.5%	.3%	.3%
Oily fish	2012	2286	**46.6%**	**47%**	33.8%	32.1%	15.9%	17.4%	3.3%	3.1%	.4%	.4%
Chips	2007	2283	3.4%	3.4%	24.7%	25.1%	**53.3%**	**56.2%**	16.1%	13.9%	2.4%	1.4%
Beans or peas	2006	2277	10.3%	9.9%	10.9%	12.2%	**46.9%**	**48.4%**	28.5%	27.1%	3.4%	2.5%

	N		**Min**		**Max**		*M*		*SD*	
Amount	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Energy drinks	2008	2254	0	0	25	20	.99	.93	1.96	1.86
Cola	1996	2253	0	0	36	32	1.49	1.47	2.14	2.22
Coffee	2014	2265	0	0	40	50	1.41	1.42	3.66	4.03
Tea	2010	2267	0	0	50	50	3.48	3.81	5.88	6.54
Crisps	2006	2262	0	0	30	30	3.62	3.55	2.88	2.75
Chocolate	2009	2269	0	0	70	50	3.15	3.12	3.56	3.39
Burgers/hot dogs	1995	2245	0	0	10	11	.73	.69	1.09	1.02
Gum	2005	2263	0	0	15	16	1.33	1.29	1.9	1.78
Fruit	2008	2263	0	0	17	18	2.82	2.74	1.91	1.82
Veg	1981	2250	0	0	15	16	2.77	2.57	1.91	1.68
Water	1964	2203	0	0	17	18	2.43	2.47	2.01	1.97

Table 6.5. Frequencies and descriptive statistics for all DABS items at T1 and T2.
Note. Modal values for frequency items are displayed in bold; all amount of consumption items were measured per week other than fruit, vegetables, and water, which were measured per day.

	Junk Food		Caffeinated Soft Drinks/Gum		Healthy Foods		Hot Caffeinated Beverages	
	T1	T2	T1	T2	T1	T2	T1	T2
Q1. How often did you eat breakfast?	.124	.146	-.456	-.409	.321	.32	.031	-.016
Q2. How often did you eat chocolate?	**.66**	**.611**	.016	-.032	-.065	-.084	.032	-.062
Q3. How often did you eat crisps?	**.669**	**.682**	-.046	-.093	-.057	-.074	-.007	-.014
Q4. How often did you eat five pieces of fruit or veg?	-.262	-.25	-.137	-.084	**.622**	**.623**	-.032	-.076
Q5. How often did you drink coffee?	.013	-.052	.144	.187	.02	.019	**.734**	**.72**
Q6. How often did you drink tea?	.001	.061	.091	.054	.103	.129	**.676**	**.656**
Q7. How often did you drink cola?	.377	.366	**.544**	**.538**	-.039	-.123	.061	.033
Q8. How often did you drink energy drinks?	.178	.171	**.742**	**.693**	-.02	-.077	.115	.196
Q9. How often did you chew gum?	.068	.036	**.61**	**.634**	.021	.079	.175	.044
Q10. How often did you eat sweets?	**.525**	**.512**	.264	.305	.031	.072	-.011	-.053
Q11. How often did you eat fast-food?	.452	.453	.342	.377	-.007	-.06	-.057	-.034
Q12. How often did you eat takeaway?	.375	.356	.259	.214	.185	.129	.069	.062
Q13. How often did you eat pies or pasties?	.312	.35	.229	.198	.395	.318	.048	.108
Q14. How often did you eat processed meat?	.266	.265	.091	.118	.206	.177	-.051	.082
Q15. How often did you eat fried fish?	.227	.239	.038	.029	.485	.457	.082	.073
Q16. How often did you eat oily fish?	.091	.063	-.107	-.062	.497	.454	.081	.188
Q17. How often did you eat chips?	**.531**	**.541**	.196	.138	.021	-.01	-.005	-.016
Q18. How often did you eat beans or peas?	.09	.103	-.069	-.146	.483	.452	.064	.071
Q19. Cans of energy drink per week	.093	.121	**.699**	**.644**	-.011	-.084	.048	.197
Q20. Cans of cola per week	.25	.276	.456	.472	-.087	-.097	-.034	-.003
Q21. Cups of coffee per week	.029	-.055	.081	.139	-.037	-.052	**.714**	**.684**
Q22. Cups of tea per week	-.005	.065	.034	-.052	.024	.068	**.683**	**.671**
Q23. Packets of crisps per week	**.67**	**.697**	-.019	-.037	-.103	-.104	.066	.105
Q24. Bars of chocolate per week	**.62**	**.626**	.02	.018	-.109	-.098	.03	.009
Q25. Burgers/hot dogs per week	.397	.447	.314	.323	.166	.042	-.023	.012
Q26. Packs of chewing gum per week	-.001	-.046	**.61**	**.658**	.04	.158	.138	-.005
Q27. Pieces of fruit per day	-.237	-.231	.054	.044	**.639**	**.66**	-.045	-.1
Q28. Portions of vegetables per day	-.195	-.151	-.02	-.006	**.616**	**.652**	-.026	-.021
Q29. Pints of water per day	-.034	-.036	.02	.044	.401	.405	-.02	.012
Initial eigenvalue	4.584	4.479	2.539	2.547	2.21	2.204	1.694	1.715
Percentage of variance explained	11.87%	12.07%	10.44%	10.26%	8.52%	8.34%	7.19%	7.07%

Table 6.6. Exploratory factor analysis of DABS items at T1 and T2.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .5 are displayed in bold.

To verify the structure described in the above paragraph, separate exploratory factor analyses were conducted for each of the three academies at both time-points. Very similar four-factor structures emerged in each of these analyses (for initial eigenvalues and percentages of variance explained by each factor, see Table 6.7; for all factor loading scores at T1 and T2 see Tables 6.8 and 6.9, respectively).

		Total	Junk Food		Caffeinated Soft Drinks/Gum		Healthy Foods		Hot Caffeinated Beverages	
		Total variance explained	Initial eigenvalue	% variance explained	Initial eigenvalue	% variance explained	Initial eigenvalue	% variance explained	Initial eigenvalue	% variance explained
School 1	T1	39.45%	5.045	13.55%	2.617	9.32%	2.171	8.85%	1.608	7.72%
	T2	40.37%	5.106	13.12%	2.628	10.36%	2.112	8.89%	1.862	7.99%
School 2	T1	38.02%	2.724	10.69%	4.356	11.38%	2.286	8.7%	1.659	7.25%
	T2	36.08%	4.005	11.91%	2.642	9.43%	2.158	7.89%	1.66	6.85%
School 3	T1	38.9%	4.687	12.4%	2.441	10.57%	2.089	8.03%	2.063	7.9%
	T2	40.56%	2.794	11.18%	4.868	12.59%	2.294	9.02%	1.806	7.77%

Table 6.7. Initial eigenvalues and variance explained by each DABS factor across individual academies at T1 and T2.

	Junk Food			**Caffeinated Soft Drinks/Gum**			**Healthy Foods**			**Hot Caffeinated Beverages**		
	School 1	School 2	School 3	School 1	School 2	School 3	School 1	School 2	School 3	School 1	School 2	School 3
Q1. Breakfast (F)	.116	.117	.2	-.462	-.488	-.353	.349	.261	.417	-.029	.103	-.068
Q2. Chocolate (F)	**.688**	**.683**	**.636**	.089	-.041	.01	-.092	-.069	.063	.033	.05	.053
Q3. Crisps (F)	**.703**	**.639**	**.676**	-.156	.014	-.012	-.064	-.021	-.058	.149	-.108	-.117
Q4. Five pieces of fruit or veg (F)	-.251	-.248	-.28	-.165	-.137	-.163	**.64**	**.605**	**.633**	-.028	.034	-.092
Q5. Coffee (F)	.005	-.02	.051	.246	.14	.104	.051	.027	-.014	**.607**	**.72**	**.722**
Q6. Tea (F)	.024	.021	-.037	.029	.079	.053	.079	.09	.145	**.763**	**.66**	**.684**
Q7. Cola (F)	.435	.307	.388	.47	**.61**	**.563**	.001	-.04	-.11	.062	.047	.061
Q8. Energy drinks (F)	.219	.103	.245	**.748**	**.764**	**.689**	-.109	.023	.019	.122	.113	.158
Q9. Chewing gum (F)	.168	.075	-.031	**.469**	**.588**	**.638**	-.021	.022	.091	.323	.254	.024
Q10. Sweets (F)	**.561**	**.545**	.452	.233	.216	.349	.043	-.014	.17	.118	.015	-.077
Q11. Fast-food (F)	**.552**	.401	.398	.333	.349	.34	-.007	-.028	.067	-.127	.018	-.089
Q12. Takeaway (F)	.394	.312	.411	.257	.308	.296	.188	.173	.273	-.046	.052	.184
Q13. Pies or pasties (F)	.383	.302	.155	.208	.217	.318	.353	.44	.356	.019	.062	.141
Q14. Processed meat (F)	.232	.212	.357	.065	.11	.117	.295	.189	.103	.16	-.201	.021
Q15. Fried fish (F)	.209	.161	.285	.096	.041	.086	.45	.499	**.517**	.124	-.037	.18
Q16. Oily fish (F)	.112	.065	.046	-.013	-.132	-.06	.444	**.538**	.481	.029	.046	.131
Q17. Chips (F)	.479	**.581**	.489	.205	.213	.178	.05	.034	-.002	.035	-.023	.017
Q18. Beans or peas (F)	.161	.015	.126	-.086	-.054	-.089	.459	**.527**	.367	.087	-.025	.211
Q19. Energy drinks per week	.153	.016	.151	**.709**	**.724**	**.659**	-.051	.002	-.016	.075	.032	.071
Q20. Cola per week	.316	.168	.276	.329	**.552**	**.534**	-.066	-.098	-.131	-.018	-.058	-.095
Q21. Coffee per week	.009	-.028	.127	.2	.078	.009	.018	-.017	-.136	**.572**	**.686**	**.726**
Q22. Tea per week	.089	-.01	-.074	-.087	.06	-.025	.03	-.026	.073	**.739**	**.685**	**.688**
Q23. Crisps per week	**.688**	**.614**	**.734**	-.097	.04	-.01	-.061	-.094	-.168	.197	-.059	-.02
Q24. Chocolate per week	**.666**	**.612**	**.627**	.104	-.006	0	-.05	-.135	-.104	-.029	.034	.08
Q25. Burgers/hot dogs per week	.442	.316	.462	.323	.371	.218	.233	.185	-.006	-.163	.016	.154
Q26. Chewing gum per week	.068	.005	-.065	.48	**.582**	**.66**	.041	.059	-.053	.33	.205	-.043
Q27. Fruit per day	-.213	-.24	-.251	.061	.034	.039	**.686**	**.658**	.468	-.068	.025	-.145
Q28. Vegetables per day	-.185	-.198	-.214	-.058	-.04	.052	**.673**	**.578**	**.571**	-.008	.024	-.11
Q29. Water per day	-.07	-.043	.04	-.093	.063	.056	.382	.392	.443	-.002	-.01	-.021

Table 6.8. Exploratory factor analysis of DABS items at T1 across individual academies.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .5 are displayed in bold. 'F' refers to 'frequency'.

	Junk Food			Caffeinated Soft Drinks/Gum			Healthy Foods			Hot Caffeinated Beverages		
	School 1	School 2	School 3	School 1	School 2	School 3	School 1	School 2	School 3	School 1	School 2	School 3
Q1. Breakfast (F)	.097	.113	.182	-.497	-.371	-.262	.298	.346	.342	.014	-.007	-.173
Q2. Chocolate (F)	**.602**	**.587**	**.629**	.053	-.154	.104	-.151	-.024	-.025	.016	-.102	-.044
Q3. Crisps (F)	**.702**	**.642**	**.73**	-.133	-.054	-.033	-.097	-.058	.04	.067	-.061	-.153
Q4. Five pieces of fruit or veg (F)	-.234	-.271	-.261	-.104	-.017	-.112	**.612**	**.632**	**.654**	-.132	-.059	-.12
Q5. Coffee (F)	.02	-.094	-.019	.101	.3	.109	.043	0	.002	**.655**	**.627**	**.795**
Q6. Tea (F)	.058	.083	-.059	.096	.003	.078	.107	.083	.268	**.714**	**.723**	**.523**
Q7. Cola (F)	.4	.442	.237	**.539**	.469	**.597**	-.091	-.164	-.079	-.05	.099	.04
Q8. Energy drinks (F)	.195	.227	.094	**.639**	**.721**	**.687**	-.096	-.049	-.113	.254	.142	.212
Q9. Chewing gum (F)	.079	.042	-.031	**.672**	**.583**	**.673**	.023	.04	.168	.147	.084	-.134
Q10. Sweets (F)	**.55**	**.54**	.324	.346	.141	**.524**	.139	.067	.017	.048	-.051	-.088
Q11. Fast-food (F)	**.508**	.43	.439	.414	.217	.497	-.03	-.094	-.041	-.098	.065	-.021
Q12. Takeaway (F)	.427	.319	.374	.185	.123	.295	.142	.144	.058	-.093	.221	.093
Q13. Pies or pasties (F)	.383	.373	.241	.209	.131	.256	.419	.286	.231	.058	.134	.217
Q14. Processed meat (F)	.261	.211	.272	.098	.086	.251	.281	-.008	.35	.086	.086	.037
Q15. Fried fish (F)	.233	.211	.184	.073	-.092	.132	**.509**	.389	.49	.196	.024	.149
Q16. Oily fish (F)	.06	.042	.011	-.117	-.15	.108	.42	.422	**.531**	.195	.18	.23
Q17. Chips (F)	**.528**	**.558**	.492	.163	.048	.268	.014	-.037	.03	.062	-.016	-.081
Q18. Beans or peas (F)	.123	.051	.128	-.099	-.184	-.098	.439	.444	.485	.032	.086	.096
Q19. Energy drinks per week	.171	.145	.069	**.601**	**.682**	**.633**	-.137	-.032	-.115	.234	.123	.275
Q20. Cola per week	.216	.362	.262	.433	.413	**.583**	-.069	-.11	-.101	-.157	.003	.21
Q21. Coffee per week	.052	-.138	-.02	.122	.228	.069	-.026	-.023	-.148	**.652**	**.539**	**.803**
Q22. Tea per week	.064	.065	-.015	.029	-.116	-.038	.066	.024	.202	**.718**	**.758**	.492
Q23. Crisps per week	**.722**	**.652**	**.737**	-.071	.008	-.004	-.089	-.077	-.049	.239	-.004	0
Q24. Chocolate per week	**.667**	**.581**	**.623**	.085	-.103	.095	-.083	-.06	-.103	.109	-.065	.07
Q25. Burgers/hot dogs per week	.467	.471	.39	.273	.257	.417	.106	-.009	.042	-.025	.017	.149
Q26. Chewing gum per week	.019	-.037	-.186	**.682**	**.618**	**.687**	.107	.138	.18	.157	-.01	-.117
Q27. Fruit per day	-.228	-.219	-.241	-.031	.193	-.05	**.664**	**.657**	**.645**	-.153	-.093	-.079
Q28. Vegetables per day	-.213	-.103	-.174	-.003	.048	-.063	**.644**	**.685**	**.571**	-.09	.019	.043
Q29. Water per day	-.051	-.065	.018	-.072	.16	.045	.455	.373	.368	.095	-.04	.026

Table 6.9. Exploratory factor analysis of DABS items at T2 across individual academies.
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .5 are displayed in bold. 'F' refers to 'frequency'.

6.3.2.3 DABS Subscales, Reliability, and Internal Consistency

Subscales for each of the four DABS factors were derived using the same methodology outlined in Chapter 3. However, it should be noted that a factor loading score of > .5 rather than > .45 was used to determine that an item was included in a factor/subscale. After doing this, it was found that the internal consistency for each subscale was acceptable or good according to generally accepted criteria (e.g. Kline, 1999). Standardised Cronbach's α values for each subscale were as follows: Junk Food (items 2, 3, 10, 17, 23, and 24) T1, .735, T2, .74; Caffeinated Soft Drinks/Gum (items 7, 8, 9, 19, and 26) T1, .741, T2, .724; Healthy Foods (items 4, 27, and 28) T1, .691, T2, .693; Hot Caffeinated Beverages (items 5, 6, 21, and 22) T1, .675, T2, .661.

In order to determine whether the subscales could provide similar measures of diet to the factors extracted through factor analysis, relationships between the relevant variables were investigated using Pearson's correlations. Strong positive correlations were observed between each subscale and its respective factor score: Junk Food: T1, $r(1697) = .744$, $p < .001$, T2, $r(1898) = .729$, $p < .001$; Caffeinated Soft Drinks/Gum: T1 $r(1697) = .747$, $p < .001$, T2 $r(1898) = .743$, $p < .001$; Healthy Foods: T1, $r(1697) = .646$, $p < .001$, T2 $r(1898) = .601$, $p < .001$; Hot Caffeinated Beverages: T1, $r(1697) = .816$, $p < .001$, T2 $r(1898) = .8$, $p < .001$.

To test whether the dietary subscales produced consistent responses over time, Pearson's correlations were carried out to determine how strongly the subscale scores from T1 correlated with those from T2. All correlations were positive and ranged from weak to moderate: Junk Food, $r(1514) = .413$, $p < .001$, Caffeinated Soft Drinks/Gum, $r(1542) = .398$, $p < .001$, Healthy Foods, $r(1535) = .295$, $p < .001$, Hot Caffeinated Beverages, $r(1594) = .475$, $p < .001$.

6.3.2.4 Discussion of the DABS and Its Effectiveness As a Measure of Dietary Consumption

Although the factor structures reported in Chapters 3, 4, and 5 were not consistent across time-points or between studies, the structure observed here was reliable, being reproduced in separate analyses of each of the three academies included in the dataset, and at both time-points. This therefore gives credence to the idea that the inconsistency of the structures observed previously were a result of insufficient sample size. Furthermore, the fact that the structures were consistent here lends support to the idea that the DABS is a useful measure of food and drink consumption, and that the four-factor model presented in this chapter can provide a useful framework for exploration of dietary effects upon other areas of life.

Although factor analyses of other FFQs have provided two-factor solutions, such as 'healthy/prudent dietary pattern' vs. 'Western pattern' (Ambrosini et al., 2011; Hu et al., 1999), and 'wholefoods' vs. 'processed foods' (Akbaraly et al., 2009), these models are likely to obscure the effects of dietary items that do not contribute much of significant nutritional value. As these very items (i.e. energy drinks, cola, and chewing gum) were found to make up a unique factor in the four-factor model presented here, this model is deemed to be very relevant when regarding potential for investigating their effects upon psychological outcomes. It is however interesting to note that if the amount of consumption items from the DABS were to be excluded from the factor analyses presented in this chapter, a similar two-factor model emerged (for factor loadings, initial eigenvalues, and percentages of variance explained by each factor, see Appendix B).

Of particular importance is that the subscale scores derived from the factors were demonstrated to have acceptable levels of internal consistency, to correlate strongly with their respective factor scores, and to produce consistent results across the two cross-sections of data. Due to these observations, the subscales will be used not only as control variables to avoid unnecessary shared variance with other dietary predictors of interest, but also to create change scores for use in longitudinal analyses presented in Chapter 9. The next section will explore how the DABS factors are related to certain aspects of demography and lifestyle.

6.3.3 Identification of Demographic and Lifestyle Correlates of Diet

The dietary variables of most interest throughout the rest of this thesis are the DABS factor scores (and in particular Caffeinated Soft Drinks/Gum), total weekly caffeine intake, breakfast consumption (dichotomised as 'every day' vs. 'not every day', i.e. answer 5 vs. answers 1, 2, 3, and 4), and energy drink consumption (dichotomised as ‘once a week or more’ vs. ‘less than once a week’, i.e. answers 3, 4, and 5 vs. answers 1 and 2). It was therefore considered important to identify demographic and lifestyle correlates of these variables so that they could be controlled for in subsequent multivariate analyses. Between-subjects t-tests, one-way between-subjects ANOVAs, Pearson’s correlations, Chi-square and Chi-square tests for linear association were used for this purpose, and analyses were conducted at both time-points. Significant and marginally significant relationships will be discussed in the next section; for outcomes of all statistical tests, see Table 6.10.

6.3.3.1 Factor 1 (Junk Food)

Junk Food consumption was higher in males and those with a SEN status at both time-points. Consumption was also lower in those eligible for FSM, although the effect was only detected at T2. Differences were observed between the three schools, though the effect was only marginally significant at T2. For this reason, post hoc tests were only carried out at T1. Tukey tests determined that Junk Food consumption was higher in Academy 3 compared to Academy 2, although the effect was only marginally significant (p = .071). School year was positively correlated with Junk Food consumption at T1, though not at T2. In a similar manner, a marginally significant positive correlation between age and Junk Food consumption was observed at T1 but not at T2. Average sleep duration was also positively associated with Junk Food consumption (at T2 only), though the effect was only marginally significant. Negative correlations were observed between Junk Food consumption and exercise frequency at both time-points.

6.3.3.2 Factor 2 (Caffeinated Soft Drinks/Gum)

Consumption of Caffeinated Soft Drinks/Gum was higher in males, and those with a SEN status at T2, though no such effects were observed at T1. Consumption of this factor was also higher in those eligible to receive FSM at both time-points, although the effect at T1 was only marginally significant. No differences were observed between schools, though consumption of Caffeinated Soft Drinks/Gum was positively correlated with school year, age, and exercise frequency at T2 (no such effects were observed at T1). Consumption of this factor was also negatively correlated with number of sleep hours at both time-points.

Control variable	Time-point	Junk Food		Caffeinated Soft Drinks/Gum		Healthy Foods		Hot Caffeinated Beverages		Total weekly caffeine		Breakfast		Energy drinks	
		t	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*t*	*p*	*χ2*	*p*	*χ2*	*p*
Sex	T1	4.267	< .001	.921	.357	1.214	.225	2.449	.014	3.191	.001	8.217	.004	7.679	.006
	T2	7.168	< .001	3.054	.002	2.671	.008	2.92	.004	4.262	< .001	39.749	< .001	56.833	< .001
SEN	T1	2.365	.018	.934	.351	1.947	.052	1.511	.131	1.305	.192	3.345	.067	3.635	.057
	T2	2.472	.014	5.291	< .001	.138	.891	1.172	.241	2.316	.021	3.058	.08	42.149	< .001
FSM	T1	-.637	.524	1.97	.05	.536	.592	.886	.376	1.962	.05	.942	.332	3.618	.057
	T2	-3.568	< .001	4.748	< .001	-.334	.738	1.705	.088	2.936	.004	11.701	.001	35.713	< .001
		F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*χ2*	*p*	*χ2*	*p*
School	T1	3.092	.046	.832	.435	3.713	.025	3.082	.046	2.044	.13	4.543	.103	2.049	.359
	T2	2.803	.061	1.93	.145	1.556	.211	.866	.421	.741	.477	1.264	.531	4.563	.102
		r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*t*	*p*	*t*	*p*
Age	T1	.045	.065	.011	.656	-.11	< .001	.108	< .001	.119	< .001	-2.212	.027	2.956	.003
	T2	.003	.888	.065	.007	-.173	< .001	.212	< .001	.228	< .001	-3.737	< .001	4.934	< .001
Sleep hours	T1	.024	.321	-.236	< .001	.168	< .001	-.052	.033	-.14	< .001	10.545	< .001	-6.863	< .001
	T2	.044	.062	-.241	< .001	.21	< .001	-.137	< .001	-.198	< .001	12.041	< .001	-8.547	< .001
Exercise frequency	T1	-.069	.006	.025	.318	.241	< .001	.046	.069	.035	.131	3.448	.001	-.235	.814
	T2	-.076	.001	.049	.039	.242	< .001	-.007	.769	.007	.737	2.57	. 01	1.933	.053
		r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*χ2 (linear)*	*p*	*χ2 (linear)*	*p*
School year	T1	.05	.039	.028	.25	-.113	< .001	.105	< .001	.112	< .001	5.981	.014	10.065	.002
	T2	.004	.878	.075	.001	-.169	< .001	.231	< .001	.241	< .001	18.176	< .001	25.957	< .001

Table 6.10. Associations between dietary predictor variables and demographic and lifestyle control variables.

6.3.3.3 Factor 3 (Healthy Foods)

Healthy Foods consumption was higher in males at T2, and higher in those with a SEN status at T1, although the latter effect was only marginally significant. Differences between the schools were observed at T1, though not at T2. A Tukey post hoc test determined that Healthy Foods consumption was higher in Academy 2 compared to Academy 1 at T1 (p = .046). Furthermore, consumption of Healthy Foods was negatively correlated with school year and age, and positively correlated with sleep hours and exercise frequency at both time-points.

6.3.3.4 Factor 4 (Hot Caffeinated Beverages)

Consumption of Hot Caffeinated Beverages was higher in males than in females at both time-points. Consumption was also marginally higher in those eligible to receive FSM at T2, though no such effect was observed at T1. The schools differed at T1, though not at T2. Tukey post hoc tests determined that consumption of Hot Caffeinated Beverages at T1 was higher in Academy 3 relative to Academies 1 (p = .045), and 2 (p = .075), although the latter effect was only marginally significant. Consumption of Hot Caffeinated Beverages was also positively correlated with age and school year, and negatively correlated with sleep hours at both time-points. In addition, a marginally significant positive relationship was observed with exercise frequency at T1, though no such effect was detected at T2.

6.3.3.5 Total Weekly Caffeine Intake

Males consumed more caffeine than did females at both time-points. This was also the case for those who were eligible to receive FSM, although the effect at T1 was only marginally significant. Children with a SEN status consumed higher levels of caffeine, though the effect was only observed at T2. In addition, consumption of caffeine was positively correlated with school year and age, and negatively correlated with sleep hours, at both time-points.

6.3.3.6 Breakfast Omission

Males were more likely than females to eat breakfast every day, and the effect was observed at both time-points. Furthermore, those with a SEN status were less likely to eat breakfast every day, although the effects at both time-points were only marginally significant. Those eligible to receive FSM were less likely to eat breakfast every day, though the effect was only observed at T2. Those who did not eat breakfast every day were significantly older, more likely to come from a higher school year, to achieve low sleep hours, and to exercise infrequently.

6.3.3.7 Frequent Energy Drink Consumption

Frequent energy drink users were more likely to be male, to have a SEN status, and to be eligible to receive FSM, although the latter two effects were only marginally significant at T1. Frequent consumers were also more likely to be older than infrequent/non consumers, to attend a higher school year, and to sleep for fewer hours per night. In addition, frequent consumers took part in exercise more often at T2, though the effect was only marginally significant.

6.3.3.8 Discussion of Dietary Variables and Their Associations With Demography and Lifestyle

This section has identified a number of demographic and lifestyle correlates of the dietary factors extracted from the DABS, as well as caffeine intake, breakfast omission, and frequent energy drink use. As already posited by others (e.g. Wardle, Parmenter, & Waller, 2000), such findings demonstrate the importance of using statistical techniques in which such variables can be controlled for, as otherwise they may obscure the true nature of the results. The next section will therefore aim to identify demographic and lifestyle correlates of mental health.

6.3.4 Correlates of Mental Health

The single-items for general health, stress, anxiety, and depression were recoded into dichotomous variables, with those who answered with 1 or 2 ('never' or 'rarely' experienced stress, anxiety, or depression; considered their general health to have been 'very good' or 'good') being placed into the above average group, and those who answered with 3, 4, or 5 ('sometimes', 'frequently', or 'very frequently' experienced stress, anxiety or depression; considered their general health to have been 'fair', 'bad', or 'very bad') comprising the below average group. Between-subjects t-tests and Chi-square tests were then used to examine relationships with continuous and categorical control variables, respectively. Analyses involving general health were performed at both time-points, though those relating to stress, anxiety, and depression could only be conducted at T2, as these variables were not recorded at T1.

6.3.4.1 Demographic and Lifestyle Correlates of Stress, Anxiety, Depression, and General Health

Between-subjects t-tests revealed that sleep hours and exercise frequency were both significantly lower in the high stress, high anxiety, high depression, and low general health groups. For all t and p values from these analyses, see Table 6.11. Chi-square analyses determined that females reported higher stress, anxiety, and depression, as well as lower general health, compared to males. There were no differences between the three academies regarding stress, anxiety or depression, although a significant effect was observed for general health at T1. This reflected a larger than expected number of participants from the good general health group coming from Academy 2. School year was also associated with each of the outcome variables (other than general health at T2). In each case a significant Chi-square linear association was observed, with pupils' mental health decreasing in higher school years: stress, $\chi2$ (1, N = 2193) = 28.289, $p < .001$; anxiety, $\chi2$ (1, N = 2183) = 42.181, $p < .001$; depression, $\chi2$ (1, N = 2181) = 5.593, $p = .018$; general health T1, $\chi2$ (1, N = 1897) = 29.182, $p < .001$. A similar effect was also observed regarding general health at T2, though it was only marginally significant, $\chi2$ (1, N = 2195) = 3.487, $p = .062$. Presence of a SEN status was associated with higher levels of depression and lower levels of general health at T2 (but not at T1). Eligibility to receive FSM was related to low general health, but also with low levels of anxiety. In addition, being a member of the low school attendance group was associated with high stress, anxiety, and depression, as well as with low general health, although this last effect was only detected at T2. For cross-tabulations, $\chi2$ and p values for stress anxiety, and depression, see Table 6.12; for general health, see Table 6.13.

6.3.4.2 Discussion of Correlates of Mental Health

This section aimed to identify demographic and lifestyle variables associated with general health, stress, anxiety, and depression. Females were found to report

	Sleep		Exercise frequency	
	t	*p*	*t*	*p*
Stress	7.628	< .001	2.804	.005
Anxiety	7.243	< .001	2.64	.008
Depression	7.073	< .001	3.401	.001
General health T1	8.866	< .001	11.912	< .001
General health T2	7.68	< .001	11.242	< .001

Table 6.11. Associations between mental health outcomes and sleep, and exercise frequency.

higher levels of stress, anxiety, depression, and lower general health than males, effects that broadly reflect those observed in older populations (e.g. Mahmoud, Staten, Hall, & Lennie, 2012; Newbury-Birch & Kamali, 2001). Although no associations were observed regarding the academy that a child attended (other than general health being higher in pupils from Academy 2 at T1), stress, anxiety, and depression increased with school year. These observations are different from those of Bayram and Bilgel (2008), who found that first and second year Turkish university students reported higher levels of stress, anxiety, and depression compared to those in their third, fourth, and fifth year. Differences in findings like these further highlight the importance of taking demographic variance into account when investigating mental health outcomes. General health was also found to decrease with school year, although the effect was only observed at T1.

Pupils with a SEN status were more likely to be members of the high depression group, and to report low general health at T2, though did not differ regarding stress or anxiety. Interestingly, although no differences were observed in relation to stress and depression, children who were eligible to receive FSM were significantly more likely to report low levels of anxiety. This finding is somewhat counterintuitive in that eligibility to receive FSM is a proxy indication of low SES (Shuttleworth, 1995), and financial difficulties have been shown to increase depression in British university students (Andrews & Wilding, 2004).

Infrequent exercise was associated with high stress, anxiety, and depression, as well as poor general health. These effects broadly replicate observations that exercise can have antidepressant and anxiolytic effects, and can help people to cope with stress (Salmon, 2001). In addition, low school attendance was associated with high stress, anxiety, and depression, as well as with low general health (at T2 only).

			Sex		Academy			School year					SEN status		FSM		Attendance	
			Male	Female	Academy 1	Academy 2	Academy 3	Year 7	Year 8	Year 9	Year 10	Year 11	Yes	No	Yes	No	High	Low
Stress	Low	Count	446	301	226	390	206	192	201	152	126	131	205	604	86	716	456	346
		Expected count	359.6	387.4	225.9	406.1	190.1	161.6	167.9	165.3	151.4	155.8	213.1	595.9	88.8	713.2	433.9	368.1
		Row %	59.7%	40.3%	27.5%	47.4%	25.1%	23.9%	25.1%	19%	15.7%	16.3%	25.3%	74.7%	10.7%	89.3%	56.9%	43.1%
		Adjusted residual	7.9	-7.9	.0	-1.4	1.7	3.4	3.6	-1.5	-2.9	-2.8	-.8	.8	-.4	.4	2	-2
	High	Count	538	759	392	721	314	250	258	300	288	295	379	1029	157	1235	732	662
		Expected count	624.4	672.6	392.1	704.9	329.9	280.4	291.1	286.7	262.6	270.2	370.9	1037.1	154.2	1237.8	754.1	639.9
		Row %	41.5%	58.5%	27.5%	50.5%	22%	18%	18.5%	21.6%	20.7%	21.2%	26.9%	73.1%	11.3%	88.7%	52.5%	47.5%
		Adjusted residual	-7.9	7.9	.0	1.4	-1.7	-3.4	-3.6	1.5	2.9	2.8	.8	-.8	.4	-.4	-2	2
		$\chi 2$	63.064, $p < .001$		3.109, $p = .211$			33.93, $p < .001$					.659, $p = .417$		.159, $p = .69$		3.874, $p = .049$	
Anxiety	Low	Count	674	502	348	624	314	291	289	256	213	203	330	933	157	1095	706	546
		Expected count	565.2	610.8	352.7	634.7	298.7	252.3	260.4	258.7	236.9	243.7	330.8	932.2	138.7	1113.3	677.5	574.5
		Row %	57.3%	42.7%	27.1%	48.5%	24.4%	23.2%	23.1%	20.4%	17%	16.2%	26.1%	73.9%	12.5%	87.5%	56.4%	43.6%
		Adjusted residual	9.8	-9.8	-.4	-.9	1.6	4.2	3.1	-.3	-2.6	-4.5	-.1	.1	2.5	-2.5	2.5	-2.5
	High	Count	305	556	266	481	206	149	165	195	200	222	248	696	85	847	477	457
		Expected count	413.8	447.2	261.3	470.3	221.3	187.7	193.6	192.3	176.1	181.3	247.2	696.8	103.3	828.7	505.5	428.5
		Row %	35.4%	64.6%	27.9%	50.5%	21.6%	16%	17.7%	20.9%	21.5%	23.8%	26.3%	73.7%	9.1%	90.9%	51.1%	48.9%
		Adjusted residual	-9.8	9.8	.4	.9	-1.6	-4.2	-3.1	.3	2.6	4.5	.1	-.1	-2.5	2.5	-2.5	2.5
		$\chi 2$	95.408, $p < .001$		2.415, $p = .299$			42.931, $p < .001$					.006, $p = .94$		6.342, $p = .012$		6.095, $p = .014$	
Depression	Low	Count	723	615	392	715	354	304	318	280	252	271	357	1081	152	1273	800	625
		Expected count	644.7	693.3	401	721.7	338.3	287.5	299.9	294.7	269.2	273.8	379.6	1058.4	157.4	1267.6	769.9	655.1
		Row %	54%	46%	26.8%	48.9%	24.2%	21.3%	22.3%	19.6%	17.7%	19%	24.8%	75.2%	10.7%	89.3%	56.1%	43.9%
		Adjusted residual	7.3	-7.3	-.9	-.6	1.7	1.9	2	-1.6	-2	-.3	-2.3	2.3	-.8	.8	2.7	-2.7
	High	Count	257	439	222	390	164	136	141	171	160	148	225	542	89	668	380	379
		Expected count	335.3	360.7	213	383.3	179.7	152.5	159.1	156.3	142.8	145.2	202.4	564.6	83.6	673.4	410.1	348.9
		Row %	36.9%	63.1%	28.6%	50.3%	21.1%	18%	18.7%	22.6%	21.2%	19.6%	29.3%	70.7%	11.8%	88.2%	50.1%	49.9%
		Adjusted residual	-7.3	7.3	.9	.6	-1.7	-1.9	-2	1.6	2	.3	2.3	-2.3	.8	-.8	-2.7	2.7
		$\chi 2$	53.688, $p < .001$		2.86, $p = .239$			11.244, $p = .024$					5.234, $p = .022$		.598, $p = .439$		7.357, $p = .007$	

Table 6.12. $\chi 2$ values and cross-tabulations between stress, anxiety, and depression, and categorical control variables.

			Sex		**Academy**			**School year**					**SEN status**		**FSM**		**Attendance**	
			Male	Female	Academy 1	Academy 2	Academy 3	Year 7	Year 8	Year 9	Year 10	Year 11	Yes	No	Yes	No	High	Low
General health T1	High	Count	703	668	453	710	228	255	278	305	286	247	258	1133	155	1216	699	672
		Expected count	675	696	470.7	679.6	240.8	239.9	266	300.7	275.4	289.1	261	1130	168.4	1202.6	695.3	675.7
		Row %	51.3%	48.7%	32.6%	51%	16.4%	18.6%	20.3%	22.2%	20.9%	18%	18.5%	81.5%	11.3%	88.7%	51%	49%
		Adjusted residual	2.9	-2.9	-1.9	3.1	-1.7	2	1.6	.5	1.4	-5.3	-.4	.4	-2.1	2.1	.4	-.4
	Low	Count	231	295	198	230	105	77	90	111	95	153	103	430	78	448	263	263
		Expected count	259	267	180.3	260.4	92.3	92.1	102	115.3	105.6	110.9	100	433	64.6	461.4	266.7	259.3
		Row %	43.9%	56.1%	37.1%	43.2%	19.7%	14.6%	17.1%	21.1%	18.1%	29.1%	19.3%	80.7%	14.8%	85.2%	50%	50%
		Adjusted residual	-2.9	2.9	1.9	-3.1	1.7	-2	-1.6	-.5	-1.4	5.3	.4	-.4	2.1	-2.1	-.4	.4
		$\chi 2$	8.239, p = .004		9.739, p = .008			29.182, p < .001					.153, p = .696		4.38, p = .036		.147, p = .701	
General health T2	High	Count	720	723	421	798	370	321	335	324	274	297	388	1174	152	1399	877	677
		Expected count	695.4	747.6	435.5	787.8	365.7	311.6	323.6	322.9	291.8	301	411.8	1150.2	171.6	1379.4	840.6	713.4
		Row %	49.9%	50.1%	26.5%	50.2%	23.3%	20.7%	21.6%	20.9%	17.7%	19.1%	24.8%	75.2%	9.8%	90.2%	56.4%	43.6%
		Adjusted residual	2.4	-2.4	-1.5	.9	.5	1.1	1.3	.1	-2.1	-.5	-2.5	2.5	-2.9	2.9	3.4	-3.4
	Low	Count	266	337	196	318	148	120	123	133	139	129	197	460	91	554	312	332
		Expected count	290.6	312.4	181.5	328.2	152.3	129.4	134.4	134.1	121.2	125	173.2	483.8	71.4	573.6	348.4	295.6
		Row %	44.1%	55.9%	29.6%	48%	22.4%	18.6%	19.1%	20.7%	21.6%	20%	30%	70%	14.1%	85.9%	48.4%	51.6%
		Adjusted residual	-2.4	2.4	1.5	-.9	-.5	-1.1	-1.3	-.1	2.1	.5	2.5	-2.5	2.9	-2.9	-3.4	3.4
		$\chi 2$	5.697, p = .017		2.276, p = .32			6.233, p = .182					6.306, p = .012		8.593, p = .003		11.699, p = .001	

Table 6.13. $\chi 2$ values and cross-tabulations between general health and categorical control variables.

These effects also broadly replicate observations in adults, with stress, anxiety, and depression being shown to predict absenteeism in the workplace (Hendriks et al., 2015; Marzec, Scibelli, & Edington, 2015). In addition to this, low sleep hours were associated with high stress, anxiety, depression, and poor general health, potentially mirroring observations that insomniacs have higher than normal risks of reporting anxiety and depression (Taylor, Lichstein, Durrence, Reidel, & Bush, 2005), and that they perceive their lives to be more stressful than do good sleepers (Morin, Rodrigue, & Ivers, 2003).

The identification of correlates of mental health is important as they can now be controlled for statistically in subsequent analyses. However, of particular concern are the findings that high stress, anxiety, and depression were relatively common, and that the occurrence of poor mental health increased throughout secondary school education. The next section will aim to identify demographic and lifestyle correlates of school performance.

6.3.5 Correlates of School Performance

6.3.5.1 Dichotomisation of School Performance Outcomes

Due to the data being heavily skewed, school attendance was dichotomised via a median split. The medians observed were 95.59% at T1 and 93.4% at T2, which are close to the minimum of 95% recommended by the UK government. This is also considered a useful cut-off point, as 73% of students who achieve ≥ 95% accomplish five or more GCSEs at grades A* to C (Taylor, 2012). However, it was decided that a median split would be more suitable than splitting the distribution into those who achieved 95% attendance or more and those who did not. This is because although the distribution of high and low attenders determined through this method would be relatively balanced at T1 (high = 55.3%, low = 44.7%), this would not be the case at T2 (high = 36.9%, low = 63.1%).

English and maths attainment could not be dichotomised using such a simple method as that utilised for attendance. This was because the grading systems differed between KS3 and KS4, and also between academies. At KS3, each of the academies utilised a system ranging from 8a (highest) to 1c (lowest), with three discreet categories within each grade boundary (e.g. 8a, 8b, 8c). This gave 24 potential grade categories. At KS4, however, each academy used a different system for grading work. Academy 1 used a system ranging from A+ to G-, in which three separate distinctions were obtainable within each grade boundary from A-G (e.g. A+, A, A-). A ‘U’ was also available in this system, indicating an ungraded standard of work (i.e. a fail grade), thereby meaning that 22 discreet grade categories were present. Academy 2 used a system that ranged from A* to G (with U again indicating that work was of an ungraded standard). In this case, however, no further differentiation within grade boundaries was made, resulting in only nine separate categories. Academy 3 used a system ranging from A*a (highest) to Gc (lowest), with a U indicating ungraded work. Each grade boundary (from A-G) was differentiated into three distinct levels (e.g. Aa, Ab, Ac), providing 25 possible grades.

Due to the array of separate grading methods used by the three academies, the data needed to be recoded before being analysed as a whole. For each system, grades were ranked from highest to lowest, and then recoded via median split to provide a high attainment group and a low attainment group (the group to which each child was assigned being based on whether they were above or below the median at KS3/KS4 within the academy that they attended). Composite variables consisting of KS3 and KS4 for the whole sample were then created for both English and maths.

As with attainment, the method used for recording behavioural sanctions also differed between schools. Academies 1 and 2 provided exact numbers of detentions received by students over the course of the school year, whereas Academy 3 utilised a behavioural points system (higher numbers indicating more occurrences of problem behaviour). Therefore, in order to be able to analyse the sample as a whole, a compound dichotomous variable was created consisting of a ‘good behaviour’ group and a ‘bad behaviour’ group. The behavioural points variable provided by Academy 3 was split into quintiles, with those in the lowest 80% being placed into the good behaviour group, along with those from Academies 1 and 2 who did not receive any detentions. The bad behaviour group was comprised of those from Academy 3 who acquired the highest 20% of behavioural points, and those from Academies 1 and 2 who received one detention or more. Recoding into quintiles was determined to be a good method of categorising those from Academy 3 as it allowed for similar percentages of students from all schools to be placed into each of the two behaviour groups.

6.3.5.2 Categorical Covariates of School Performance

Chi-square tests were used to examine associations between school performance and the categorical demographic/lifestyle variables. Cross-tabulations, $\chi 2$, and p values for these analyses from T1 and T2 are displayed in Tables 6.14 and 6.15, respectively.

High attainment and good behaviour were more common in females than males, although no effects were observed regarding maths attainment at T2, or school attendance at either time-point. Differences between the schools were detected for each of the outcomes at both time-points, though the association with behavioural sanctions at T2 was only marginally significant (for the specific differences between academies at T1 and T2, see the cross-tabulations presented in Tables 6.14 and 6.15, respectively). The year group attended was also associated with each of the school performance outcomes at both time-points. Chi-square tests for linear association showed that school attendance was negatively associated with year group, at both T1, $\chi 2$ (1, N = 3040) = 20.896, $p < .001$, and T2, $\chi 2$ (1, N = 3009) = 165.982, $p < .001$. Attainment, on the other hand, was positively associated with school year: English T1, $\chi 2$ (1, N = 2941) = 163.468, $p < .001$; English T2, $\chi 2$ (1, N = 2957) = 65.777, $p < .001$; maths T1, $\chi 2$ (1, N = 2960) = 67.421, $p < .001$; maths T2, $\chi 2$ (1, N = 2952) = 5.324, $p = .021$. The occurrence of behavioural sanctions was also found to increase throughout secondary education: T1, $\chi 2$ (1, N = 3028) = 16.639, $p < .001$; T2, $\chi 2$ (1, N = 2987) = 25.36, $p < .001$. In addition, SEN status and being eligible for FSM were associated with low school attendance, low English and maths attainment, and high occurrences of behavioural sanctions at both time-points. As might be expected, low school attendance was associated with low English and maths attainment, as well as with a high occurrence of behavioural sanctions at both time-points.

6.3.5.3 Continuous Covariates of School Performance

Associations between school performance and continuous lifestyle variables were investigated using between-subjects t-tests. Higher sleep hours and more

			Sex		**Academy**			**School year**					**SEN status**		**FSM**		**School attendance**	
			Male	Female	Academy 1	Academy 2	Academy 3	Year 7	Year 8	Year 9	Year 10	Year 11	Yes	No	Yes	No	High	Low
School attendance	High	Count	787	732	588	528	403	325	327	294	280	293	291	1228	129	1390	-	-
		Expected count	776.5	742.5	473.7	672.6	372.8	287.8	300.3	306.3	306.3	318.3	334.3	1184.7	197.9	1321.1	-	-
		Row %	51.8%	48.2%	38.7%	34.8%	26.5%	21.4%	21.5%	19.4%	18.4%	19.3%	19.2%	80.8%	8.5%	91.5%	-	-
		Adjusted residual	.8	-.8	9	-10.6	2.5	3.4	2.4	-1.1	-2.4	-2.3	-3.8	3.8	-7.4	7.4	-	-
	Low	Count	767	754	360	818	343	251	274	319	333	344	378	1143	267	1254	-	-
		Expected count	777.5	743.5	474.3	673.4	373.2	288.2	300.7	306.7	306.7	318.7	334.7	1186.3	198.1	1322.9	-	-
		Row %	50.4%	49.6%	23.7%	53.8%	22.6%	16.5%	18%	21%	21.9%	22.6%	24.9%	75.1%	17.6%	82.4%	-	-
		Adjusted residual	-.8	.8	-9	10.6	-2.5	-3.4	-2.4	1.1	2.4	2.3	3.8	-3.8	7.4	-7.4	-	-
		χ2	.582, *p* = .446		122.141, *p* < .001			23.865, *p* < .001					14.36, *p* < .001		55.085, *p* < .001		-	
English attainment	High	Count	556	840	461	567	368	164	225	290	323	394	80	1316	112	1284	788	608
		Expected count	712.5	683.5	434.8	620.9	340.3	261.5	275.3	285.3	279.6	294.3	300.9	1095.1	175.6	1220.4	702	694
		Row %	39.8%	60.2	33%	40.6%	26.4%	11.7%	16.1%	20.8%	23.1%	28.2%	5.7%	94.3%	8%	92%	56.4%	43.6%
		Adjusted residual	-11.6	11.6	2.1	-4	2.4	-9.2	-4.7	.4	4	9	-19.8	19.8	-7.1	7.1	6.3	-6.3
	Low	Count	945	600	455	741	349	387	355	311	266	226	554	991	258	1287	691	854
		Expected count	788.5	756.5	481.2	687.1	376.7	289.5	304.7	315.7	309.4	325.7	333.1	1211.9	194.4	1350.6	777	768
		Row %	61.2%	38.8%	29.4%	48%	22.6%	25%	23%	20.1%	17.2%	14.6%	35.9%	64.1%	16.7%	83.3%	44.7%	55.3%
		Adjusted residual	11.6	-11.6	-2.1	4	-2.4	9.2	4.7	-.4	-4	-9	19.8	-19.8	7.1	-7.1	-6.3	6.3
		χ2	133.608, *p* < .001		16.182, *p* < .001			164.035, *p* < .001					393.625, *p* < .001		50.194, *p* < .001		40.309, *p* < .001	
Maths attainment	High	Count	761	836	447	784	366	184	359	338	321	395	113	1484	114	1483	882	715
		Expected count	814.1	782.9	498.5	708.9	389.5	301.6	316.7	325.9	316.2	336.7	344.2	1252.8	199.6	1397.4	805	792
		Row %	47.7%	52.3%	28%	49.1%	22.9%	11.5%	22.5%	21.2%	20.1%	24.7%	7.1%	92.9%	7.1%	92.9%	55.2%	44.8%
		Adjusted residual	-3.9	3.9	-4.1	5.6	-2	-11.1	3.9	1.1	.4	5.3	-20.7	20.7	-9.5	9.5	5.7	-5.7
	Low	Count	748	615	477	530	356	375	228	266	265	229	525	838	256	1107	610	753
		Expected count	694.9	668.1	425.5	605.1	332.5	257.4	270.3	278.1	269.8	287.3	293.8	1069.2	170.4	1192.6	687	676
		Row %	54.9%	45.1%	35%	38.9%	26.1%	27.5%	16.7%	19.5%	19.4%	16.8%	38.5%	61.5%	18.8%	81.2%	44.8%	55.2%
		Adjusted residual	3.9	-3.9	4.1	-5.6	2	11.1	-3.9	-1.1	-.4	-5.3	20.7	-20.7	9.5	-9.5	-5.7	5.7
		χ2	15.37, *p* < .001		31.912, *p* < .001			134.935, *p* < .001					429.968, *p* < .001		91.154, *p* < .001		32.274, *p* < .001	
Behavioural sanctions	Good	Count	1233	1341	760	1226	598	516	522	503	501	532	475	2109	291	2283	1328	1246
		Expected count	1313.4	1260.6	810.9	1144.1	629	484.5	509.2	519.4	519.4	541.5	565.4	2018.6	334.1	2239.9	1289.6	1284.4
		Row %	47.9%	52.1%	29.4%	47.4%	23.1%	20%	20.3%	19.5%	19.5%	20.7%	18.4%	81.6%	11.3%	88.7%	51.6%	48.4%
		Adjusted residual	-8.2	8.2	-5.6	8.4	-3.7	4.1	1.6	-2.1	-2.3	-1.2	-11.1	11.1	-6.5	6.5	3.9	-3.9
	Bad	Count	312	142	194	120	142	54	77	108	110	105	190	265	102	352	189	265
		Expected count	231.6	222.4	143.1	201.9	111	85.5	89.8	91.6	91.6	95.5	99.6	355.4	58.9	395.1	227.4	226.6
		Row %	68.7%	31.3%	42.5%	26.3%	31.1%	11.9%	17%	23.8%	24.2%	23.1%	41.8%	58.2%	22.5%	77.5%	41.6%	58.4%
		Adjusted residual	8.2	-8.2	5.6	-8.4	3.7	-4.1	-1.6	2.1	2.3	1.2	11.1	-11.1	6.5	-6.5	-3.9	3.9
		χ2	66.946, *p* < .001		70.571, *p* < .001			24.678, *p* < .001					123.671, *p* < .001		42.57 *p* < .001		15.323, *p* < .001	

Table 6.14. χ2 values and cross-tabulations between school performance outcomes and categorical control variables at T1.

			Sex		Academy			School year					SEN status		FSM		School attendance	
			Male	Female	Academy 1	Academy 2	Academy 3	Year 7	Year 8	Year 9	Year 10	Year 11	Yes	No	Yes	No	High	Low
School attendance	High	Count	546	558	324	727	452	365	324	344	302	165	404	1098	130	1370	-	-
		Expected count	538.8	565.2	462	665.1	375.9	281.2	295.6	304.6	303.1	315.6	440.8	1061.2	190.9	1309.1	-	-
		Row %	49.5%	50.5%	21.6%	48.4%	30.1%	24.3%	21.6%	22.9%	20.1%	11%	26.9%	73.1%	8.7%	91.3%	-	-
		Adjusted residual	.6	-.6	-10.9	4.5	6.4	7.8	2.6	3.6	-.1	-13.5	-2.9	2.9	-6.7	6.7	-	-
	Low	Count	455	492	604	609	303	199	269	267	306	468	480	1030	253	1256	-	-
		Expected count	462.2	484.8	466	670.9	379.1	282.8	297.4	306.4	304.9	317.4	443.2	1066.8	192.1	1316.9	-	-
		Row %	48%	52%	39.8%	40.2%	20%	13.2%	17.8%	17.7%	20.3%	31%	31.8%	68.2%	16.8%	83.2%	-	-
		Adjusted residual	-.6	.6	10.9	-4.5	-6.4	-7.8	-2.6	-3.6	.1	13.5	2.9	-2.9	6.7	-6.7	-	-
		χ2	.406, *p* = .524		124.257, *p* < .001			208.702, *p* < .001					8.686, *p* = .003		44.424, *p* < .001		-	
English attainment	High	Count	413	593	474	590	366	161	280	339	292	346	208	1212	121	1297	757	663
		Expected count	491.4	514.6	443.2	631.4	355.4	264.2	280.1	290.1	286.8	296.8	411	1009	177	1241	711	709
		Row %	41.1%	58.9%	33.1%	41.3%	25.6%	11.4%	19.7%	23.9%	20.6%	24.4%	14.6%	85.4%	8.5%	91.5%	53.3%	46.7%
		Adjusted residual	-7	7	2.4	-3.1	.9	-9.8	.0	4.5	.5	4.4	-16.5	16.5	-6.2	6.2	3.4	-3.4
	Low	Count	582	449	454	732	378	390	304	266	306	273	649	892	248	1291	728	818
		Expected count	503.6	527.4	484.8	690.6	388.6	286.8	303.9	314.9	311.2	322.2	446	1095	192	1347	774	772
		Row %	56.5%	43.5%	29%	46.8%	24.2%	25.3%	19.8%	17.3%	19.9%	17.7%	42.1%	57.9%	16.1%	83.9%	47.1%	52.9%
		Adjusted residual	7	-7	-2.4	3.1	-.9	9.8	.0	-4.5	-.5	-4.4	16.5	-16.5	6.2	-6.2	-3.4	3.4
		χ2	48.305, *p* < .001		9.9, *p* = .007			109.137, *p* < .001					271.11, *p* < .001		38.838, *p* < .001		11.456, *p* = .001	
Maths attainment	High	Count	476	512	456	562	364	193	314	341	185	333	195	1173	110	1256	749	622
		Expected count	482.1	505.9	429.2	613.5	339.4	255.9	271.2	279.5	273	286.4	393.4	974.6	170.8	1195.3	685.7	685.3
		Row %	48.2%	51.8%	33%	40.7%	26.3%	14.1%	23%	25%	13.5%	24.4%	14.3%	85.7%	8.1%	91.9%	54.6%	45.4%
		Adjusted residual	-.5	.5	2.1	-3.8	2.1	-6	4	5.6	-8.1	4.2	-16.2	16.2	-6.8	6.8	4.7	-4.7
	Low	Count	514	527	471	763	369	360	272	263	405	286	655	933	259	1327	732	858
		Expected count	507.9	533.1	497.8	711.5	393.6	297.1	314.8	324.5	317	332.6	456.6	1131.4	198.3	1387.8	795.3	794.7
		Row %	49.4%	50.6%	29.4%	47.6%	23%	22.7%	17.2%	16.6%	25.5%	18%	41.2%	58.8%	16.3%	83.7%	46%	54%
		Adjusted residual	.5	-.5	-2.1	3.8	-2.1	6	-4	-5.6	8.1	-4.2	16.2	-16.2	6.8	-6.8	-4.7	4.7
		χ2	.291, *p* = .59		14.485, *p* = .001			133.463, *p* < .001					261.366, *p* < .001		45.977, *p* < .001		21.749, *p* < .001	
Behavioural sanctions	Good	Count	720	900	740	1022	746	468	476	457	433	466	584	1720	249	2051	1202	1102
		Expected count	791.5	828.5	735.9	1046.3	725.8	430.4	454.3	467.4	464.3	483.6	674	1630	293.4	2006.6	1149.7	1154.3
		Row %	44.4%	55.6%	29.5%	40.7%	29.7%	20.3%	20.7%	19.9%	18.8%	20.3%	25.3%	74.7%	10.8%	89.2%	52.2%	47.8%
		Adjusted residual	-7.7	7.7	.4	-2.1	1.9	4.2	2.4	-1.1	-3.4	-1.9	-8.6	8.6	-5.8	5.8	4.6	-4.6
	Bad	Count	283	150	199	313	180	91	114	150	170	162	291	396	132	555	289	395
		Expected count	211.5	221.5	203.1	288.7	200.2	128.6	135.7	139.6	138.7	144.4	201	486	87.6	599.4	341.3	342.7
		Row %	65.4%	34.6%	28.8%	45.2%	26%	13.2%	16.6%	21.8%	24.7%	23.6%	42.4%	57.6%	19.2%	80.8%	42.3%	57.7%
		Adjusted residual	7.7	-7.7	-.4	2.1	-1.9	-4.2	-2.4	1.1	3.4	1.9	8.6	-8.6	5.8	-5.8	-4.6	4.6
		χ2	59.808, *p* < .001		5.327, *p* = .07			31.721, *p* < .001					73.992, *p* < .001		33.445, *p* < .001		20.755, *p* < .001	

Table 6.15. χ2 values and cross-tabulations between school performance outcomes and categorical control variables at T2.

frequent exercise were associated with the high attendance group at T2, although no such effects were observed at T1. Strangely, the high English attainment group at T1 reported lower sleep hours than did the low attainment group, though no such effect was observed at T2. Higher exercise frequency scores were also associated with the high English attainment group, although at both time-points the effects were only marginally significant. For maths attainment, however, the high performance group achieved significantly higher exercise frequency scores than did the low performance group at both time-points. The high maths attainment group at T2 also reported higher sleep hours, although the effect was only marginally significant, and was not detected at T1. In addition, the good behaviour group at T2 reported higher sleep hours, though no such effect was observed at T1. For *t* and *p* values for associations between school performance and continuous demographic/lifestyle variables at both time-points, see Table 6.16.

		Sleep		**Exercise frequency**	
		t	*p*	*t*	*p*
School attendance	T1	1.373	.17	1.385	.166
	T2	6.66	< .001	2.286	.022
English attainment	T1	-2.394	.017	1.877	.061
	T2	-.676	.499	1.675	.094
Maths attainment	T1	-1.404	.161	2.988	.003
	T2	1.933	.053	3.004	.003
Behavioural sanctions	T1	-.841	.401	.721	.471
	T2	5.782	< .001	.276	.783

Table 6.16. Associations between school performance outcomes and continuous control variables at T1 and T2.

6.3.5.4 Discussion of Correlates of School Performance

Findings from this section broadly replicate those observed in the literature. For instance, although no sex differences were detected for school attendance, the observation that males achieved lower attainment and incurred a greater number of behavioural sanctions compared to females is similar to previously reported findings (e.g. Gorard, Rees, & Salisbury, 2001). Although such observations can be considered relatively unremarkable, as with those relating to mental health, the identification of demographic and lifestyle correlates of school performance is important. This is because such variables can subsequently be controlled for statistically, reducing the likelihood of the observed effects being better explainable by the influence of confounding factors Decreasing attendance and increasing behavioural sanctions throughout secondary school were detected, findings that are consistent with the observation that antisocial behaviour temporarily increases almost 10-fold during adolescence (Moffitt, 1993). However, Moffitt suggests that adolescent delinquency conceals two distinct subgroups of individuals: a large group who are antisocial only during adolescence, and a smaller group that engages in antisocial activities throughout every stage of life. Although this is clearly an important distinction to make if attempting to predict future criminal outcomes, the current methodology would be unable to effectively differentiate between these subgroups. This is an area that may therefore be of particular interest for future research.

As might be expected, SEN status was consistently associated with low attendance, low attainment, and problem behaviour. Eligibility for FSM was also related to each of these outcomes, which is consistent with FSM being an indication of low SES (Shuttleworth, 1995), as well as with the observation that low parental SES can predict a child's level of school achievement (Gregg & Machin, 2001).

Although effects relating to average sleep duration were not entirely consistent (e.g. those who achieved high levels of English attainment at T1 reported lower sleep hours than those who achieved low attainment), the findings broadly pointed towards benefits of high sleep hours. This is therefore consistent with a recent meta-analysis (Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010), which found the school performance of children and adolescents to be positively associated with sleep duration and quality, and negatively associated with sleepiness.

Although no associations were observed with behavioural sanctions, analyses determined that frequent exercise participation was associated with high attendance at T2, and with high English and maths attainment at both time-points (though those relating to English attainment were both marginally significant). Overall, the findings suggest that frequent exercise participation is likely to be beneficial to school performance, which is in line with previous findings (see Singh, Uijtdewilligen, Twisk, van Mechelen, & Chinapaw, 2012).

As well as being an outcome, school attendance was investigated as an additional predictor when examining English attainment, maths attainment, and behavioural sanctions. In each case low attendance was associated with undesirable outcomes. These findings suggest children who frequently fail to attend school fall behind in their academic studies (e.g. Taylor, 2012), as they essentially only complete the parts of the course for which they are present. Furthermore, such children likely exhibit behavioural problems in the first place given the fact that, as a whole, they appear to incur significantly more behavioural sanctions than do other children, even though they spend less time at school in which to accrue them. Given the other associated demographic risk factors identified in the current sample (e.g. eligibility for FSM), it is likely that such problems stem from the home. These are children that may represent an at-risk subgroup, for which interventions might be beneficial.

6.4 General Discussion

Chapters 3, 4, and 5 initially aimed to investigate the efficacy of the DABS as a measure of food and drink consumption, and to examine relationships between dietary variables and GPA, work efficiency, low wellbeing, and course stress in university students. However, the three studies presented suffered from a number of methodological shortcomings that made the results difficult to interpret with much certainty. The Cornish Academies Project, data from which are presented in the current chapter as well as in Chapters 7, 8, 9, and 10, therefore aimed to address some of these issues by using the DABS to examine associations between diet and mental health and school performance outcomes in a large sample of secondary school children. The current chapter aimed to provide an overview of the study, to investigate the structure associated with the DABS in this sample, and to identify demographic and lifestyle correlates of diet, mental health, and school performance.

6.4.1 Establishing the DABS As an Effective Measure of Dietary Consumption

The current chapter has shown that the DABS can be associated with an underlying four-factor model of diet in secondary school children, which consists of

Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, and Hot Caffeinated Beverages. These factors were also related to a number of different aspects of demography and lifestyle, implying the need to control for such variables when utilising multivariate approaches to data analysis. Subscales were created for each of the DABS factors, and were found to have acceptable levels of internal consistency, to correlate strongly with their respective factor scores, and to be consistent over time. Although the DABS requires validation from further research, this chapter has shown that it may be a useful tool for providing an indication of dietary consumption whilst reducing time costs associated with other commonly used data collection methods.

It should at this point be noted that, though the results reported in this chapter appear to be more reliable than those of Chapters 3, 4, and 5, differences in the demographic groups studied make comparisons difficult. Beyond the more obvious differences, such as age, socioeconomic background, educational level etc., an important example in this regard is that the groups are likely to have differed in their reasons for consuming energy drinks. Although some of the reasons provided may overlap with those given by university students (e.g. to combat insufficient sleep, to increase energy; Malinauskas et al., 2007), secondary school children in the UK are typically not old enough to hold a driving licence or to purchase alcohol, meaning that they are unlikely to use them for the purposes of mixing with alcohol, treating a hangover, or staying alert whilst driving for a long period of time. Though underage drinking may occur at a rate that is less than desirable, the opportunities to acquire alcoholic beverages will be considerably reduced in those less than 18 years of age (although it should be noted that studies in US populations may be confounded in this regard, as the legal drinking age there is 21).

6.4.2 Correlates of Diet, Mental Health, and School Performance in Secondary School Children

Analyses presented in the current chapter identified a number of demographic and lifestyle correlates of diet, mental health, and school performance. Coupled with the observation that the participants who completed the questionnaires were not entirely representative of the schools from which they came, the findings suggest that these variables should be controlled for when investigating associations between diet and mental health and school performance. Although relationships between some of these variables differed across outcomes and time-points, considering the sample size, it was deemed important to control for each of these covariates wherever possible. Therefore, multivariate analyses presented in Chapters 7 and 8 will control for sex, academy, school year, SEN status, eligibility to receive FSM, sleep hours, and exercise frequency. Though also used as an outcome, it was deemed sensible to control for school attendance when investigating dietary associations with mental health, attainment, and problem behaviour.

6.4.3 Methodological Limitations

It must be acknowledge that several limitations are incurred by the research presented in the current chapter. Firstly, the results are somewhat preliminary, and so, need validation from future studies. In addition to this, the sample population was quite homogeneous (being made up almost entirely of white children from a specific age range, as well as including a high proportion of pupils with a SEN status), and came from a specific geographical area. Furthermore, the two cross-sections of data differed considerably more than initially expected. The sample at T2 was larger, which mainly reflected an increased number of pupils from Academy 3 taking part at T2 compared to T1. In addition, the proportion of pupils with a SEN status was noticeably increased at T2. This was due to higher percentages of pupils with a SEN status at Academies 2 and 3 taking part at T2 compared to T1. These observations therefore lend further support to the decision to control as much demographic and lifestyle variance as possible in multivariate analyses presented in later chapters.

6.4.4 Conclusions

The current chapter aimed to build on the findings of previous chapters by testing the efficacy of the DABS in a large sample of secondary school children. A four-factor structure of diet was associated with the questionnaire, which consisted of Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, and Hot Caffeinated Beverages. Of particular importance was that this structure was reliably reproduced at both time-points, and within each of the three schools. In addition to this, a profile of mental health, academic performance, and problem behaviour in secondary school pupils was provided, and demographic and lifestyle correlates were identified. Building on these findings, Chapter 7 will aim to investigate associations between dietary variables of interest (i.e. breakfast, energy drinks, caffeine, and the DABS factors) and stress, anxiety, depression, and general health.

Chapter 7: Cross-Sectional Associations Between Diet and Mental Health in Secondary School Children

7.1 Introduction

Chapter 6 showed that the Diet and Behaviour Scale (DABS) can be an effective tool for fast assessment of dietary intake, that it can be associated with a four-factor model of Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, and Hot Caffeinated Beverages, and that certain demographic and lifestyle variables should be controlled for when analysing data from the Cornish Academies Project.

The DABS factor labelled 'Caffeinated Soft Drinks/Gum' was identified as being of particular importance to the current research due to it being comprised of energy drinks, cola, and chewing gum, dietary variables that contribute little of nutritional significance yet may exert far-reaching effects on psychological outcomes. These items are functionally related in that they all have potential to increase alertness. Tea and coffee also share this property, though loaded onto their own unique factor ('Hot Caffeinated Beverages'). The differential formation of these two factors may be explainable in terms of social processes involved in acquiring and consuming the products in question. Essentially, tea and coffee are likely to be consumed at home, and not be actively discouraged by parents, whereas energy drinks, cola, and chewing gum may more likely be acquired outside of the home, and perhaps used to cultivate an image akin to the 'toxic jock' reported by Miller (2008a).

The current chapter aims to examine how dietary variables of interest (caffeine, breakfast, energy drinks, Caffeinated Soft Drinks/Gum) may relate to self-assessed general health, stress, anxiety, and depression in secondary school children.

7.2 Method

7.2.1 Design

In the analyses presented in the current chapter the following predictor variables were used: 1) total weekly caffeine intake, 2) weekly caffeine intake from individual sources (i.e. energy drinks, cola, coffee, and tea), 3) breakfast consumption (every day vs. not every day), 4) energy drink consumption (once a week or more vs. less than once a week), 5) combinations of breakfast and energy drink consumption (all four groupings of frequent/infrequent intake), and 6) consumption of the Caffeinated Soft Drinks/Gum DABS factor. The dependent variables investigated were: 1) general health, 2) stress, 3) anxiety, and 4) depression.

7.2.2 Statistical Procedures[7, 8]

Associations between dietary variables and mental health outcomes were examined cross-sectionally at both time-points for general health, but only at T2 for stress, anxiety, and depression, as these latter variables were not recorded at T1. Univariate analyses were conducted using Chi-square and Chi-square tests for linear association when predictor variables were categorical, and between-subjects t-tests when predictor variables were continuous. In each case these were followed-up with multivariate level binary logistic regression analyses (using enter method), in which further variance was controlled for statistically.

In addition to Chapter 6 identifying a number of correlates of the dietary and mental health variables in question here, it was also determined that the sample was not fully representative of the academies from which it came. For this reason, and due to the large sample size available, a conservative approach was taken in which each of the demographic and lifestyle variables examined in Chapter 6 were controlled for. Therefore, the following covariates were entered into all multivariate analyses presented in the current chapter: sex, academy attended, school year, SEN status, FSM, sleep hours, exercise frequency, school attendance. For ease of reporting, these variables will henceforth collectively be referred to as ‘demographic

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[7] Omnibus tests of model coefficients determined that the model fit was significant for each multivariate analysis presented in Chapters 7, 8, and 9 (all $p < .001$). For tests of model fitness and percentage of variance explained by each multivariate analysis, see Appendix C.

[8] No interaction analyses are presented or discussed in this chapter, as findings as a whole were inconsistent and most effects were not statistically significant. However, cross-sectional interactions between the main dietary predictor variables examined in this chapter (i.e. total weekly caffeine intake, frequency of breakfast consumption, frequency of energy drink use, and consumption of the Caffeinated Soft Drinks/Gum DABS factor) and certain aspects of demography/lifestyle (sex, SEN status, FSM, and average sleep duration) were investigated in relation to the mental health outcomes, and are included in Appendix D.

and lifestyle covariates'. In addition, certain dietary covariates are also used. However, as their inclusion varies between analyses, specific reference to them will be made when relevant. See Table 7.1 for all covariates entered into each multivariate analysis presented in this chapter.

7.3 Results & Discussion

7.3.1 Total Weekly Caffeine Consumption and Mental Health

7.3.1.1 Calculation of Weekly Caffeine Intake

Although negative mood effects have been associated with high caffeine use in adults (see Lara, 2010, for a review), surprisingly little research has been conducted on younger populations. Therefore, this section aims to investigate associations between its total consumption and general health, stress, anxiety, and depression.

The same method for calculating caffeine intake from the DABS outlined in Chapter 3, section 3.3.5.1 (i.e. 133mg per can of energy drink, 25mg per can of cola, 80mg per cup of coffee, and 40mg per cup of tea) was again used here. This included the same value for caffeine consumed from energy drinks, as the same three brands were also the most commonly used in the current sample (together accounting for 54.7% of cases at T1 and 53.2% at T2).

Large variability was observed for the amount of caffeine consumed, with the mean total intake being 419.84mg/w (SD = 526.76) at T1, and 421.77mg/w (SD = 550) at T2. The highest individual source was tea, which contributed 33.19% of all caffeine consumed at T1 (M = 139.32mg/w, SD = 235.27), and 36.12% at T2 (M = 152.33mg/w, SD = 261.65). This was followed by energy drinks, which accounted for 31.44% at T1 (M = 132.01mg/w, SD = 260.32), and 29.34% at T2 (M = 123.74mg/w, SD = 246.99). Coffee consumption explained 26.8% of all caffeine consumed at T1 (M = 112.53mg/w, SD = 292.68), and 26.97% at T2 (M = 113.77mg/w, SD = 322.51). Cola on the other hand account for only 8.88% at T1 (M = 37.26mg/w, SD = 53.58), and 8.7% at T2 (M = 36.7mg/w, SD = 55.52).

Predictor variable(s)	Dietary covariates	Demographic covariates	Lifestyle covariates
Total weekly caffeine	**Total caffeine (categorical variable with six consumption groups)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)
Caffeine from individual sources	**Caffeine from energy drinks (non/low/high consumption)** **Caffeine from cola (non/low/high consumption)** **Caffeine from coffee (non/low/high consumption)** **Caffeine from tea (non/low/high consumption)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)
Breakfast	**Breakfast (every day vs. not every day)** Junk Food DABS subscale score Healthy Foods DABS subscale score Total weekly caffeine (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)
Energy drinks	**Energy drinks (once a week or more vs. less than once a week)** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)
Energy drinks/breakfast combinations	**Combinations of frequent/infrequent consumption of breakfast and energy drinks** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)
Caffeinated Soft Drinks/Gum	Junk Food DABS factor score **Caffeinated Soft Drinks/Gum DABS factor score** Healthy Foods DABS factor score Hot Caffeinated Beverages DABS factor score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high/low)

Table 7.1. Covariates entered into multivariate analyses of mental health from the Cornish Academies Project.
Note. Predictor variables are highlighted in bold in the dietary covariates column.

7.3.1.2 Univariate Associations Between Total Weekly Caffeine Intake and Mental Health

Total weekly caffeine intake was recoded into a categorical variable consisting of the following six consumption groups: 0mg/w, 0.1-250mg/w, 250.1-500mg/w, 500.1-750mg/w, 750.1-1000mg/w, > 1000mg/w. Chi-square tests for linear association were then conducted to examine relationships between this variable and the dichotomous mental health outcomes discussed in Chapter 6. Each effect was statistically significant. In particular, the > 1000mg/w condition was associated with low general health and high stress, anxiety, and depression. In addition to this, consuming 0.1-250mg/w was associated with low stress, and non-consumption was associated with high general health at T2. For $\chi 2$ and *p* values, as well as cross-tabulations between total weekly caffeine intake and mental health outcomes, see Table 7.2.

7.3.1.3 Multivariate Associations Between Total Weekly Caffeine Intake and Mental Health

The analyses described in the previous section indicated that being a very high consumer of caffeine was associated with poor mental health outcomes. It was therefore deemed important to further investigate such effects at the multivariate level, so that additional variance could be controlled for statistically. In order to do this, the same categorical variable for total weekly caffeine intake was entered into binary logistic regression analyses upon the dichotomous outcomes of general health, stress, anxiety, and depression, and the 0mg/w group was chosen as the comparison condition. Demographic, and lifestyle covariates were also entered, as were the DABS subscale scores (continuous variables) for Junk Food and Healthy Foods. The subscales for Caffeinated Soft Drinks/Gum and Hot Caffeinated Beverages were not entered, in order to avoid unnecessary shared variance with the predictor variable (i.e. total weekly caffeine intake).

The outputs of greatest interest from logistic regression analyses (to the current research at least) are the odds ratio (OR), 95% confidence intervals (95% CIs) and *p* value. The OR provides an indication of the increased/decreased risk associated with each experimental condition compared to the comparison group. (Please note

			Total weekly caffeine intake					
			0mg/w	0.1-250mg/w	250.1-500mg/w	500.1-750mg/w	750.1-1000mg/w	> 1000mg/w
General health T1	Good	Count	155	543	302	147	86	130
		Expected count	148.3	540.4	292.3	149.8	89.7	142.5
		Column %	75.6%	72.7%	74.8%	71%	69.4%	66%
		Adjusted residual	1.1	.3	1.2	-.5	-.8	-2.1
	Bad	Count	50	204	102	60	38	67
		Expected count	56.7	206.6	111.7	57.2	34.3	54.5
		Column %	24.4%	27.3%	25.2%	29%	30.6%	34%
		Adjusted residual	-1.1	-.3	-1.2	.5	.8	2.1
		χ^2 linear	5.021, *p* = .025					
General health T2	Good	Count	175	614	332	179	87	144
		Expected count	159.1	620.6	325.2	171.8	87.3	166.9
		Column %	78.1%	70.3%	72.5%	74%	70.7%	61.3%
		Adjusted residual	2.5	-.6	.8	1.1	-.1	-3.5
	Bad	Count	49	260	126	63	36	91
		Expected count	64.9	253.4	132.8	70.2	35.7	68.1
		Column %	21.9%	29.7%	27.5%	26%	29.3%	38.7%
		Adjusted residual	-2.5	.6	-.8	-1.1	.1	3.5
		χ^2 linear	8.043, *p* = .005					
Stress	Low	Count	81	342	165	89	42	66
		Expected count	81.6	318.5	166.9	88.2	44.8	84.9
		Column %	36.2%	39.1%	36%	36.8%	34.1%	28.3%
		Adjusted residual	-.1	2.1	-.2	.1	-.5	-2.7
	High	Count	143	532	293	153	81	167
		Expected count	142.4	555.5	291.1	153.8	78.2	148.1
		Column %	63.8%	60.9%	64%	63.2%	65.9%	71.7%
		Adjusted residual	.1	-2.1	.2	-.1	.5	2.7
		_2 linear	6.599, *p* = .01					
Anxiety	Low	Count	134	519	258	143	75	110
		Expected count	128.7	502.9	262.7	139.1	71	134.5
		Column %	60.1%	59.6%	56.7%	59.3%	61%	47.2%
		Adjusted residual	.8	1.4	-.5	.5	.7	-3.4
	High	Count	89	352	197	98	48	123
		Expected count	94.3	368.1	192.3	101.9	52	98.5
		Column %	39.9%	40.4%	43.3%	40.7%	39%	52.8%
		Adjusted residual	-.8	-1.4	.5	-.5	-.7	3.4
		χ^2 linear	6.976, *p* = .008					
Depression	Low	Count	158	574	308	157	77	131
		Expected count	146.1	569.5	300.1	157.3	80.6	151.4
		Column %	70.9%	66.1%	67.2%	65.4%	62.6%	56.7%
		Adjusted residual	1.8	.4	.9	.0	-.7	-3
	High	Count	65	295	150	83	46	100
		Expected count	76.9	299.5	157.9	82.7	42.4	79.6
		Column %	29.1%	33.9%	32.8%	34.6%	37.4%	43.3%
		Adjusted residual	-1.8	-.4	-.9	.0	.7	3
		χ^2 linear	9.101, *p* = .003					

Table 7.2. Cross-tabulations between total weekly caffeine intake and mental health outcomes.

that for ease of reporting, the comparison group will sometimes be referred to as the 'control' group). For example, in the current context, an OR of 1.5 in the >1000mg/w consumption condition could indicate that a member of that group was 1.5 times more likely to report high stress compared to a member of the control group (i.e. the non-consumption group). An OR of > 1 is therefore associated with increased risk, whereas an OR of < 1 is associated with reduced risk. CIs are reported as an indication of error; for the difference between groups to be significant, the 95% CIs must not overlap. Therefore, for one of the caffeine consumption groups to be at a significantly increased risk compared to the control, the lower CI needs to be > 1. In order to be easily interpreted, some ORs and 95% CIs will be plotted on histograms; when the independent variable of interest is comprised of more than two levels, the significance of the overall effect can be interpreted via the Wald statistic and p value.

The overall association between total weekly caffeine intake and general health at T1 was not significant, Wald = 2.179, $p = .824$, though the effect at T2 was, Wald = 12.848, $p = .025$. The latter reflected an increased risk of low general health being reported by the > 1000mg/w condition. For ORs, 95% CIs, and p values relating to the associations between total weekly caffeine intake and general health at T1 and T2, see Figures 7.1 and 7.2, respectively.

Although no multivariate association with stress was observed, Wald = 6.21, $p = .286$, total weekly caffeine intake did remain significantly associated with anxiety, Wald = 12.28, $p = .031$. This effect reflected increased risk of high anxiety occurring in the > 1000mg/w group, though none of the other conditions differed significantly from the non-consumers. The relationship with depression also remained significant, Wald = 14.42, $p = .013$: in this case increased risk was associated with each of the consumption groups compared to the non-consumers (though the effect relating to the 250.1-500mg/w group was only marginally significant, and the effect relating to the 500.1-750mg/w group was not significant). For ORs and 95% CIs for the multivariate associations between total weekly caffeine intake and stress, anxiety, and depression, see Figures 7.3, 7.4, and 7.5, respectively.

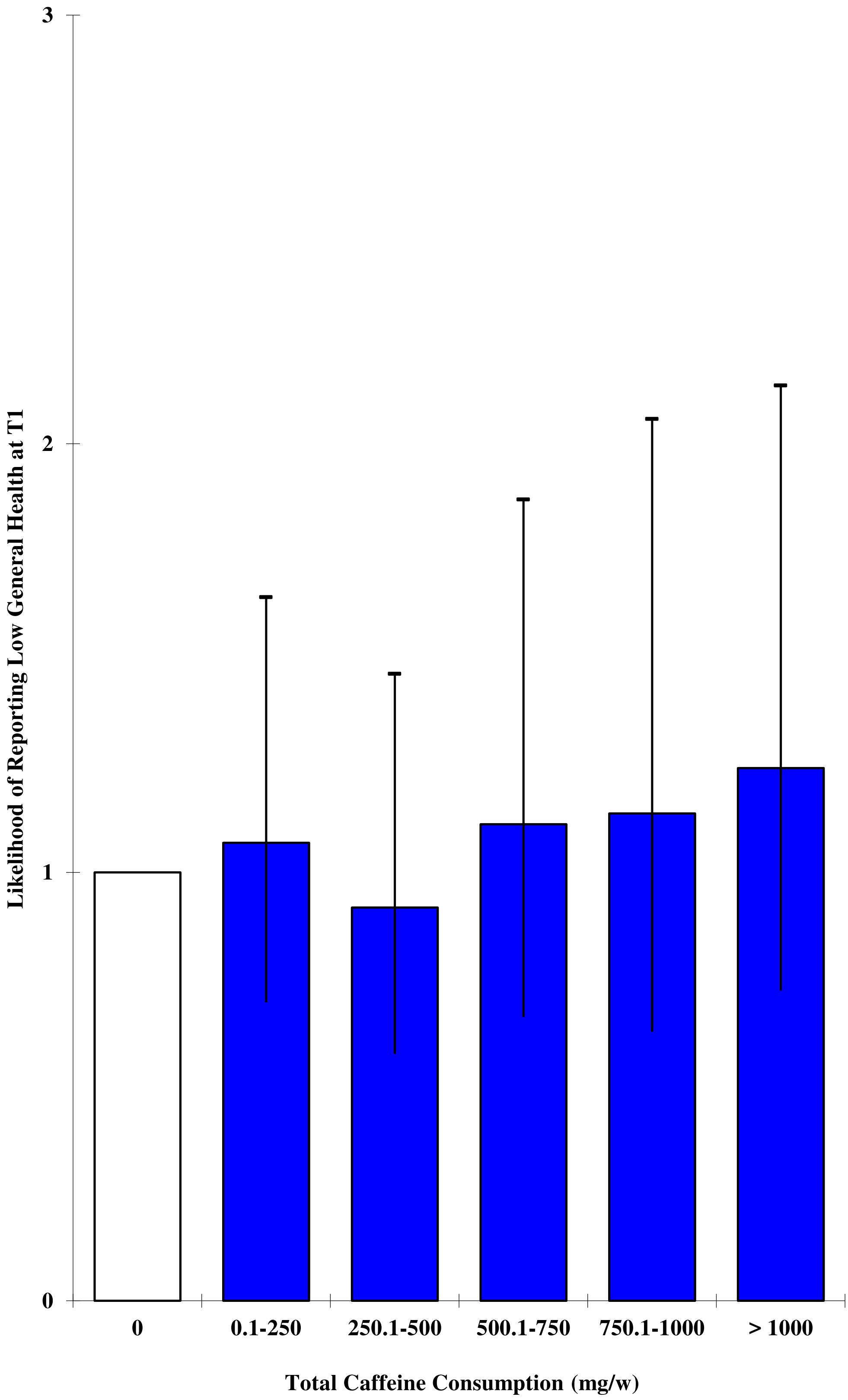

Figure 7.1. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and general health at T1.

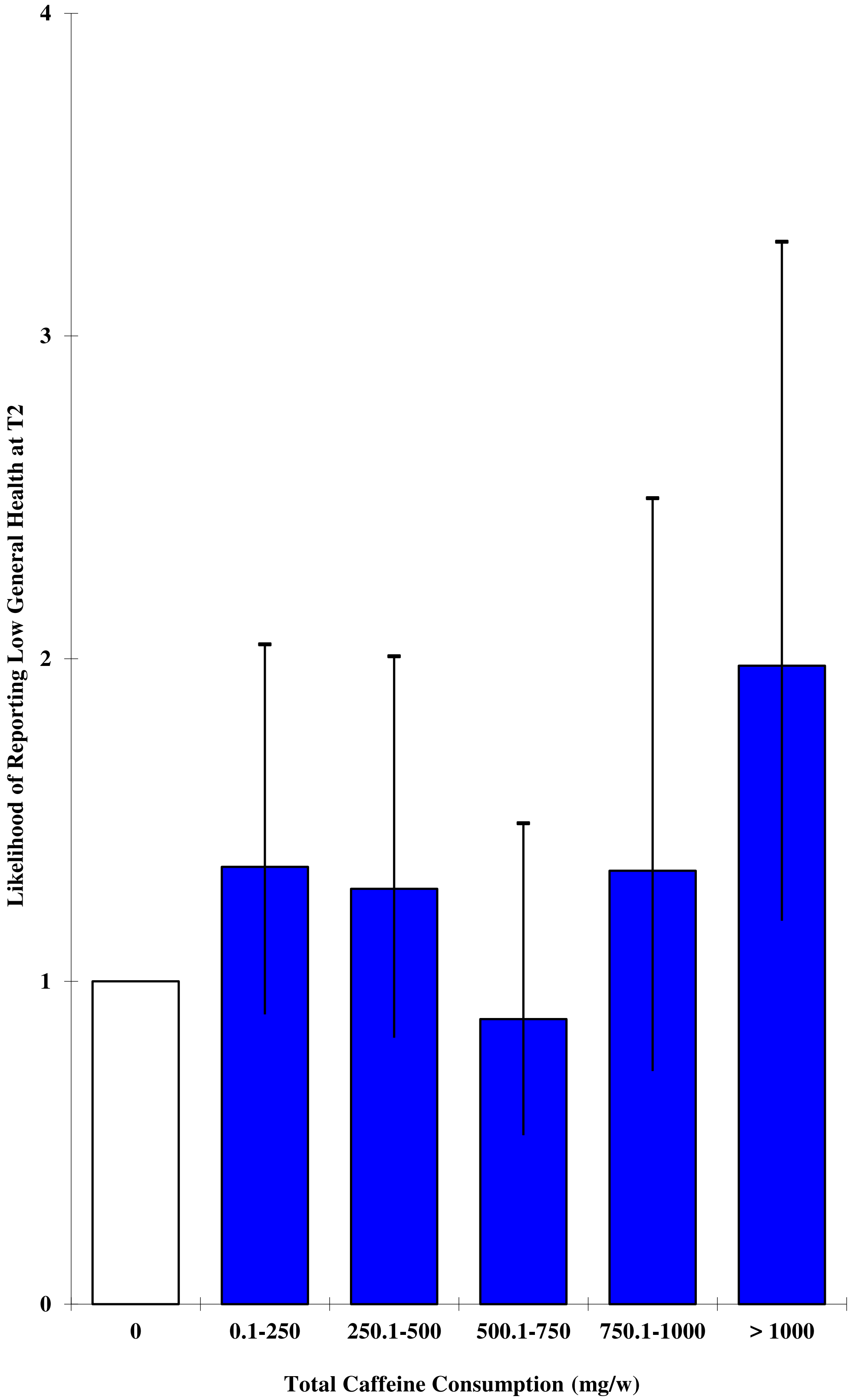

Figure 7.2. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and general health at T2.

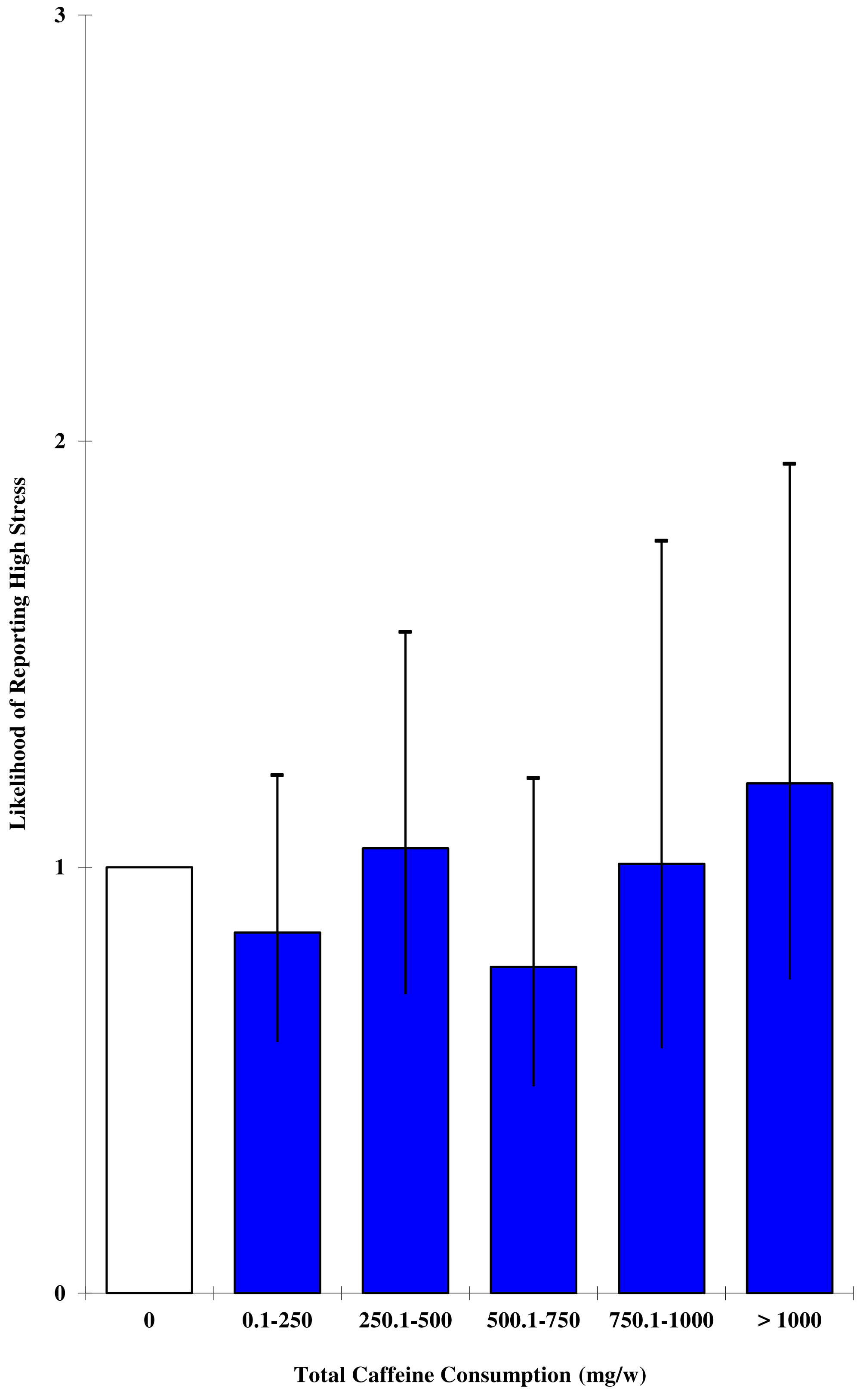

Figure 7.3. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and stress.

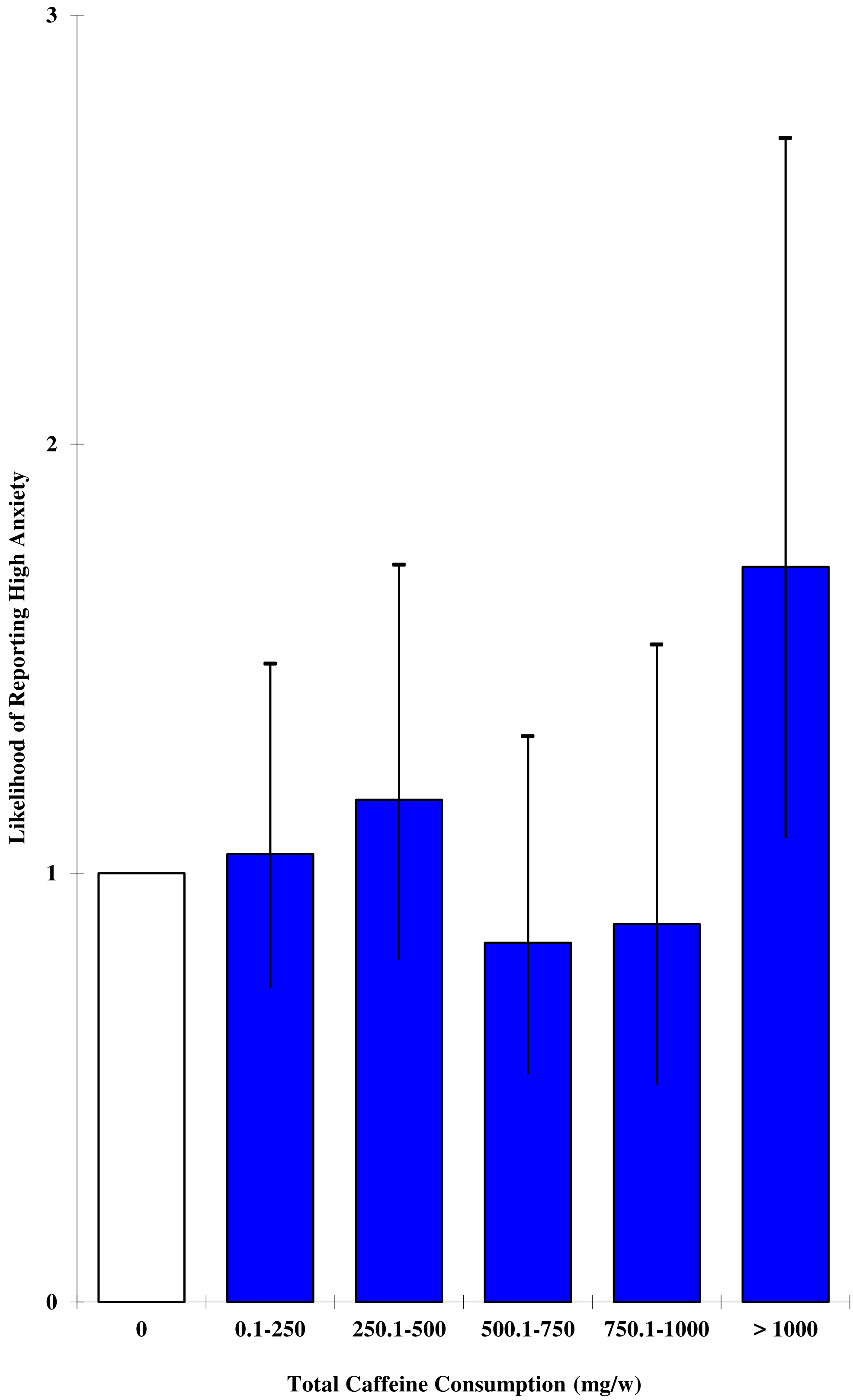

Figure 7.4. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and anxiety.

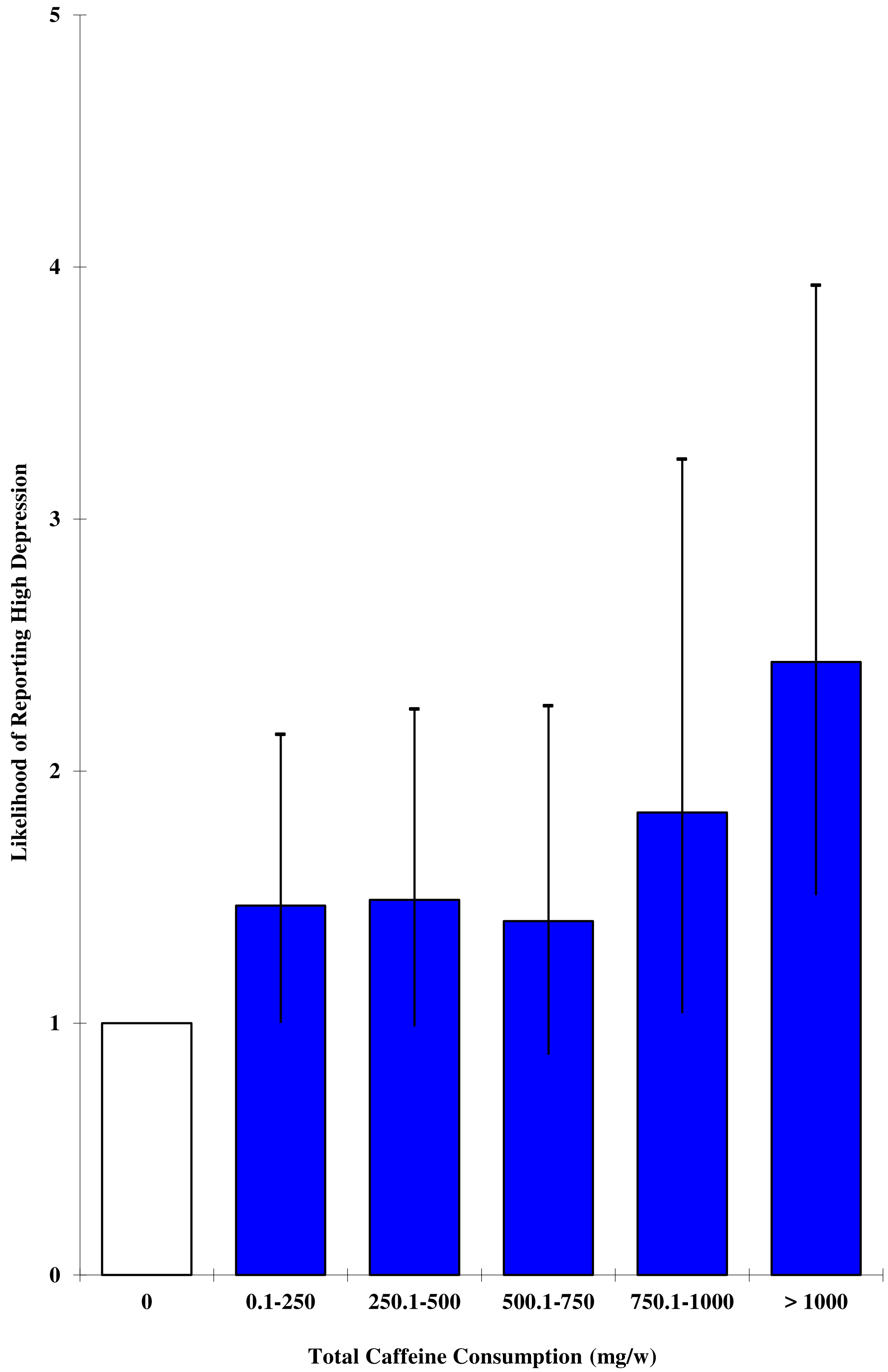

Figure 7.5. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and depression.

7.3.1.4 Discussion of Associations Between Total Weekly Caffeine Intake and Mental Health

Initially, total weekly caffeine intake was found to be positively associated with stress, anxiety, and depression, and negatively associated with general health. After adjusting for dietary, demographic, and lifestyle covariates, the relationships with anxiety, depression, and general health remained significant (the last effect only occurring at T2). However, the association with stress disappeared. This was particularly interesting considering that a similar significant linear trend between caffeine intake and course stress was observed in Chapter 4, though in that case the effect remained marginally significant at the multivariate level. In addition, a similar cross-lag effect between caffeine intake at T1 and course stress at T2 was reported in Chapter 5. Likewise, this effect also became marginally significant once covariates had been controlled for.

The effects observed relating to anxiety and general health in this section appeared to reflect increased risks being associated with very high intake (> 1000mg/w). However, in the case of depression, caffeine consumption in general appeared to be related to increased risk. This finding therefore differed considerably from that of Smith (2009b), who observed adult caffeine consumers to report lower levels of depression than non-consumers. These findings are therefore likely to highlight differences between the populations studied. The next section will aim to address the question as to whether the associations between total caffeine intake and mental health observed here are attributable to particular dietary sources, or to more general consumption of the substance.

7.3.2 Associations Between Individual Sources of Caffeine and Mental Health

7.3.2.1 Univariate Associations Between Individual Sources of Caffeine and Mental Health

Due to the considerably larger sample size available here than in Chapters 3, 4, and 5, it was possible to investigate associations between individual caffeine sources and mental health outcomes. In order to do this, caffeine values obtained from energy drinks, cola, tea, and coffee were recoded into three groups (non-consumption, low consumption, and high consumption), and Chi-square tests for linear association were investigated in relation to the mental health outcomes. Because the distributions were skewed, the cut-off points to determine what constituted 'low consumption' and 'high consumption' were determined in a manner that assigned relatively balanced numbers of participants to each group. These distinctions are shown in Table 7.3; essentially 'low consumption' related to one can of energy drink, one can of cola, 1-2 cups of coffee, and 1-3 cups of tea per week, and 'high consumption' related to any values above these.

The high caffeine consumption groups for energy drinks and cola were associated with poor general health, and non-consumption of caffeine from cola was associated with good general health at both time-points. In addition, high consumption of caffeine from tea was associated with good general health at T2, though the overall effect was not significant. For $\chi 2$ and p values, and cross-tabulations between general health and caffeine consumed from individual sources, see Table 7.3.

Caffeine consumed from energy drinks and tea was not associated with stress, anxiety, or depression. Interestingly, although consumption of caffeine from cola was not related to anxiety or depression, its non-consumption was associated with high stress levels, and being a low consumer was associated with low stress levels.

Positive linear relationships were observed between caffeine consumption from coffee and stress, anxiety, and depression (for $\chi 2$ linear associations and cross-tabulations between stress, anxiety, and depression, and caffeine consumed from individual sources, see Table 7.4). However these associations are likely explained by coffee being the major contributor to high overall caffeine intake. This is reflected in the observation that those above the median for caffeine intake from coffee consumed more total caffeine than did those above the median for each of the other sources: caffeine from coffee low M = 261.42 (SD = 331.82), high M = 827.65 (SD = 748.51); caffeine from energy drinks low M = 247.63 (SD = 382.38), high M = 674.24 (649.38); caffeine from tea low M = 225.97 (SD = 365.43), high M = 640.55 (SD = 633.11); caffeine from cola low M = 295.12 (SD = 448.63), high M = 486.88 (SD = 585).

			Caffeine from energy drinks			Caffeine from cola			Caffeine from coffee			Caffeine from tea		
			0mg	0.1-133mg	> 133mg	0mg	0.1-25mg	> 25mg	0mg	0.1-160mg	> 160mg	0mg	0.1-120mg	> 120mg
General health T1	High	Count	826	306	249	486	466	418	981	190	212	579	396	408
		Expected count	810.2	296.6	274.2	457.9	459.3	452.8	975.3	190.9	216.9	586.2	379.9	416.9
		Row %	59.8%	22.2%	18%	35.5%	34%	30.5%	70.9%	13.7%	15.3%	41.9%	28.6%	29.5%
		Adjusted residual	1.6	1.2	-3.2	3.1	.7	-3.8	.6	-.1	-.7	-.7	1.8	-1
	Low	Count	294	104	130	148	170	209	368	74	88	231	129	168
		Expected count	309.8	113.4	104.8	176.1	176.7	174.2	373.7	73.1	83.1	223.8	145.1	159.1
		Row %	55.7%	19.7%	24.6%	28.1%	32.3%	39.7%	69.4%	14%	16.6%	43.8%	24.4%	31.8%
		Adjusted residual	-1.6	-1.2	3.2	-3.1	-.7	3.8	-.6	.1	.7	.7	-1.8	1
		χ2 linear	6.915, $p = .009$			15.653, $p < .001$			.525, $p = .469$			.01, $p = .92$		
General health T2	High	Count	949	345	269	561	556	448	1127	222	220	645	404	521
		Expected count	929.7	341.8	291.5	535.4	529	500.6	1120.9	214.9	233.2	648.9	420.6	500.5
		Row %	60.7%	22.1%	17.2%	35.8%	35.5%	28.6%	71.8%	14.1%	14%	41.1%	25.7%	33.2%
		Adjusted residual	1.8	.4	-2.7	2.5	2.7	-5.3	.6	1	-1.7	-.4	-1.7	2.1
	Low	Count	365	138	143	194	190	258	459	82	110	273	191	187
		Expected count	384.3	141.2	120.5	219.6	217	205.4	465.1	89.1	96.8	269.1	174.4	207.5
		Row %	56.5%	21.4%	22.1%	30.2%	29.6%	40.2%	70.5%	12.6%	16.9%	41.9%	29.3%	28.7%
		Adjusted residual	-1.8	-.4	2.7	-2.5	-2.7	5.3	-.6	-1	1.7	.4	1.7	-2.1
		χ2 linear	6.211, $p = .013$			20.326, $p < .001$			1.492, $p = .222$			1.795, $p = .18$		

Table 7.3. Cross-tabulations between general health and weekly caffeine intake from energy drinks, cola, coffee, and tea at T1 and T2.

			Caffeine from energy drinks			Caffeine from cola			Caffeine from coffee			Caffeine from tea		
			0mg	0.1-133mg	> 133mg	0mg	0.1-25mg	> 25mg	0mg	0.1-160mg	> 160mg	0mg	0.1-120mg	> 120mg
Stress	Low	Count	493	164	145	245	295	266	602	110	94	333	227	248
		Expected count	476.6	175.6	149.8	275.7	272.4	257.8	576.3	110.5	119.2	335	216.3	256.7
		Row %	61.5%	20.4%	18.1%	30.4%	36.6%	33%	74.7%	13.6%	11.7%	41.2%	28.1%	30.7%
		Adjusted residual	1.5	-1.2	-.5	-2.9	2.1	.8	2.5	-.1	-3.1	-.2	1.1	-.8
	High	Count	818	319	267	509	450	439	984	194	234	587	367	457
		Expected count	834.4	307.4	262.2	478.3	472.6	447.2	1009.7	193.5	208.8	585	377.7	448.3
		Row %	58.3%	22.7%	19%	36.4%	32.2%	31.4%	69.7%	13.7%	16.6%	41.6%	26%	32.4%
		Adjusted residual	-1.5	1.2	.5	2.9	-2.1	-.8	-2.5	.1	3.1	.2	-1.1	.8
		χ2 linear	1.426, *p* = .232			4.477, *p* = .034			9.308, *p* = .002			.121, *p* = .728		
Anxiety	Low	Count	755	277	233	412	447	408	933	172	166	524	352	394
		Expected count	752.8	276.3	236	432.9	427.7	406.4	907.9	174.9	188.1	525.8	339.6	404.6
		Row %	59.7%	21.9%	18.4%	32.5%	35.3%	32.2%	73.4%	13.5%	13.1%	41.3%	27.7%	31%
		Adjusted residual	.2	.1	-.3	-1.9	1.8	.2	2.4	-.4	-2.7	-.2	1.2	-1
	High	Count	553	203	177	338	294	296	645	132	161	391	239	310
		Expected count	555.2	203.7	174	317.1	313.3	297.6	670.1	129.1	138.9	389.2	251.4	299.4
		Row %	59.3%	21.8%	19%	36.4%	31.7%	31.9%	68.8%	14.1%	17.2%	41.6%	25.4%	33%
		Adjusted residual	-.2	-.1	.3	1.9	-1.8	-.2	-2.4	.4	2.7	.2	-1.2	1
		χ2 linear	.081, *p* = .776			1.434, *p* = .231			7.62, *p* = .006			.196, *p* = .658		
Depression	Low	Count	864	316	255	497	491	447	1048	198	193	612	369	460
		Expected count	853.4	313.7	267.9	489.5	485.5	460	1029.5	197.6	211.9	597.8	384.4	458.8
		Row %	60.2%	22%	17.8%	34.6%	34.2%	31.1%	72.8%	13.8%	13.4%	42.5%	25.6%	31.9%
		Adjusted residual	1	.3	-1.5	.7	.5	-1.3	1.8	.1	-2.4	1.3	-1.6	.1
	High	Count	442	164	155	251	251	256	531	105	132	304	220	243
		Expected count	452.6	166.3	142.1	258.5	256.5	243	549.5	105.4	113.1	318.2	204.6	244.2
		Row %	58.1%	21.6%	20.4%	33.1%	33.1%	33.8%	69.1%	13.7%	17.2%	39.6%	28.7%	31.7%
		Adjusted residual	-1	-.3	1.5	-.7	-.5	1.3	-1.8	-.1	2.4	-1.3	1.6	-.1
		χ2 linear	1.805, *p* = .179			1.288, *p* = .257			5.164, *p* = .023			.465, *p* = .495		

Table 7.4. Cross-tabulations between stress, anxiety and depression, and weekly caffeine intake from energy drinks, cola, coffee, and tea at T1 and T2.

7.3.2.2 Multivariate Associations Between Individual Sources of Caffeine and Mental Health

In order to further investigate associations between caffeine from different sources and mental health, the non-consumption/low consumption/high consumption variables for caffeine from energy drinks, cola, tea, and coffee were entered together into binary logistic regression analyses using enter method. The same dietary, demographic, and lifestyle variables that were controlled for in the multivariate analyses of total weekly caffeine intake were again entered as covariates here.

High consumption of caffeine from cola remained associated with low general health at both time-points, although the overall effect was only marginally significant at T1. Low consumption of caffeine from tea was also marginally associated with low general health, though the effect was only observed at T2, and was also of marginal significance. No other associations between individual caffeine sources and general health were observed. For ORs, 95% CIs, and *p* values for multivariate level associations between individual caffeine sources and general health, see Table 7.5.

Low consumption of caffeine from energy drinks was associated with high stress, although the overall effect was not significant. Both low and high consumption of caffeine from cola, on the other hand, were significantly associated with low stress. Low caffeine from energy drinks and high caffeine from coffee were both marginally associated with high anxiety, though neither effect was significant overall. Low consumption of caffeine from tea was associated with high depression, and the overall effect was significant. High caffeine consumption from coffee was also associated with high depression, though in this case the overall effect was not significant. For ORs, 95% CIs, and *p* values for all multivariate level associations between individual caffeine sources and stress, anxiety, and depression, see Table 7.6.

7.3.2.3 Discussion of Associations Between Individual Sources of Caffeine and Mental Health

When individual caffeine sources were investigated, negative effects were observed in relation to each product type, though they were not consistent across

	Caffeine source		OR	95% CI	*p*
General health T1	Energy drinks	Low	.843	.615, 1.155	.288
		High	1.206	.873, 1.668	.256
		Wald	3.582, p = .167		
	Cola	Low	1.093	.802, 1.489	.575
		High	1.419	1.029, 1.957	.033
		Wald	5.168, p = .075		
	Coffee	Low	1.034	.716, 1.493	.859
		High	.978	.699, 1.368	.898
		Wald	.059, p = .971		
	Tea	Low	.833	.617, 1.124	.232
		High	1.024	.77, 1.363	.869
		Wald	1.936, p = .38		
General health T2	Energy drinks	Low	1.01	.754, 1.351	.948
		High	1.038	.745, 1.447	.825
		Wald	.049, p = .976		
	Cola	Low	.897	.673, 1.196	.458
		High	1.434	1.071, 1.92	.015
		Wald	11.557, p = .003		
	Coffee	Low	.761	.54, 1.073	.119
		High	1.171	.836, 1.641	.357
		Wald	3.859, p = .145		
	Tea	Low	1.291	.98, 1.701	.069
		High	.937	.712, 1.234	.643
		Wald	5.095, p = .078		

Table 7.5. Multivariate associations between individual sources of caffeine and general health.

	Caffeine source		OR	95% CI	*p*
Stress	Energy drinks	Low	1.373	1.048, 1.798	.021
		High	1.089	.797, 1.488	.591
		Wald	5.351, *p* = .069		
	Cola	Low	.72	.556, .934	.013
		High	.679	.516, .893	.006
		Wald	9.066, *p* = .011		
	Coffee	Low	.955	.703, 1.297	.767
		High	1.29	.928, 1.795	.13
		Wald	2.6, *p* = .273		
	Tea	Low	1.013	.783, 1.31	.92
		High	1.049	.816, 1.35	.708
		Wald	.144, *p* = .93		
Anxiety	Energy drinks	Low	1.258	.967, 1.637	.088
		High	1.043	.766, 1.42	.789
		Wald	3.008, *p* = .222		
	Cola	Low	.86	.668, 1.107	.241
		High	.827	.633, 1.082	.166
		Wald	2.218, *p* = .33		
	Coffee	Low	1.137	.841, 1.536	.405
		High	1.346	.987, 1.835	.061
		Wald	3.788, *p* = .15		
	Tea	Low	.942	.73, 1.215	.646
		High	.954	.747, 1.22	.709
		Wald	.251, *p* = .882		
Depression	Energy drinks	Low	.998	.76, 1.311	.99
		High	1.112	.813, 1.522	.505
		Wald	.503, *p* = .777		
	Cola	Low	1.179	.907, 1.532	.219
		High	1.218	.923, 1.608	.164
		Wald	2.279, *p* = .32		
	Coffee	Low	.935	.684, 1.277	.673
		High	1.37	1.002, 1.872	.049
		Wald	4.489, *p* = .106		
	Tea	Low	1.405	1.084, 1.822	.01
		High	1.096	.85, 1.413	.481
		Wald	6.786, *p* = .034		

Table 7.6. Multivariate associations between individual sources of caffeine and stress, anxiety, and depression.

variables, often only marginally statistically significant, and many disappeared once covariates had been controlled for. One relationship of particular interest was however observed: both low (0.1-25mg/w) and high (> 25mg/w) consumption groups for caffeine obtained from cola were associated with low stress levels. This finding may reflect reports of students using caffeinated products to cope with stress (Ríos et al., 2013).

Caffeine consumed through the medium of coffee was associated with high stress, anxiety, and depression at the univariate level. Although these findings may initially have implicated coffee consumption as being responsible, as high consumption of caffeine via coffee was also noted to be a strong indicator of high caffeine intake in general (i.e. more so than were the other individual sources of the substance), it is more likely that high caffeine consumption itself, regardless of its source, explains the negative associations with mental health outcomes. Furthermore, although high consumption of caffeine from coffee remained marginally associated with high anxiety and depression, neither of these effects remained significant overall once covariates had been controlled for, and that relating to stress disappeared altogether.

Taken together, other than the association between caffeine from cola and low stress, all effects observed suggested that caffeine consumption, regardless of its source, was associated with undesirable mental health outcomes. However, the general lack of consistent findings from this analysis implies that caffeine is best examined in terms of its total intake.

7.3.3 Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

The previous two sections provided evidence to suggest that caffeine consumption is associated with mental health outcomes in secondary school children. The current section therefore aims to investigate whether frequent consumption of energy drinks and breakfast omission, either alone or in combination, may also be risk factors.

7.3.3.1 Independent Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

7.3.3.1.1 Univariate Independent Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

The single-item DABS questions for frequency of consumption of breakfast and energy drinks were recoded into dichotomous variables; breakfast was coded as 'every day' vs. 'not every day' (answer 5 vs. answers 1, 2, 3, and 4), and energy drinks was coded as 'once a week or more' vs. 'less than once a week' (answers 3, 4, and 5 vs. answers 1 and 2). These variables were then investigated in relation to the dichotomous mental health outcomes.

Eating breakfast every day was associated with above average general health, and low levels of stress, anxiety, and depression. Energy drink use was not related to stress or anxiety, but consuming them once a week or more was associated with poor general health and high levels of depression (though the latter effect was only marginally significant). For $\chi2$ values and cross-tabulations between the frequency of breakfast and energy drink consumption and mental health outcomes, see Table 7.7.

7.3.3.1.2 Multivariate Independent Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

Breakfast (every day vs. not every day) and energy drinks (once a week or more vs. less than once a week) were each entered separately (i.e. they were not entered into the same model) into binary logistic regression analyses upon the dichotomous general health, stress, anxiety, and depression outcomes. As with previous multivariate analyses, demographic and lifestyle covariates were entered along with the DABS subscale scores for Junk Food and Healthy Foods. In addition, when the predictor variable was energy drinks, caffeine from cola, coffee, and tea (continuous variables) were also entered; when the predictor variable was breakfast consumption total weekly caffeine intake (continuous variable) was entered instead.

At the multivariate level, each positive relationship between mental health and breakfast consumption remained significant. However, though frequent energy drink use remained associated with low general health at T2, the effect at T1 disappeared, and no association remained between energy drink consumption and depression. For ORs, 95% CIs, and p values, see Table 7.8.

			Breakfast		Energy drinks	
			Not every day	Every day	< Once a week	≥ Once a week
General health T1	High	Count	606	778	1031	343
		Expected count	682.6	701.4	1010.1	363.9
		Row %	43.8%	56.2%	75%	25%
		Adjusted residual	-7.8	7.8	2.4	-2.4
	Low	Count	339	193	365	160
		Expected count	262.4	269.6	385.9	139.1
		Row %	63.7%	36.3%	69.5%	30.5%
		Adjusted residual	7.8	-7.8	-2.4	2.4
		$\chi 2$	61.102, $p < .001$		5.928, $p = .015$	
General health T2	High	Count	731	858	1232	347
		Expected count	825.6	763.4	1194.3	384.7
		Row %	32.5%	38.1%	78%	22%
		Adjusted residual	-8.8	8.8	4.1	-4.1
	Low	Count	438	223	460	198
		Expected count	343.4	317.6	497.7	160.3
		Row %	19.5%	9.9%	69.9%	30.1%
		Adjusted residual	8.8	-8.8	-4.1	4.1
		$\chi 2$	76.758, $p < .001$		16.599, $p < .001$	
Stress	Low	Count	370	452	633	184
		Expected count	428.6	393.4	617.8	199.2
		Row %	16.5%	20.1%	77.5%	22.5%
		Adjusted residual	-5.1	5.1	1.6	-1.6
	High	Count	802	624	1057	361
		Expected count	743.4	682.6	1072.2	345.8
		Row %	35.7%	27.8%	74.5%	25.5%
		Adjusted residual	5.1	-5.1	-1.6	1.6
		$\chi 2$	26.347, $p < .001$		2.425, $p = .119$	
Anxiety	Low	Count	604	681	972	307
		Expected count	668.9	616.1	967.4	311.6
		Row %	27%	30.4%	76%	24%
		Adjusted residual	-5.6	5.6	.5	-.5
	High	Count	561	392	711	235
		Expected count	496.1	456.9	715.6	230.4
		Row %	25.1%	17.5%	75.2%	24.8%
		Adjusted residual	5.6	-5.6	-.5	.5
		$\chi 2$	30.854, $p < .001$		.207, $p = .649$	
Depression	Low	Count	679	782	1115	336
		Expected count	759.2	701.8	1096.6	354.4
		Row %	30.4%	35%	76.8%	23.2%
		Adjusted residual	-7.1	7.1	1.9	-1.9
	High	Count	483	292	565	207
		Expected count	402.8	372.2	583.4	188.6
		Row %	21.6%	13.1%	73.2%	26.8%
		Adjusted residual	7.1	-7.1	-1.9	1.9
		$\chi 2$	50.949, $p < .001$		3.651, $p = .056$	

Table 7.7. Cross-tabulations and $\chi 2$ values for frequency of breakfast and energy drink consumption and mental health outcomes.

	Dietary predictor	OR	95% CI	*p*
General health T1	Breakfast	1.7	1.323, 2.184	< .001
	Energy drinks	1.103	.835, 1.458	.49
General health T2	Breakfast	1.979	1.558, 2.514	< .001
	Energy drinks	1.428	1.08, 1.889	.012
Stress	Breakfast	1.273	1.026, 1.581	.028
	Energy drinks	1.121	.857, 1.466	.404
Anxiety	Breakfast	1.313	1.06, 1.625	.013
	Energy drinks	.936	.718, 1.22	.625
Depression	Breakfast	1.52	1.219, 1.896	< .001
	Energy drinks	1.135	.867, 1.486	.358

Table 7.8. Multivariate associations between breakfast and energy drink consumption and mental health.

7.3.3.2 Combined Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

7.3.3.2.1 Univariate Combined Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

To investigate their combined effects, the dichotomous breakfast and energy drink consumption variables were combined into the following groups: 1) breakfast every day/energy drinks less than once a week, 2) breakfast every day/energy drinks once a week or more, 3) breakfast not every day/energy drinks less than once a week, 4) breakfast not every day/energy drinks once a week or more. For ease of reporting, frequency of breakfast and energy drink consumption will both henceforth be referred to as ‘frequent’ or ‘infrequent’. Chi-square analysis showed infrequent breakfast was consistently associated with poor mental health, and the role of energy drinks differed between outcomes. For $\chi2$ values and cross-tabulations between breakfast and energy drink consumption combinations and mental health, see Table 7.9.

At both T1 and T2, frequently consuming energy drinks seemed to reduce the apparent benefit of eating breakfast on general health. At T2, however, frequently consuming energy drinks also appeared to exacerbate the negative effect of infrequently eating breakfast. Although slightly different across the two time-points, the findings are consistent in that they both suggest a positive effect of breakfast and a negative effect of energy drinks.

			Frequent breakfast/ infrequent energy drinks	Frequent breakfast/ frequent energy drinks	Infrequent breakfast/ infrequent energy drinks	Infrequent breakfast/ frequent energy drinks
General health T1	High	Count	622	141	404	200
		Expected count	561	126.5	444.6	234.9
		Row %	45.5%	10.3%	29.6%	14.6%
		Adjusted residual	6.4	2.6	-4.5	-4.8
	Low	Count	154	34	211	125
		Expected count	215	48.5	170.4	90.1
		Row %	29.4%	6.5%	40.3%	23.9%
		Adjusted residual	-6.4	-2.6	4.5	4.8
		$\chi2$	62.076, $p < .001$			
General health T2	High	Count	713	142	519	205
		Expected count	632	128.5	562.8	255.6
		Row %	45.2%	9%	32.9%	13%
		Adjusted residual	7.7	2.3	-4.2	-6.4
	Low	Count	182	40	278	157
		Expected count	263	53.5	234.2	106.4
		Row %	27.7%	6.1%	42.3%	23.9%
		Adjusted residual	-7.7	-2.3	4.2	6.4
		$\chi2$	85.863, $p < .001$			
Stress	Low	Count	368	83	265	101
		Expected count	326.2	65.8	291.8	133.1
		Row %	45%	10.2%	32.4%	12.4%
		Adjusted residual	3.7	2.8	-2.5	-3.8
	High	Count	524	97	533	263
		Expected count	565.8	114.2	506.2	230.9
		Row %	37%	6.8%	37.6%	18.6%
		Adjusted residual	-3.7	-2.8	2.5	3.8
		$\chi2$	31.609, $p < .001$			
Anxiety	Low	Count	559	121	413	185
		Expected count	511.4	102.9	455.7	208
		Row %	43.7%	9.5%	32.3%	14.5%
		Adjusted residual	4.2	2.9	-3.8	-2.7
	High	Count	331	58	380	177
		Expected count	378.6	76.1	337.3	154
		Row %	35%	6.1%	40.2%	18.7%
		Adjusted residual	-4.2	-2.9	3.8	2.7
		$\chi2$	33.313, $p < .001$			
Depression	Low	Count	651	128	464	208
		Expected count	581.8	116.9	515.2	237
		Row %	44.9%	8.8%	32%	14.3%
		Adjusted residual	6.3	1.8	-4.8	-3.5
	High	Count	240	51	325	155
		Expected count	309.2	62.1	273.8	126
		Row %	31.1%	6.6%	42.2%	20.1%
		Adjusted residual	-6.3	-1.8	4.8	3.5
		$\chi2$	51.674, $p < .001$			

Table 7.9. Cross-tabulations and $\chi2$ values for breakfast and energy drink consumption combinations and mental health outcomes.

The effects relating to stress and anxiety appeared to reflect the benefits of breakfast, with no additional influence coming from energy drinks. These findings echo the effects initially observed when investigating breakfast and energy drinks separately. For depression, frequently consuming breakfast predicted positive outcomes, though the addition of frequent energy drink consumption was found to reduce the effect.

7.3.3.2.2 Multivariate Combined Associations Between Energy Drink Consumption, Breakfast Omission, and Mental Health

Binary logistic regression analyses were conducted, and the frequent breakfast/infrequent energy drinks group was set as the control. The same covariates as entered in the analyses of energy drink consumption in isolation were used here.

The overall effect of breakfast and energy drinks groups was significant in relation to each of the outcome variables: general health T1, Wald = 17.927, $p < .001$; general health T2, Wald = 34.37, $p < .001$; stress, Wald = 7.909, $p = .048$; anxiety, Wald = 8.568, $p = .036$; depression, Wald = 14.814, $p = .002$. High stress levels were significantly associated with being a member of the infrequent breakfast/frequent energy drinks condition, OR = 1.492, 95% CI [1.059, 2.102], $p = .022$, whereas high anxiety was associated with the infrequent breakfast/infrequent energy drinks condition, OR = 1.31, 95% CI [1.031, 1.663], $p = .027$. High levels of depression, on the other hand, were associated with both groups that did not consume breakfast every day: infrequent breakfast/infrequent energy drinks, OR = 1.577, 95% CI [1.231, 2.019], $p < .001$; infrequent breakfast/frequent energy drinks, OR = 1.579, 95% CI [1.127, 2.212], $p = .008$. This was also the case for low general health at both time-points: T1 infrequent breakfast/infrequent energy drinks, OR = 1.621, 95% CI [1.213, 2.166], $p = .001$; infrequent breakfast/frequent energy drinks, OR = 1.75, 95% CI [1.228, 2.492, $p = .002$; T2 infrequent breakfast/infrequent energy drinks, OR = 1.892, 95% CI [1.443, 2.481], $p < .001$; infrequent breakfast/frequent energy drinks, OR = 2.508, 95% CI [1.763, 3.568], $p < .001$. For visual representations of the ORs and 95% CIs for general health at T1 and T2, see Figures 7.6, and 7.7; for stress, anxiety and depression, see Figures 7.8, 7.9, and 7.10, respectively.

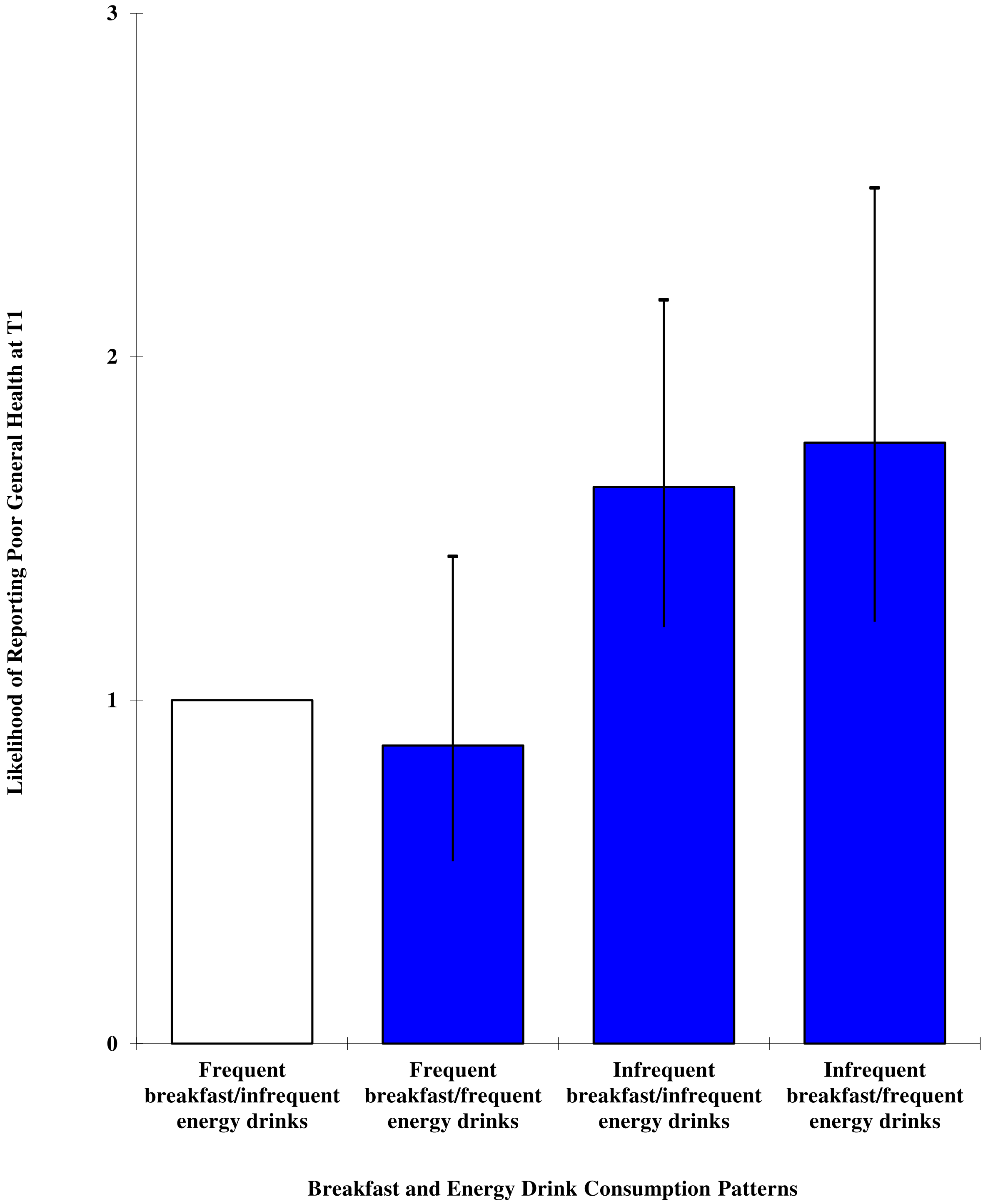

Figure 7.6. Likelihood of reporting poor general health as a function of breakfast and energy drink combinations at T1.

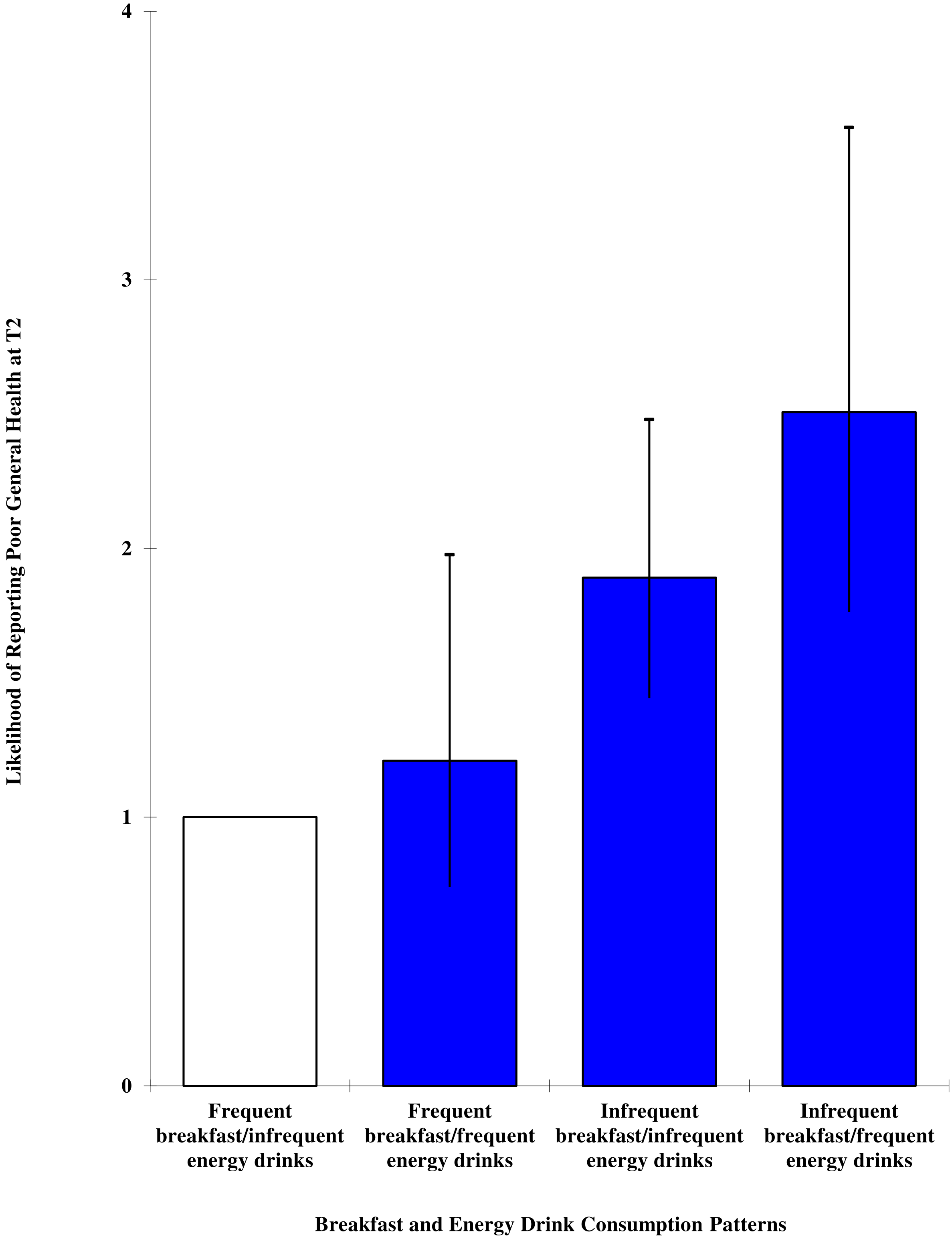

Figure 7.7. Likelihood of reporting poor general health as a function of breakfast and energy drink combinations at T2.

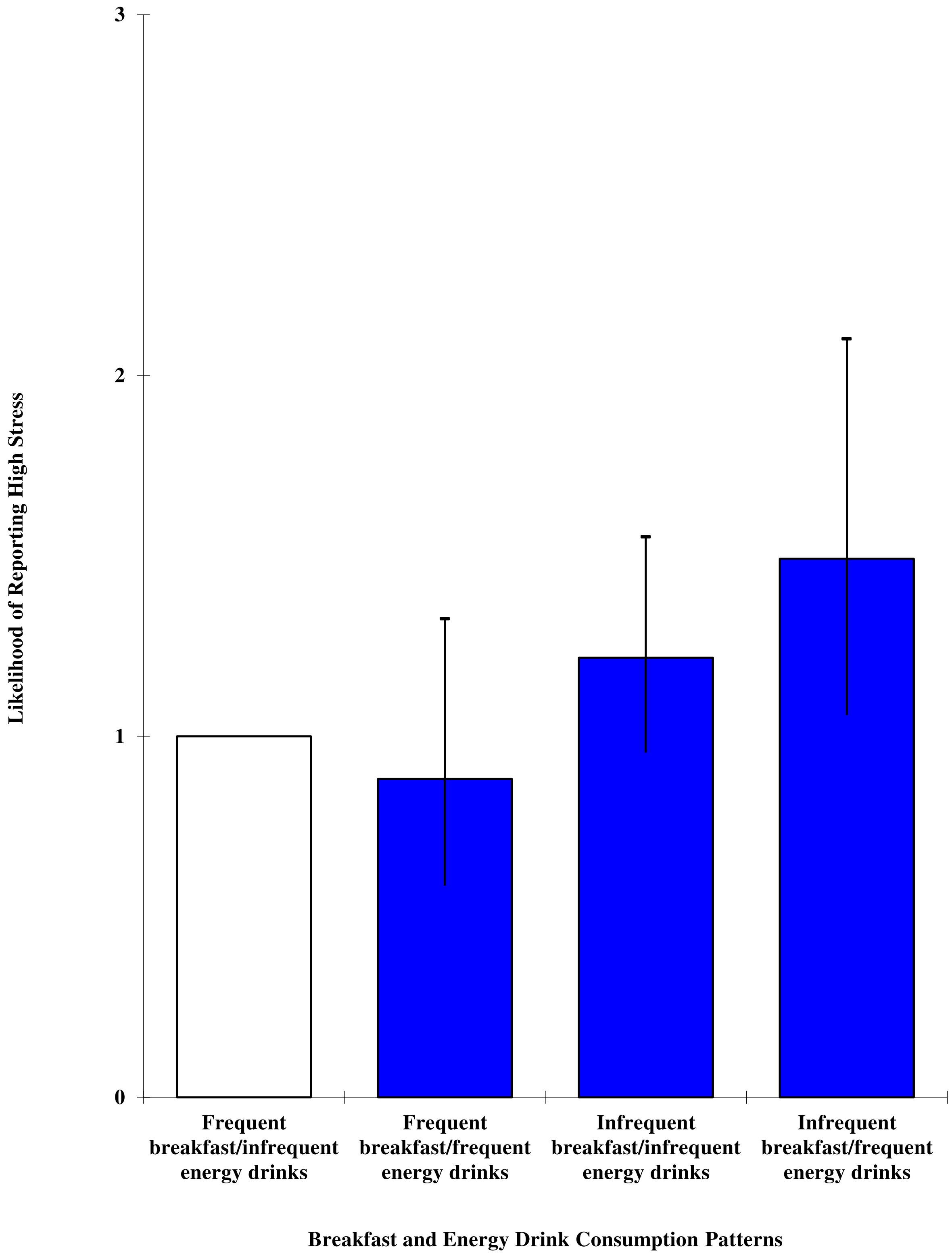

Figure 7.8. Likelihood of reporting high stress as a function of breakfast and energy drink combinations.

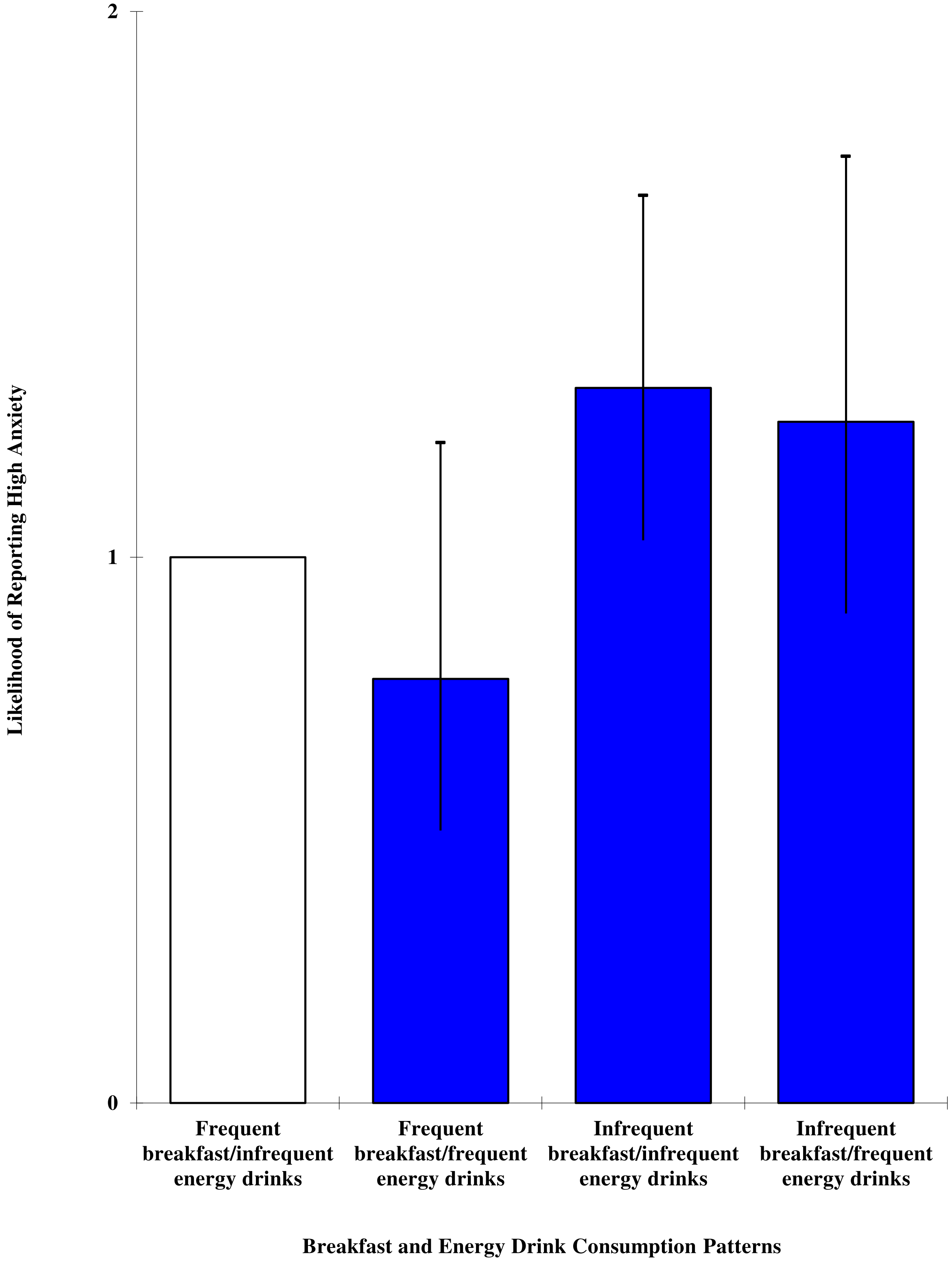

Figure 7.9. Likelihood of reporting high anxiety as a function of breakfast and energy drink combinations.

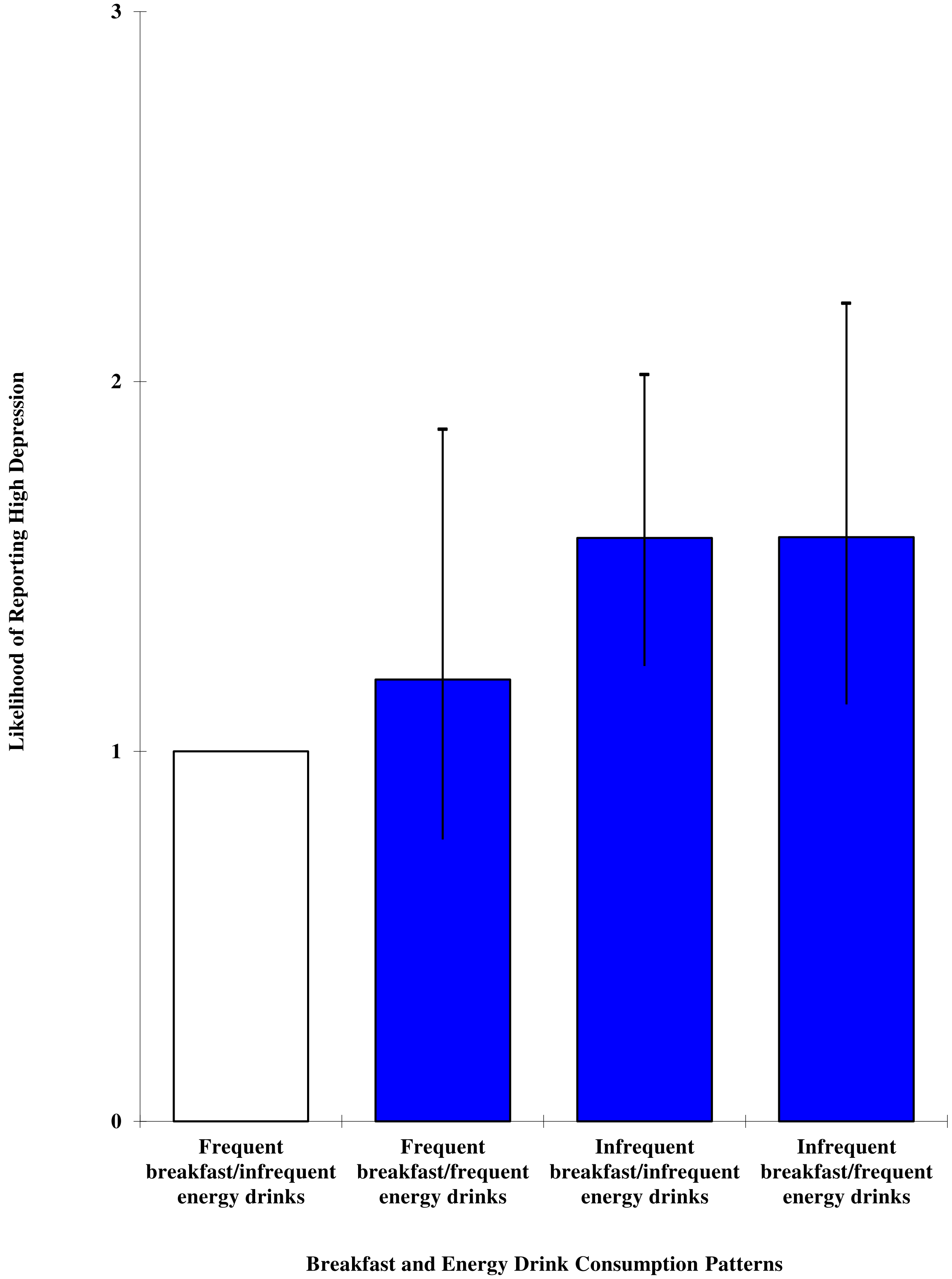

Figure 7.10. Likelihood of reporting high depression as a function of breakfast and energy drink combinations.

7.3.3.3 Discussion of Energy Drink Consumption, Breakfast Omission, and Mental Health

Chapters 3, 4, and 5 examined associations between breakfast and energy drink consumption and general health, low wellbeing, and course stress in university students. However, the findings were somewhat inconclusive. The current section therefore aimed to further investigate whether these dietary practices were related to mental health outcomes in a much larger sample consisting of secondary school children.

Eating breakfast every day was found to be predictive of high general health, and low stress, anxiety, and depression. These effects generally reflected those already reported in the literature (e.g. O'Sullivan et al., 2009; Smith, 1998). Although frequent energy drink consumption was associated with low general health, and a marginally significant relationship also existed with depression, only that relating to general health at T2 remained significant at the multivariate level. In addition, energy drink consumption was not associated with stress, or anxiety. These findings were somewhat surprising considering that a number of studies have previously reported positive relationships between energy drink use and stress (Hofmeister et al., 2010; Pettit & DeBarr, 2011), anxiety (Hofmeister et al., 2010; Stasio et al., 2011; Trapp et al., 2014), and depression (Azagba et al., 2014). However, it should also be noted that a number of such studies (e.g. Arria et al., 2011; Hofmeister et al., 2010; Trapp et al., 2014) provided mixed results.

Combined effects of breakfast and energy drinks were observed in relation to each of the mental health outcome variables. High stress was associated with being a member of the infrequent breakfast/frequent energy drinks condition, whereas high anxiety was associated with being a member of the infrequent breakfast/infrequent energy drinks condition. High depression and low general health, on the other hand, were associated with both groups that did not consume breakfast every day. Taken together, the findings from this section suggest that breakfast omission is consistently associated with undesirable mental health outcomes, and that such effects can generally be observed in those who frequently consume energy drinks as well as those who do not.

7.3.4 Associations Between the DABS Factors and Mental Health

In order to further investigate the effects of energy drinks, it was deemed appropriate to examine associations between the four DABS factor score variables and the mental health outcomes. The factor labelled ‘Caffeinated Soft Drinks/Gum’ was identified as being of particular interest due to it being comprised of the frequency and amount of consumption items for energy drinks, cola, and chewing gum.

7.3.4.1 Univariate Associations Between the DABS Factors and Mental Health

Between-subjects t-tests were used to determine whether the DABS factor scores differed between the high and low groups for general health, stress, anxiety, and depression. The low general health group at T1 consumed significantly more Junk Food than did the high general health group, though no such effect was observed at T2. Higher Junk Food consumption was also observed in the groups that reported low stress, anxiety, and depression. Higher consumption of Caffeinated Soft Drinks/Gum was observed in the groups that reported low general health, and high stress and depression, though no difference was observed in relation to anxiety levels. Healthy Foods consumption was significantly higher in each of the groups that reported high general health, and low stress, anxiety, and depression. Hot Caffeinated Beverages intake was not associated with general health or depression. However, its consumption was found to be higher in those who reported high anxiety and stress, although the latter effect was only marginally significant. For *t* and *p* values for these analyses, see Table 7.10.

	Junk Food		**Caffeinated Soft Drinks/Gum**		**Healthy Foods**		**Hot Caffeinated Beverages**	
	t	*p*	*t*	*p*	*t*	*p*	*t*	*p*
General health T1	-2.483	.013	-3.407	.001	8.551	< .001	.903	.367
General health T2	-.007	.994	-5.734	< .001	9.371	< .001	-.992	.322
Stress	3.26	.001	-2.114	.035	2.66	.008	-1.678	.094
Anxiety	2.431	.015	-1.178	.239	4.638	< .001	-2.879	.004
Depression	4.065	< .001	-4.48	< .001	3.165	.002	-1.568	.117

Table 7.10. Differences between DABS factor scores as a function of high and low general health, stress, anxiety, and depression.

7.3.4.2 Multivariate Associations Between the DABS Factors and Mental Health

In order to further investigate the relationships between the DABS factors and mental health outcomes, binary logistic regression analyses were conducted so that additional variance could be controlled for. In these analyses, all four DABS factor scores were simultaneously entered as continuous variables. As with previously reported multivariate analyses in this chapter, demographic and lifestyle covariates were also entered into the regression models. However, in this case, no additional dietary covariates were included; additional variance from caffeine intake was not controlled for in order to avoid shared variance with the DABS factor scores.

High consumption of Junk Food remained associated with low depression scores, although the effects relating to stress and anxiety disappeared. Furthermore, high consumption also remained associated with low general health at T1, though the effect became only marginally significant. Although the relationship with stress disappeared, high consumption of Caffeinated Soft Drinks/Gum remained associated with low general health and high depression. In a similar manner, high consumption of Healthy Foods remained associated with high general health and low anxiety, though the effects relating to stress and depression observed at the univariate level did not remain significant. High consumption of Hot Caffeinated Beverages was marginally associated with high anxiety and high depression, and, although the former relationship was observed at the univariate level, the latter was not. The marginally significant relationship with stress, however, was not observed again at the multivariate level. For all ORs, 95% CIs, and p values for multivariate associations between the DABS factors and mental health outcomes, see Table 7.11.

7.3.4.3 Discussion of Associations Between the DABS Factors and Mental Health

Analyses were performed in order to investigate whether the four DABS factors (Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, and Hot Caffeinated Beverages) were associated with the mental health outcomes. Due to being comprised of items measuring the intake of energy drinks, cola, and chewing gum, particular attention was paid to the factor labelled ‘Caffeinated Soft Drinks/Gum’. High consumption of this factor was related to low general health, high stress, and high depression at the univariate level. Furthermore, other than the relationship with stress, each effect remained significant once additional dietary, demographic, and lifestyle covariates had been controlled for. The next section therefore aims to investigate to which component(s) of the Caffeinated Soft Drinks/Gum factor these effects might be attributable.

	DABS factor	OR	95% CI	*p*
General health T1	Junk Food	1.121	.988, 1.272	.076
	Caffeinated Soft Drinks/Gum	1.183	1.042, 1.344	.01
	Healthy Foods	.693	.605, .794	< .001
	Hot Caffeinated Beverages	.931	.819, 1.058	.274
General health T2	Junk Food	1.002	.886, 1.133	.978
	Caffeinated Soft Drinks/Gum	1.318	1.163, 1.494	< .001
	Healthy Foods	.67	.587, .764	< .001
	Hot Caffeinated Beverages	1.011	.895, 1.142	.858
Stress	Junk Food	.912	.814, 1.023	.116
	Caffeinated Soft Drinks/Gum	1.082	.96, 1.218	.196
	Healthy Foods	.952	.847, 1.069	.403
	Hot Caffeinated Beverages	1.023	.912, 1.147	.697
Anxiety	Junk Food	.95	.851, 1.061	.363
	Caffeinated Soft Drinks/Gum	1.042	.929, 1.169	.481
	Healthy Foods	.85	.757, .954	.006
	Hot Caffeinated Beverages	1.112	.997, 1.241	.057
Depression	Junk Food	.857	.763, .962	.009
	Caffeinated Soft Drinks/Gum	1.208	1.073, 1.359	.002
	Healthy Foods	.958	.851, 1.079	.479
	Hot Caffeinated Beverages	1.116	.997, 1.25	.056

Table 7.11. Likelihood of reporting below average mental health outcomes as a function of intake of each DABS factor.
Note. All effects relate to DABS factor scores, which were entered as continuous variables.

7.3.5 Analysis of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the Mental Health Outcomes

7.3.5.1 Chi-Square Analysis of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the Mental Health Outcomes

In order to determine which component(s) of the Caffeinated Soft Drinks/Gum factor may have been responsible for the negative associations with mental health reported in the previous section, it was deemed important to investigate their combined effects. To do this, the tertile scores for individual items used to calculate the DABS subscales were utilised to compute individual scores for energy drinks, cola, and chewing gum. The tertile scores for each product type were added together (e.g. energy drinks frequency tertile + energy drinks amount tertile), with the resulting variables being dichotomised via median split to produce a high consumption group and a low consumption group for energy drinks, cola, and chewing gum. Respondents were then further categorised into all possible consumption combinations for these three items: 1) low in energy drinks, cola, and gum, 2) high in energy drinks only, 3) high in cola only, 4) high in gum only, 5) high in energy drinks and cola, low in gum, 6) high in energy drinks and gum, low in cola, 7) high in cola and gum, low in energy drinks, 8) high in energy drinks, cola, and gum. Frequency statistics for each of these groups are displayed in Table 7.12.

	T1		**T2**	
Combination	*N*	%	*N*	%
Low in all	313	16.2%	372	17.1%
High energy drinks only	165	8.5%	158	7.3%
High cola only	176	9.1%	209	9.6%
High gum only	160	8.3%	191	8.8%
High energy drinks/cola	221	11.4%	264	12.1%
High energy drinks/gum	151	7.8%	213	9.8%
High cola/gum	168	8.7%	186	8.5%
High in all	580	30%	585	26.9%

Table 7.12. Frequency statistics for each combination of high/low consumption of energy drinks, cola, and chewing gum at T1 and T2.

Chi-square tests were conducted to investigate associations between the different dietary consumption patterns outlined in the above section, and the dichotomous mental health outcome variables. The overall effects relating to general health at T2, stress, and anxiety were significant, and those relating to general health at T1 and depression were marginally significant. For $\chi 2$ values and cross-tabulations, see Table 7.13.

Good general health was related to being a low consumer of all three products, whereas poor general health was associated with being a high consumer of all three products (though only a trend for the latter effect was observed at T1). High stress levels were predicted by being a high consumer of all three products, or a high

			Low in all	High energy drinks	High cola only	High gum only	Energy drinks & cola	Energy drinks & gum	Cola & gum	High in all
General health T1	High	Count	231	111	118	117	149	114	107	385
		Expected count	215.5	112.8	121.5	110.6	153.3	104.1	114.3	399.9
		Row %	17.3%	8.3%	8.9%	8.8%	11.2%	8.6%	8%	28.9%
		Adjusted residual	2.2	-.3	-.6	1.2	-.7	1.9	-1.3	-1.7
	Low	Count	67	45	50	36	63	30	51	168
		Expected count	82.5	43.2	46.5	42.4	58.7	39.9	43.7	153.1
		Row %	13.1%	8.8%	9.8%	7.1%	12.4%	5.9%	10%	32.9%
		Adjusted residual	-2.2	.3	.6	-1.2	.7	-1.9	1.3	1.7
		$\chi2$	13.299, p = .065							
General health T2	High	Count	279	109	138	141	175	153	135	380
		Expected count	258	111	146.3	132.9	183.8	147	130.8	400.1
		Row %	18.5%	7.2%	9.1%	9.3%	11.6%	10.1%	8.9%	25.2%
		Adjusted residual	2.6	-.4	-1.3	1.4	-1.3	1	.7	-2.2
	Low	Count	86	48	69	47	85	55	50	186
		Expected count	107	46	60.7	55.1	76.2	61	54.2	165.9
		Row %	13.7%	7.7%	11%	7.5%	13.6%	8.8%	8%	29.7%
		Adjusted residual	-2.6	.4	1.3	-1.4	1.3	-1	-.7	2.2
		$\chi2$	15.419, p = .031							
Stress	Low	Count	124	62	89	52	121	69	71	186
		Expected count	132.4	56.6	75.4	68.2	93.9	75.8	66.4	205.3
		Row %	16%	8%	11.5%	6.7%	15.6%	8.9%	9.2%	24%
		Adjusted residual	-1	.9	2.1	-2.6	3.7	-1	.7	-2
	High	Count	241	94	119	136	138	140	112	380
		Expected count	232.6	99.4	132.6	119.8	165.1	133.2	116.6	360.7
		Row %	17.7%	6.9%	8.8%	10%	10.1%	10.3%	8.2%	27.9%
		Adjusted residual	1	-.9	-2.1	2.6	-3.7	1	-.7	2
		$\chi2$	28.041, p < .001							
Anxiety	Low	Count	210	89	127	88	166	114	120	314
		Expected count	210.2	88.9	120.1	108.5	149	120.1	105.1	326.2
		Row %	17.1%	7.2%	10.3%	7.2%	13.5%	9.3%	9.8%	25.6%
		Adjusted residual	0	0	1	-3.2	2.3	-.9	2.3	-1.2
	High	Count	154	65	81	100	92	94	62	251
		Expected count	153.8	65.1	87.9	79.5	109	87.9	76.9	238.8
		Row %	17.1%	7.2%	9%	11.1%	10.2%	10.5%	6.9%	27.9%
		Adjusted residual	0	0	-1	3.2	-2.3	.9	-2.3	1.2
		$\chi2$	21.578, p = .003							
Depression	Low	Count	247	101	137	120	178	132	134	343
		Expected count	237.8	100.9	135.6	123.2	169	135.6	119.9	370.1
		Row %	17.7%	7.3%	9.8%	8.6%	12.8%	9.5%	9.6%	24.6%
		Adjusted residual	1.1	0	.2	-.5	1.3	-.6	2.3	-2.8
	High	Count	116	53	70	68	80	75	49	222
		Expected count	125.2	53.1	71.4	64.8	89	71.4	63.1	194.9
		Row %	15.8%	7.2%	9.5%	9.3%	10.9%	10.2%	6.7%	30.3%
		Adjusted residual	-1.1	0	-.2	.5	-1.3	6	-2.3	2.8
		$\chi2$	13.556, p = .06							

Table 7.13. Cross-tabulations between energy drinks, cola, and chewing gum consumption combinations and mental health outcomes.

consumer of gum only, the latter effect potentially reflecting the observation that chewing gum is often used in order to help combat stress (Princeton Review & Wrigley, 2005). Interestingly, being only a high consumer of cola, or a high consumer of energy drinks/cola, appeared to be associated with low stress levels. Being a high consumer of chewing gum only was predictive of high anxiety levels, although being a high consumer of energy drinks/cola, or cola/gum, was associated with low anxiety. High consumption of cola/gum was further associated with low depression, although consuming high amounts of all three products predicted high levels of depression.

7.3.5.2 Discussion of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the Mental Health Outcomes

Low consumption of all three products was associated with high general health, whereas high consumption of all three was associated with low general health (T2 only) and high depression. Furthermore, conditions in which cola was consumed in high amounts were typically associated with positive outcomes, potentially reflecting a successful coping strategy. The high cola only condition was associated with low stress, high energy drinks/cola was associated with low stress and low anxiety, and high cola/gum was associated with low anxiety and low depression. The high gum only condition, on the other hand, was associated with high stress and high anxiety.

As the overall associations between Caffeinated Soft Drinks/Gum consumption and stress and anxiety were not significant at the multivariate level, associations between specific components of the factor and these outcomes should be interpreted with caution. Taking together the findings from the current analysis that related to effects that were significant in the original multivariate level analysis (i.e. general health and depression), it appears that high consumption of a combination of all three items comprising the factor is the strongest predictor of undesirable outcomes. The only additional significant association was between the high cola/gum condition and low depression. It is therefore considered likely that the Caffeinated Soft Drinks/Gum factor represents a pervasive dietary/behavioural pattern, and so in the current sample may be better analysed as a whole rather than in separate units.

7.4 General Discussion

7.4.1 Dietary Patterns Associated With Undesirable Mental Health Outcomes in Secondary School Children

The current chapter identified three dietary patterns of potential concern regarding the mental health of secondary school children. The first was consumption of > 1000mg/w of caffeine, which was associated with low general health and high anxiety and depression (though it should be noted that the effect relating to depression appeared to occur with the consumption of caffeine in general, but was also most pronounced in those who consumed > 1000mg/w). Although individual sources of caffeine were also analysed separately, the results obtained were not entirely consistent across variables or time-points, suggesting that, at least within the context of adolescent mental health, caffeine is better investigated as a whole.

The second dietary pattern of potential concern identified in this chapter was a combination of energy drink consumption and breakfast omission. Combined effects of energy drinks and breakfast were significantly associated with each of the mental health outcome variables, even after covariates had been controlled for. The effects relating to general health and depression appeared mainly to reflect the omission of breakfast, whereas those relating to stress and anxiety were somewhat more specific. High stress was associated with the infrequent breakfast/frequent energy drinks condition, whereas high anxiety related to the infrequent breakfast/infrequent energy drinks condition. Taken together, these findings suggest that breakfast omission is related to the presence of mental health problems, and that the effects are observable in those who use energy drinks frequently as well as those who do not.

The third dietary pattern of concern identified in this chapter was high consumption of the Caffeinated Soft Drinks/Gum DABS factor (i.e. high consumption of energy drinks, cola, and chewing gum). This dietary pattern was associated with high depression and low general health. On closer inspection, high consumption of all three products appeared to be the strongest predictor of undesirable outcomes, suggesting that the factor represents a dietary/behaviour pattern that, within the sample examined here at least, is best investigated as a whole rather than as individual components.

7.4.2 Methodological Limitations

Although statistically controlling for the aspects of the sample for which it was not fully representative is considered to have been an effective way of increasing the generalisability of the findings, some variables could not be effectively controlled for. Due to very small numbers being present in the relevant minority groups, ethnicity, whether or not English was spoken as an additional language, and whether or not a non-parental guardian looked after the child were not entered as covariates. Future research could therefore aim to investigate the effects of these variables in more representative samples.

The question of reverse-causation should also be taken into account here. It is highly probable that, although diet is likely to affect mental health, mental health may also affect choices made regarding diet and lifestyle. It is possible therefore, that certain dietary variables, particularly those associated with the Caffeinated Soft Drinks/Gum DABS factor, may be viewed as outcomes rather than causes of behaviour. An obvious reason that such effects may occur, as already alluded to on several occasions, is the use of dietary coping strategies to combat stress and mental health problems. For instance, though high caffeine intake might cause stress, being highly stressed may lead to the consumption of caffeinated products as a coping strategy (Ríos et al., 2013). In examples such as this, it is also therefore difficult to rule out the possibility that the effects observed are bidirectional in nature.

In addition to the limitations addressed above, it has been noted that a healthy diet may be reflective of an overall healthy lifestyle (e.g. Akbaraly et al., 2009). Therefore, any effects observed may not necessarily be attributable specifically to diet. Although the current chapter attempted to address such issues by controlling for lifestyle covariates such as exercise frequency and average sleep hours, it is likely that other variables not controlled for in these analyses exert additional influences.

7.4.3 Conclusions

The current chapter found that high caffeine intake, frequently missing breakfast, and being a high consumer of the Caffeinated Soft Drinks/Gum DABS factor were all consistently associated with undesirable mental health outcomes.

Chapter 8 will therefore aim to investigate these dietary patterns further, to ascertain whether or not they are also related to school attendance, attainment, and problem behaviour.

Chapter 8: Cross-Sectional Associations Between Diet and School Performance in Secondary School Children

8.1 Introduction

Chapter 7 demonstrated that several dietary patterns were related to undesirable mental health outcomes. The risk factors identified were very high (> 1000mg/w) caffeine intake, a combination of breakfast omission and energy drink consumption, and being a high consumer of the Caffeinated Soft Drinks/Gum DABS factor. The current chapter therefore aims to build on these findings by investigating whether similar relationships exist between diet and school attendance, attainment, and behavioural sanctions.

8.1.1 Diet and School Performance

A number of studies have reported links between diet and school performance. For example, in a study of 5200 Grade 5 students from Nova Scotia, Canada, Florence, Asbridge, and Veugelers (2008) found that overall quality of diet was predictive of performance on a provincial standardised literacy assessment, even after socioeconomic and sex differences had been controlled for. An area of diet that has been assigned particular importance in explaining such relationships is the intake or omission of breakfast. However, though the majority of relevant studies provide evidence to suggest that regular breakfast consumption is beneficial regarding academic performance, Grantham-McGregor (2005) claimed that many such studies had design flaws, focussed only on short-term interventions, and were not conducted in countries where the effects of malnutrition are likely to be commonplace. Furthermore, Public Health England (2013) has suggested that apparent effects of diet on attainment may simply reflect increased school attendance associated with intervention programmes. Due to this observation, when investigating associations between diet and attainment, the current research continues to use a multivariate approach to data analysis in which school attendance can be controlled for statistically.

Although healthy nutritional habits may potentially bestow benefits regarding school performance, poor quality diet can be problematic. A junk food dietary pattern at three years of age, for instance, has been shown to predict subsequent school attainment (Feinstein et al., 2008). However, it should also be noted that educational attainment is positively related to quality of diet later in life (Kushi et al., 1988), potentially implying that improved nutritional knowledge may promote good dietary habits.

8.1.2 An Investigation of the Components of the Caffeinated Soft Drinks/Gum DABS Factor

As the DABS factor labelled 'Caffeinated Soft Drinks/Gum' was found to be consistently associated with negative mental health outcomes in Chapter 7, an examination of each of its components (i.e. energy drinks, cola, and chewing gum) is considered useful before further investigating whether it is also associated with school attendance, attainment, and problem behaviour.

8.1.2.1 Energy Drinks

As discussed in the literature review presented in Chapter 2, only four published studies have so far investigated relationships between energy drink use and academic attainment. Pettit and DeBarr (2011) reported a significant negative relationship between GPA and the largest number of energy drinks consumed in a single sitting in the previous 30 days, Azagba et al. (2014) found a self-reported GPA of $\geq$ 80% to predict lower instances of both moderate (3-8 times per year) and high (more than once a month) energy drink consumption, and Martz et al. (2015) found alcoholic energy drink use to be associated with low GPA. Since the literature review was conducted, Champlin et al. (2016) showed that self-reported GPA was negatively associated with energy drink intake quantity by frequency, as well as with the number of energy drinks used at the last time of consumption. The effects also remained significant after controlling for a range of possible confounding variables. Although that relating to consumption quantity by frequency disappeared once alcohol intake had also been controlled for, the effect relating to number of drinks consumed on the previous occasion remained, suggesting the finding to be robust.

It is possible that relationships between energy drink use (with or without the co-consumption of alcohol) and school performance are explained by increased risk-taking behaviour. For instance, a recent study of Canadian schoolchildren (Azagba et al., 2014) found sensation seeking and substance use to be higher in energy drink users compared to non-users, and higher again in high consumers compared to low consumers. Miller (2008b) also reported positive associations between energy drink consumption and marijuana use, seatbelt omission, fighting, sexual risk-taking, smoking, drinking, alcohol problems, taking risks on a dare, and illicit prescription drug use. Further associations have been found between alcoholic energy drink use and risk-taking behaviour in university students (e.g. Brache & Stockwell, 2011). Although it is possible that energy drink consumption simply reflects another aspect of risk-taking that is common within a particular subgroup of the population, additional research (e.g. Calamaro et al., 2009; Kristjánsson et al., 2011; Malinauskas et al., 2007), suggests that sleep disturbances associated with the use of such products may have potential to disrupt school attendance, attainment, and in-class behaviour.

8.1.2.2 Chewing Gum

Chewing gum use has been shown to be widespread, with a survey of 584 American undergraduate psychology students reporting that nearly 87% chew gum at least occasionally (Britt, Collins, & Cohen, 1999). Furthermore, 61% of respondents to a survey of full-time workers from the UK indicated that they chewed gum (Smith, 2009c). The act of chewing gum in itself, however, may be deemed to be somewhat unusual in that it involves the feeding behaviour of chewing in absence of the associated digestion (Allen, 2013). In the current context, chewing gum is of interest because it is likely to affect psychological processes. Evidence for this idea comes from a student survey conducted by Princeton Review and Wrigley (2005), which found respondents to chew gum in order to alleviate stress (41%) and to improve focus and concentration (23%).

Chewing gum has been associated with several cognitive outcomes that may be relevant to school performance. Although some studies have failed to find any effect on self-reported alertness (e.g. Torney, Johnson, & Miles, 2009), positive effects have been found on pre-test alertness (Smith, 2009a, 2010), post-test alertness (Johnson, Jenks, Miles, Albert, & Cox, 2011; Scholey et al., 2009; Smith, 2009d, 2010), and on reducing the fall in alertness induced by a vigilance task (Morgan, Johnson, & Miles, 2014). Though such effects may not provide any obvious benefits regarding school attendance, an improvement in alertness may be beneficial regarding academic attainment and in-class behaviour.

A review of research on both humans and non-human animals suggests that impaired mastication may lead to detriments in cognition (Weijenberg, Scherder, & Lobbezoo, 2011). Allen, Galvis, and Katz (2006) found a slight improvement in examination performance in students who chewed gum whilst studying dental anatomy, though it should be noted that this observation was not statistically significant. Furthermore, a follow-up study (Allen, Norman, & Katz, 2008) reported no such effect. Nevertheless, another study, in which US high school students were assigned to chewing gum or non-chewing gum conditions during maths classes (Johnston, Tyler, Stansberry, Moreno, & Foreyt, 2012), found that the chewing gum group performed better on a standardised test aligned with the state curriculum. However, no difference was observed on a more general maths assessment, potentially implying that chewing gum aided in the encoding of information learned in class rather than improving general cognitive capacity (Allen, 2013). Evidence for this idea comes from studies showing immediate and delayed word recall to be improved in those chewing gum over those not (Wilkinson, Scholey, & Wesnes, 2002). Stephens and Tunney (2004) also found chewing gum to improve immediate recall compared to sucking a sweet, implying that the effect is not wholly attributable to flavour. However, other studies have not found gum to facilitate immediate word recall (e.g. Tucha, Mecklinger, Maier, Hammerl, & Lange, 2004) or recall of a story (Smith, 2009d).

In addition to the above, chewing gum has been demonstrated to provide beneficial effects to sustained attention (Johnson, Muneem, & Miles, 2013), performance on a repeated digits vigilance task (Smith, 2010), and multi-tasking ability (Scholey et al., 2009). These are of course effects that may be of interest in the current context, as they might relate to improved school performance. Although not without inconsistencies and replication failures, the literature generally points towards chewing gum having a beneficial effect on school performance and wellbeing via a reduction in stress levels. However, results from Chapter 7 suggested that reductions in stress relating to the Caffeinated Soft Drinks/Gum factor occurred in the groups that only consumed high amounts of cola, or high amounts of cola and energy drinks; indeed, the group that only consumed high amounts of gum was actually significantly more likely to report high levels of stress. In addition, as high consumption of the Caffeinated Soft Drinks/Gum factor might represent a behavioural pattern associated with a subgroup of problem children, beneficial effects of chewing gum may be unlikely to become apparent. For an overview of the cognitive effects of chewing gum, see Allen and Smith (2011).

8.1.2.3 Cola

Cola has consistently remained a popular type of soft drink, and its worldwide consumption is known to be very high (Celec & Behuliak, 2010). Although the US Food and Drug Administration (1980, as cited in Reissig et al., 2009) proposed to remove caffeine from such beverages, soft drinks manufacturers justified adding the substance on the basis of it enhancing flavour (PepsiCo Inc., 1981, as cited in Reissig et al., 2009). However, regular consumers of cola drinks have been shown unable to reliably detect flavour differences between caffeinated (0.1mg/ml; the approximate concentration in most cola products) and non-caffeinated cola (Griffiths & Vernotica, 2000). On this basis, Griffiths and Vernotica (p. 727) concluded that, "the high rates of consumption of caffeinated soft drinks more likely reflect the mood-altering and physical dependence–producing effects of caffeine as a central nervous system–active drug than its subtle effects as a flavoring agent."

The consumption of cola has been associated with a number of physical problems, such as dental erosion (Jensdottir, Holbrook, Nauntofte, Buchwald, & Bardow, 2006), chronic kidney disease (Saldana, Basso, Darden, & Sandler, 2007), and Type 2 diabetes (Schulze, et al., 2004). Its high intake has further been found to predict increased instances of coronary heart disease, but also decreased instances of cancers, effects that appear to be mediated by personality and stress (Grossarth-Maticek & Eysenk, 1991). Although research into the psychological outcomes of consuming cola is particularly sparse, such effects may be similar to those attributable to other sources of caffeine. If indeed these effects do occur, they may be small and difficult to detect due to concentrations of the substance being considerably lower in cola than in other caffeinated products.

8.1.3 Aims of Chapter 8

The current chapter presents data from the Cornish Academies Project to investigate relationships between diet and school attendance, Key Stage 3/Key Stage 4 English and maths attainment, and the occurrence of behavioural sanctions. The main purpose of this chapter is therefore to provide an initial examination of how diet and school performance are associated cross-sectionally, before such relationships are investigated longitudinally in Chapter 9.

8.2 Method

As the participants, materials, and procedure used in the Cornish Academies Project have been discussed in detail in Chapter 6, they are not addressed again here. The current section therefore aims only to outline the variables of interest and methods of statistical analysis used in the current chapter.

8.2.1 Design

The predictor variables used in this chapter are: 1) caffeine (total weekly consumption, as well as that obtained separately from energy drinks, cola, coffee, and tea), 2) breakfast and energy drinks (in isolation and in combination), and 3) the Caffeinated Soft Drinks/Gum DABS factor. The dependent variables investigated are: 1) school attendance, 2) KS3/KS4 English attainment, 3) KS3/KS4 maths attainment, and 4) behavioural sanctions.

8.2.2 Statistical Analysis[9]

Descriptive statistics relating to demography, lifestyle, and school performance are not included here because they have already been reported in Chapter 6. The methods for determining the dependent variables for school attendance, English attainment, maths attainment, and behavioural sanctions were

[9] As with Chapter 7, interactions are not presented or discussed here because findings made from such analyses were generally inconsistent, and few statistically significant effects were observed. Cross-sectional interactions between the dietary predictor variables and certain aspects of demography and lifestyle (sex, SEN status, FSM, and sleep) that related to school performance are instead included in Appendix D.

also discussed in Chapter 6, as were relationships between these variables and the demographic, and lifestyle covariates.

As with the statistical methods used in Chapter 7, initial univariate associations between diet and school performance were investigated using between-subjects t-tests for continuous dietary variables, and Chi-square test (as well as Chi-square tests for linear association) for categorical dietary variables. These analyses were then followed up with binary logistic regression (using enter method). As with analyses presented in Chapter 7, each demographic and lifestyle variable was included in all multivariate analyses (except that school attendance was not entered as a covariate when it was also the outcome). Table 8.1 provides a breakdown of all the covariates entered into each of the multivariate analyses presented in this chapter. Because all the relevant variables were collected at both T1 and T2, cross-sectional analyses are performed at both time-points.

8.3 Results & Discussion

8.3.1 Caffeine Consumption and School Performance

8.3.1.1 Associations Between Total Weekly Caffeine Consumption and School Performance

As Chapter 7 identified high caffeine intake to be a predictor of poor mental health outcomes in the data from the Cornish Academies Project, it was deemed appropriate to investigate whether similar effects occurred in relation to school performance. Total weekly caffeine consumption, coded in the same manner (i.e. 0mg/w, 0.1-250mg/w, 250.1-500mg/w, 500.1-750mg/w, 750.1-1000mg/w, and > 1000mg/w), was therefore investigated in relation to the dichotomous school performance outcomes using Chi-square tests for linear association.

Significant linear trends were observed for all outcome variables at both time-points, except for maths attainment at T1 (though it should be noted that participants in the 0mg/w group were still significantly more likely to achieve above average attainment). Although there were small differences between outcomes and time-points, negative effects tended to occur in the > 1000mg/w condition, and positive

Predictor variable(s)	Dietary covariates	Demographic covariates	Lifestyle covariates
Total weekly caffeine	**Total caffeine (categorical variable with six consumption groups)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Caffeine from individual sources	**Caffeine from energy drinks (non/low/high consumption)** **Caffeine from cola (non/low/high consumption)** **Caffeine from coffee (non/low/high consumption)** **Caffeine from tea (non/low/high consumption)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Breakfast	**Breakfast (every day vs. not every day)** Junk Food DABS subscale score Healthy Foods DABS subscale score Total weekly caffeine (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Energy drinks	**Energy drinks (once a week or more vs. less than once a week)** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Energy drinks/breakfast combinations	**Combinations of frequent/infrequent consumption of breakfast and energy drinks** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Caffeinated Soft Drinks/Gum	Junk Food DABS factor score **Caffeinated Soft Drinks/Gum DABS factor score** Healthy Foods DABS factor score Hot Caffeinated Beverages DABS factor score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)

Table 8.1. Covariates entered into cross-sectional multivariate analyses of school performance.

Note. Predictor variables are highlighted in bold in the dietary covariates column. Cross-sectional analyses from T1 used covariates from T1; cross-sectional analyses from T2 used covariates from T2. School attendance was not entered as a covariate when it was also the outcome variable.

effects were associated with low consumption and non-consumption, findings that are similar to those reported in relation to mental health in Chapter 7. It was interesting, however, to note that negative effects for each outcome variable also occurred in relation to the 500.1-750mg/w condition at T2. For $\chi 2$ and *p* values, and cross-tabulations between total weekly caffeine intake and school performance outcomes at T1 and T2, see Tables 8.2 and 8.3, respectively.

			Total weekly caffeine intake					
			0mg/w	0.1-250mg/w	250.1-500mg/w	500.1-750mg/w	750.1-1000mg/w	> 1000mg/w
School attendance	High	Count	109	414	215	107	61	82
		Expected count	108.3	390	214	109.3	63.2	103.2
		Column %	50.9%	53.7%	50.8%	49.5%	48.8%	40.2%
		Adjusted residual	.1	2.2	.1	-.3	-.4	-3.1
	Low	Count	105	357	208	109	64	122
		Expected count	105.7	381	209	106.7	61.8	100.8
		Column %	49.1%	46.3%	49.2%	50.5%	51.2%	59.8%
		Adjusted residual	-.1	-2.2	-.1	.3	.4	3.1
		$\chi 2$ linear	8.795, $p = .003$					
English attainment	High	Count	113	379	203	98	62	89
		Expected count	102	371.7	205.6	104	60.1	100.6
		Column %	54.6%	50.3%	48.7%	46.4%	50.8%	43.6%
		Adjusted residual	1.6	.7	-.3	-.9	.3	-1.7
	Low	Count	94	375	214	113	60	115
		Expected count	105	382.3	211.4	107	61.9	103.4
		Column %	45.4%	49.7%	51.3%	53.6%	49.2%	56.4%
		Adjusted residual	-1.6	-.7	.3	.9	-.3	1.7
		$\chi 2$ linear	4.264, $p = .039$					
Maths attainment	High	Count	132	412	221	116	70	112
		Expected count	116.5	421.7	229	116.5	67.3	112
		Column %	62.6%	53.9%	53.3%	55%	57.4%	55.2%
		Adjusted residual	2.3	-.9	-.9	-.1	.5	.0
	Low	Count	79	352	194	95	52	91
		Expected count	94.5	342.3	186	94.5	54.7	91
		Column %	37.4%	46.1%	46.7%	45%	42.6%	44.8%
		Adjusted residual	-2.3	.9	.9	.1	-.5	.0
		$\chi 2$ linear	.272, $p = .602$					
Behavioural sanctions	Good	Count	193	684	352	185	112	155
		Expected count	183.6	662.4	363	187.1	109	175.9
		Column %	90.2%	88.6%	83.2%	84.9%	88.2%	75.6%
		Adjusted residual	1.9	2.9	-1.7	-.4	.8	-4.4
	Bad	Count	21	88	71	33	15	50
		Expected count	30.4	109.6	60	30.9	18	29.1
		Column %	9.8%	11.4%	16.8%	15.1%	11.8%	24.4%
		Adjusted residual	-1.9	-2.9	1.7	.4	-.8	4.4
		$\chi 2$ linear	19.202, $p < .001$					

Table 8.2. Cross-tabulations between total weekly caffeine intake and school performance outcomes at T1.

			Total weekly caffeine intake					
			0mg/w	0.1-250mg/w	250.1-500mg/w	500.1-750mg/w	750.1-1000mg/w	> 1000mg/w
School attendance	High	Count	132	517	244	109	59	98
		Expected count	119.6	471.2	248.3	129.3	64.6	126
		Column %	59.5%	59.1%	52.9%	45.4%	49.2%	41.9%
		Adjusted residual	1.8	4	-.5	-2.8	-1.1	-3.9
	Low	Count	90	358	217	131	61	136
		Expected count	102.4	403.8	212.7	110.7	55.4	108
		Column %	40.5%	40.9%	47.1%	54.6%	50.8%	58.1%
		Adjusted residual	-1.8	-4	.5	2.8	1.1	3.9
		χ2 linear	30.45, $p < .001$					
English attainment	High	Count	133	430	215	102	57	110
		Expected count	107.9	426.6	222.6	116.7	58.8	114.3
		Column %	60.5%	49.4%	47.4%	42.9%	47.5%	47.2%
		Adjusted residual	3.6	.3	-.8	-2	-.3	-.6
	Low	Count	87	440	239	136	63	123
		Expected count	112.1	443.4	231.4	121.3	61.2	118.7
		Column %	39.5%	50.6%	52.6%	57.1%	52.5%	52.8%
		Adjusted residual	-3.6	-.3	.8	2	.3	.6
		χ2 linear	6.308, $p = .012$					
Maths attainment	High	Count	134	442	203	97	54	95
		Expected count	105.3	417.8	219.7	113.5	57.2	111.5
		Column %	61.2%	50.9%	44.4%	41.1%	45.4%	40.9%
		Adjusted residual	4.1	2.1	-1.8	-2.3	-.6	-2.3
	Low	Count	85	427	254	139	65	137
		Expected count	113.7	451.2	237.3	122.5	61.8	120.5
		Column %	38.8%	49.1%	55.6%	58.9%	54.6%	59.1%
		Adjusted residual	-4.1	-2.1	1.8	2.3	.6	2.3
		χ2 linear	20.97, $p < .001$					
Behavioural sanctions	Good	Count	196	735	353	175	88	153
		Expected count	174.5	692.5	363.2	188.7	95.5	185.6
		Column %	88.7%	83.8%	76.7%	73.2%	72.7%	65.1%
		Adjusted residual	3.7	4.6	-1.3	-2.3	-1.7	-5.5
	Bad	Count	25	142	107	64	33	82
		Expected count	46.5	184.5	96.8	50.3	25.5	49.4
		Column %	11.3%	16.2%	23.3%	26.8%	27.3%	34.9%
		Adjusted residual	-3.7	-4.6	1.3	2.3	1.7	5.5
		χ2 linear	58.892, $p < .001$					

Table 8.3. Cross-tabulations between total weekly caffeine intake and school performance outcomes at T2.

In order to further investigate the relationships observed, the caffeine variable consisting of six consumption groups was entered into binary logistic regression models, along with additional covariates, upon the dichotomous school performance outcomes.

At T1, the overall association between total weekly caffeine intake and school attendance was not significant, Wald = 5.496, $p = .358$, and none of the consumption groups differed significantly from the control. At T2 however, the effect was significant, Wald = 15.375, $p = .009$; this reflected increased risk of low attendance occurring in the 250.1-500mg/w, 500.1-750mg/w, and > 1000mg/w conditions. For

ORs and 95% CIs for multivariate associations between total weekly caffeine intake and school attendance at T1 and T2, see Figures 8.1 and 8.2, respectively.

There was no association between total weekly caffeine intake and English attainment at T1, Wald = 3.2, $p = .669$, and none of the consumption groups differed from the control. At T2, the overall effect was also not significant, Wald = 8.196, $p = .146$, although each of the caffeine consumption groups was associated with increased risk of achieving low attainment compared to the control (though the effect observed in relation to the 750.1-1000mg/w group was only marginally significant). For ORs and 95% CIs for the multivariate associations between total weekly caffeine intake and English attainment at T1 and T2, see Figures 8.3 and 8.4, respectively.

The association between total weekly caffeine intake and maths attainment at T1 was not significant, Wald = 2.388, $p = .793$, and none of the caffeine consumption groups differed from the control. At T2, the overall effect was significant, Wald = 17.518, $p = .004$, and reflected increased risk of low attainment occurring in each of the caffeine consumption groups relative to the control. For ORs and 95% CIs for the multivariate associations between total weekly caffeine consumption and maths attainment at T1 and T2, see Figures 8.5 and 8.6, respectively.

The association between total weekly caffeine intake and behavioural sanctions was significant at both time-points: T1, Wald = 12.886, $p = .024$; T2, Wald = 14.133, $p = .015$. In each case the > 1000mg/w condition was predictive of bad behaviour, although at T2 higher risk was also associated with the 250.1-500mg/w and 500.1-750mg/w conditions (though the latter effect was only marginally significant). For ORs and 95% CIs for multivariate associations between total weekly caffeine intake and behavioural sanctions at T1 and T2, see Figures 8.7 and 8.8, respectively.

8.3.1.2 Associations Between Individual Sources of Caffeine and School Performance

Chi-square tests for linear association were conducted to determine whether caffeine consumed specifically from energy drinks, cola, coffee, and tea, were related to the school performance outcomes. The same categorical variables (i.e. non-

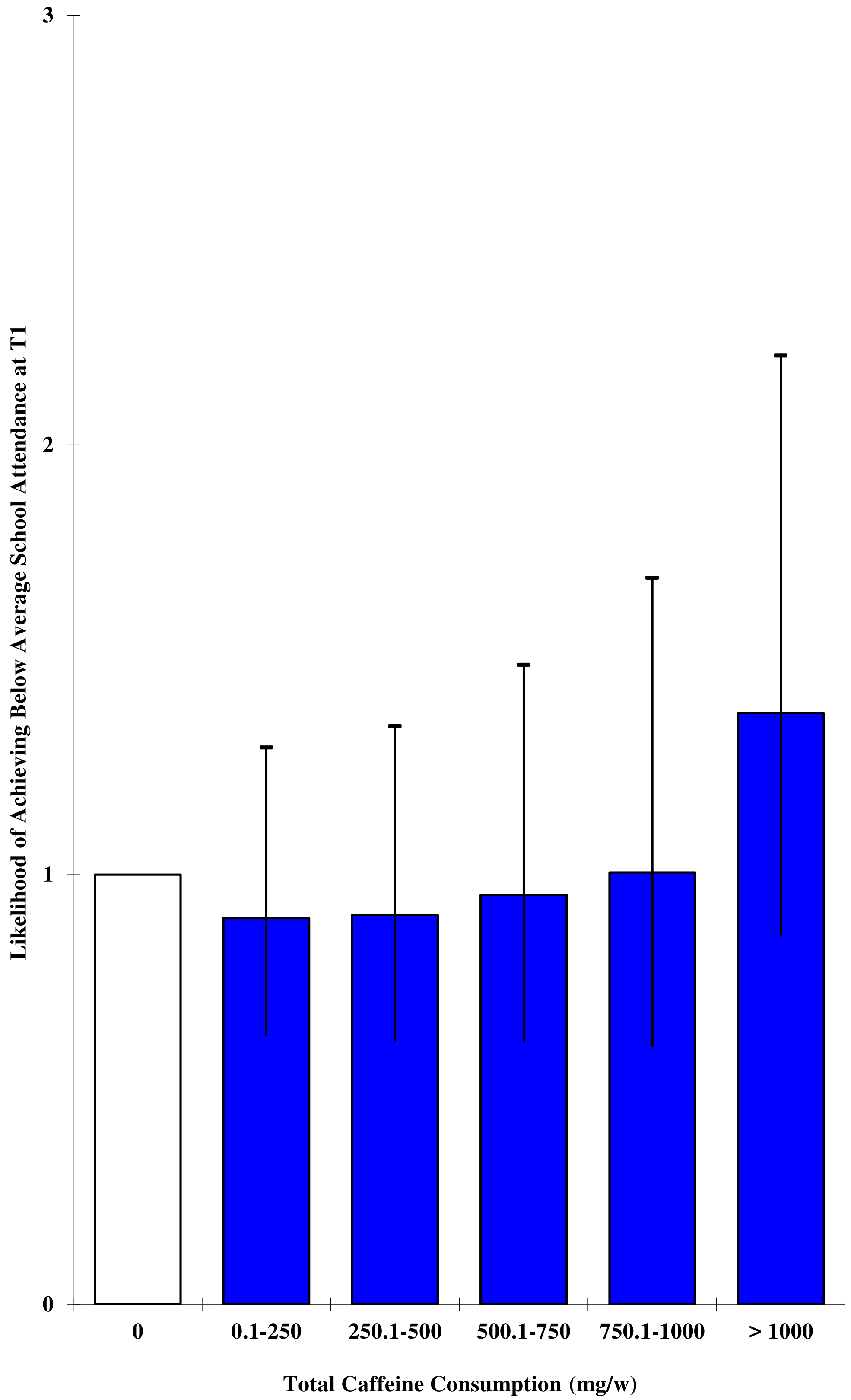

Figure 8.1. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and school attendance at T1.

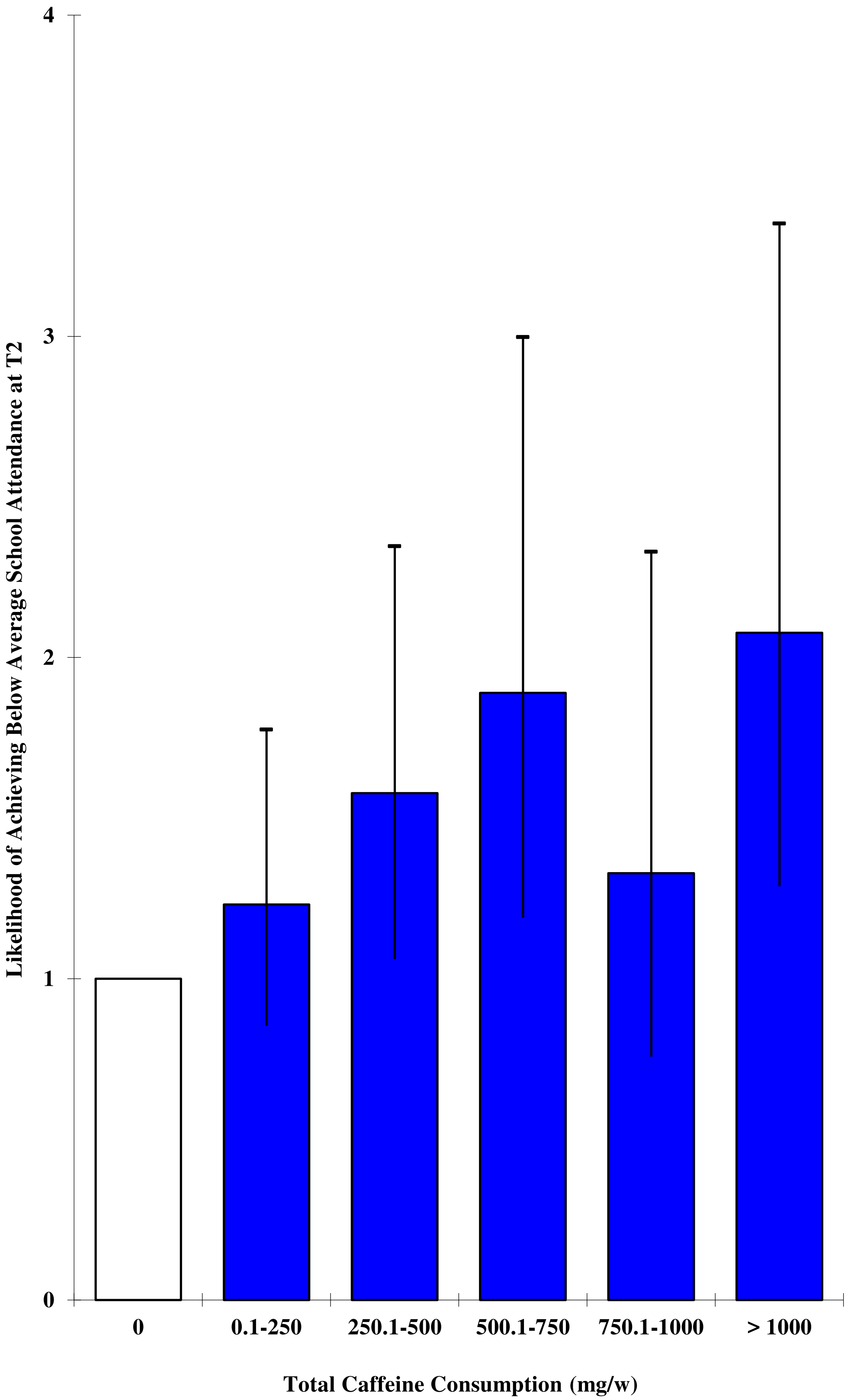

Figure 8.2. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and school attendance at T2.

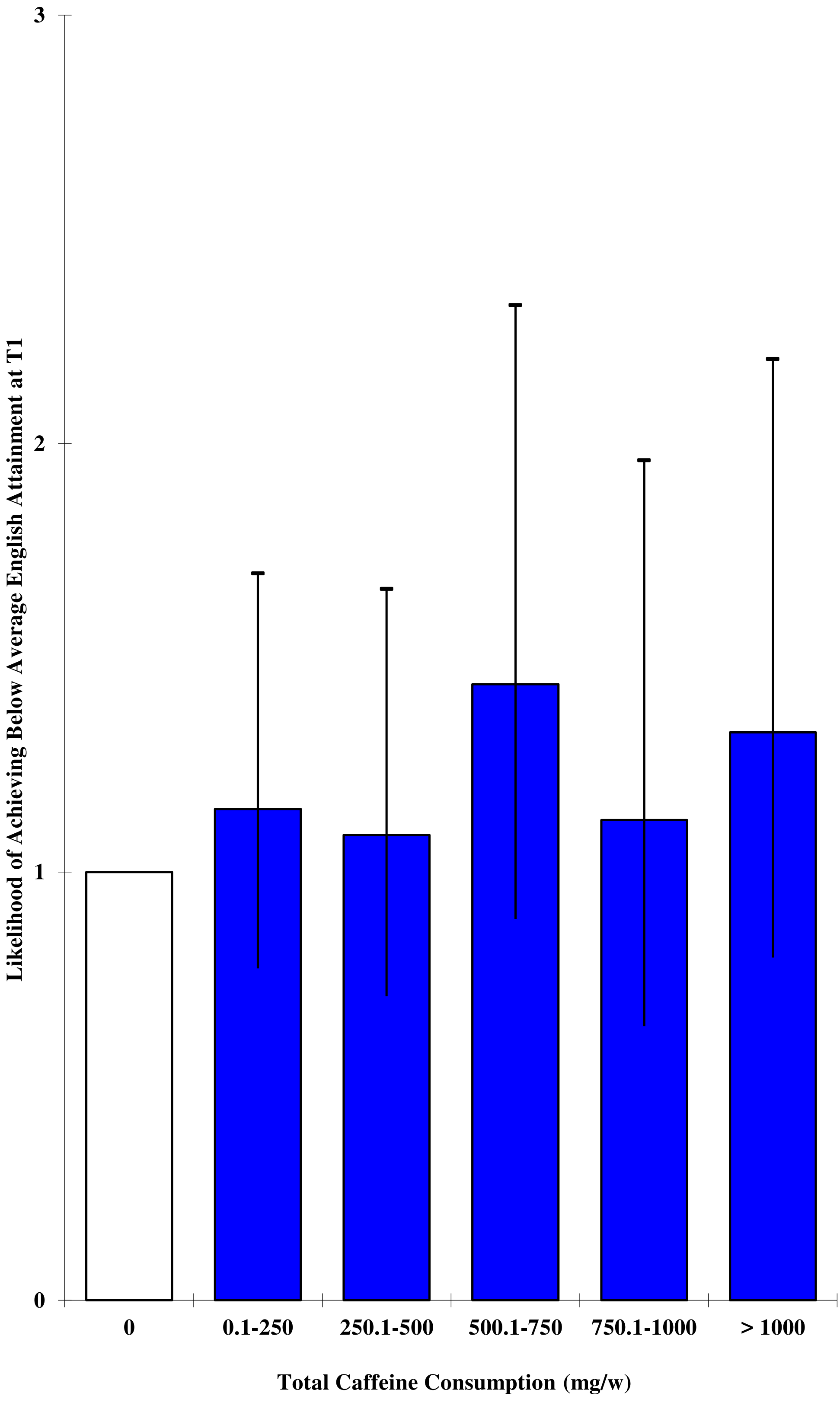

Figure 8.3. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and English attainment at T1.

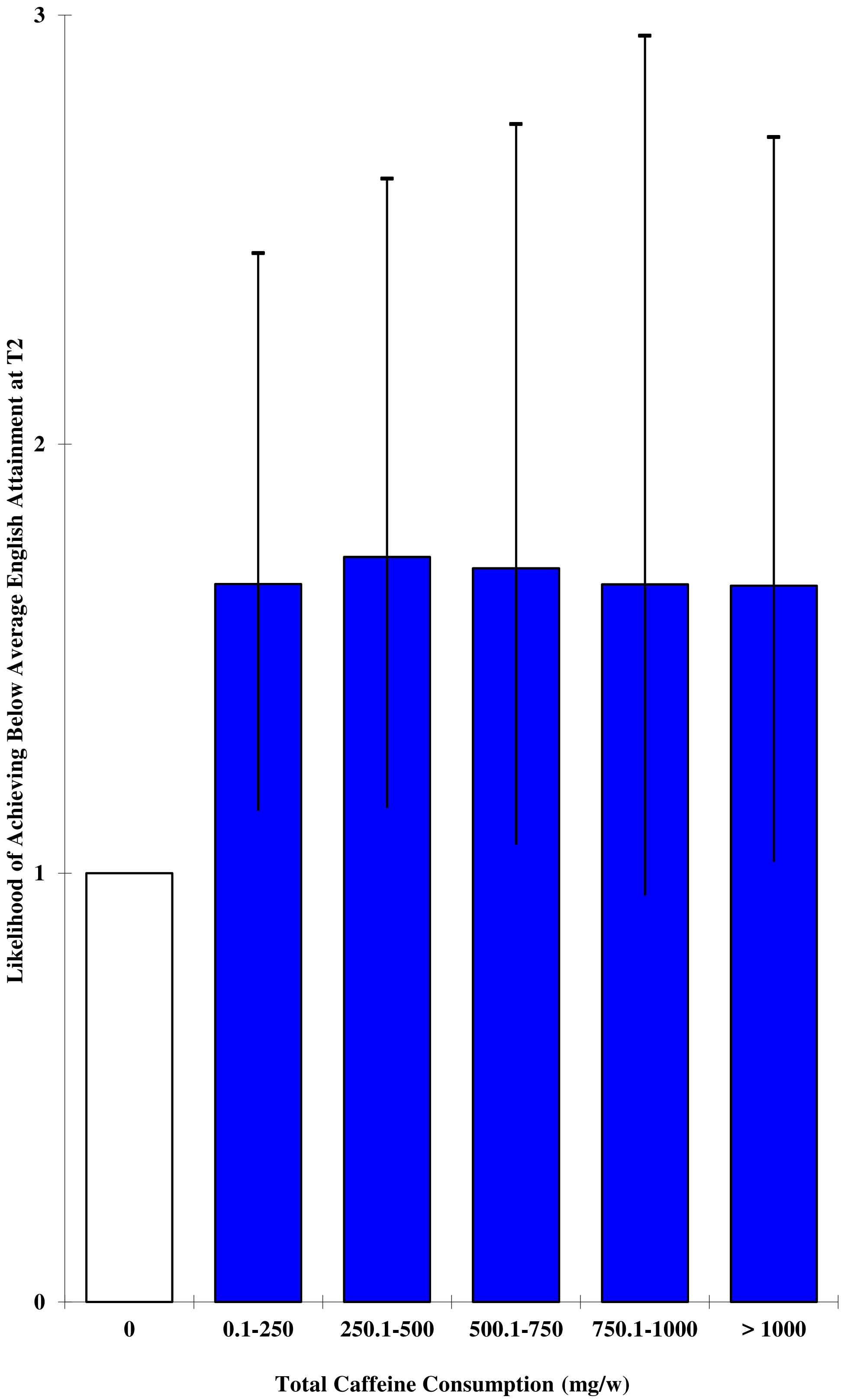

Figure 8.4. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and English attainment at T2.

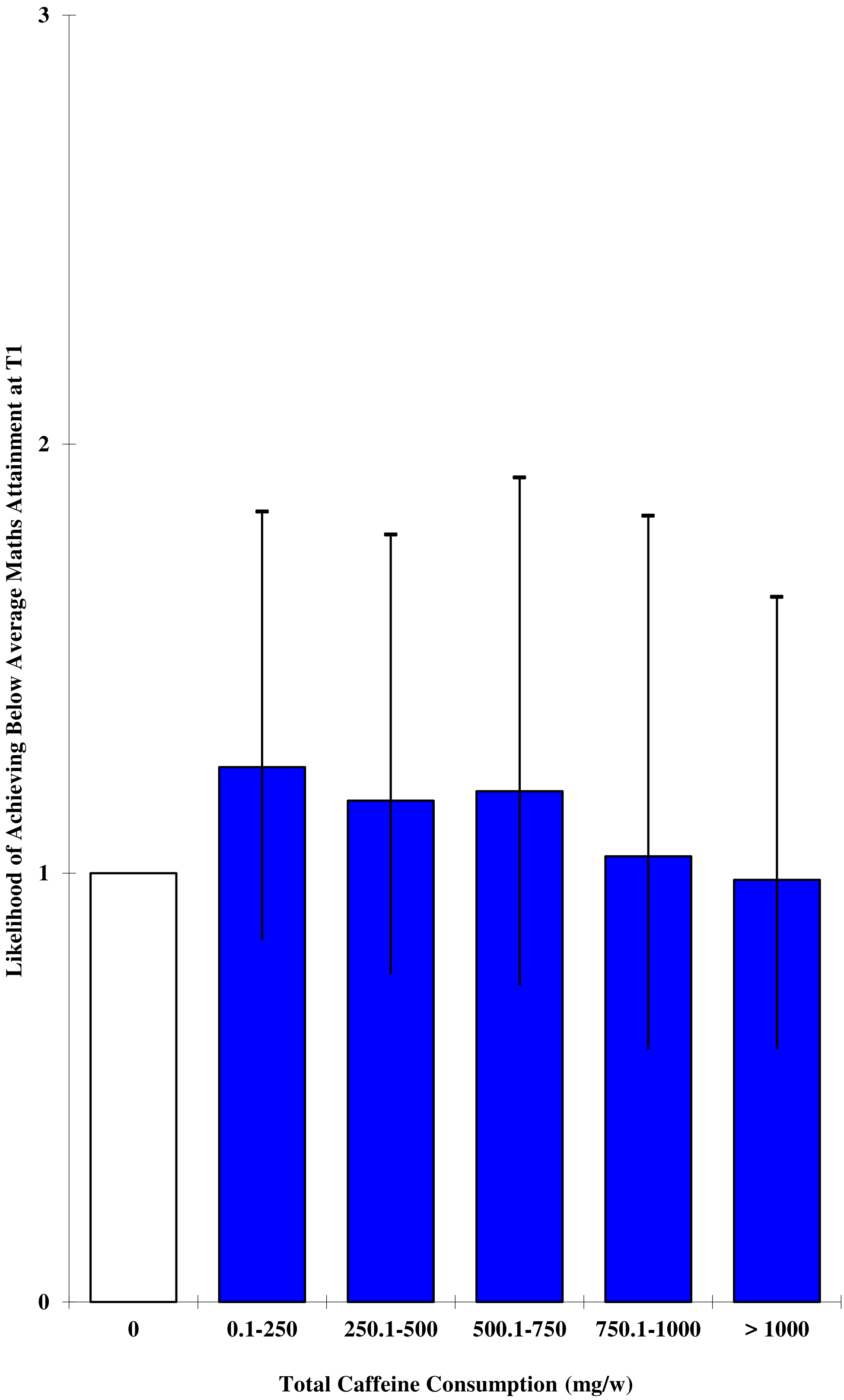

Figure 8.5. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and maths attainment at T1.

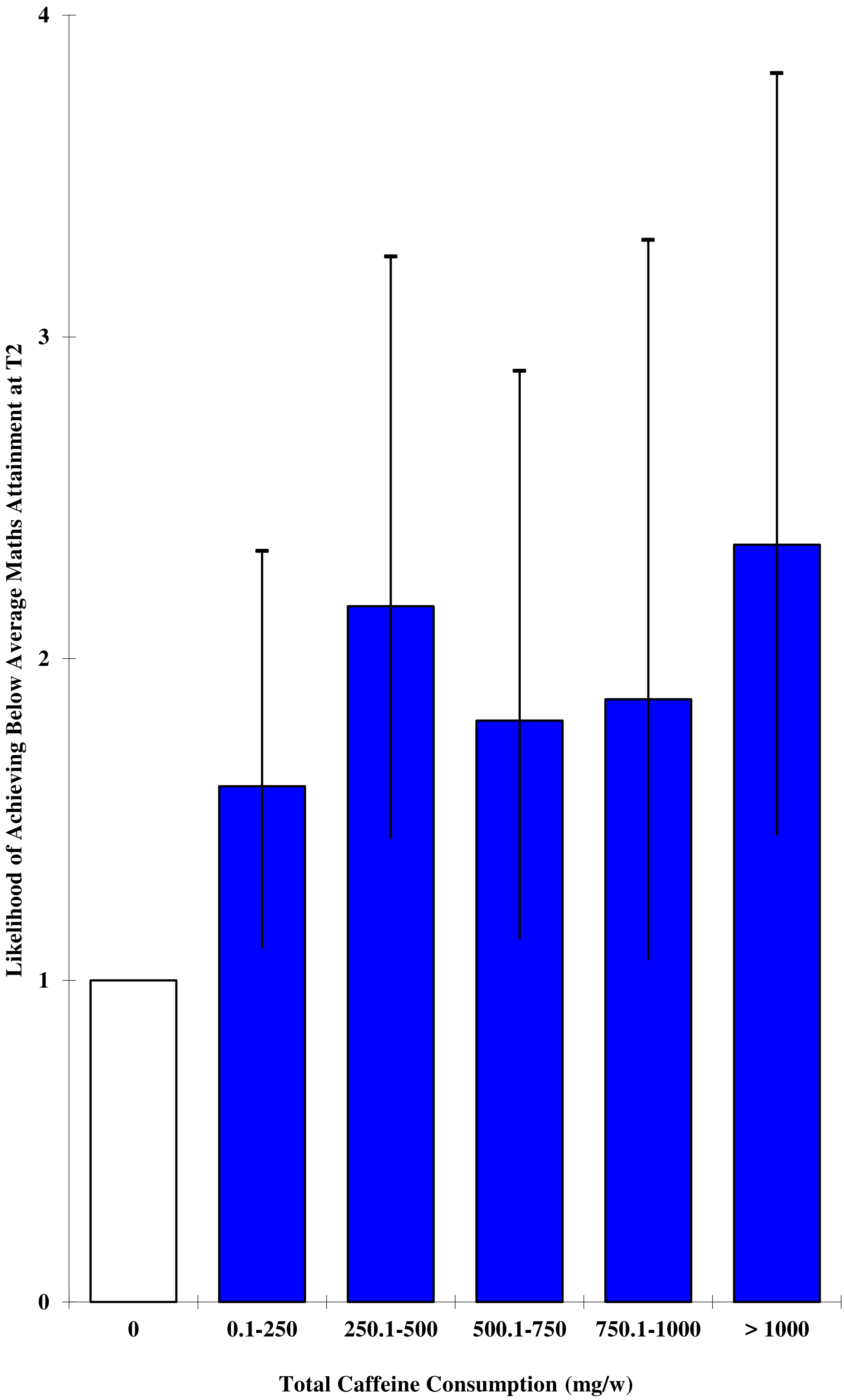

Figure 8.6. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and maths attainment at T2.

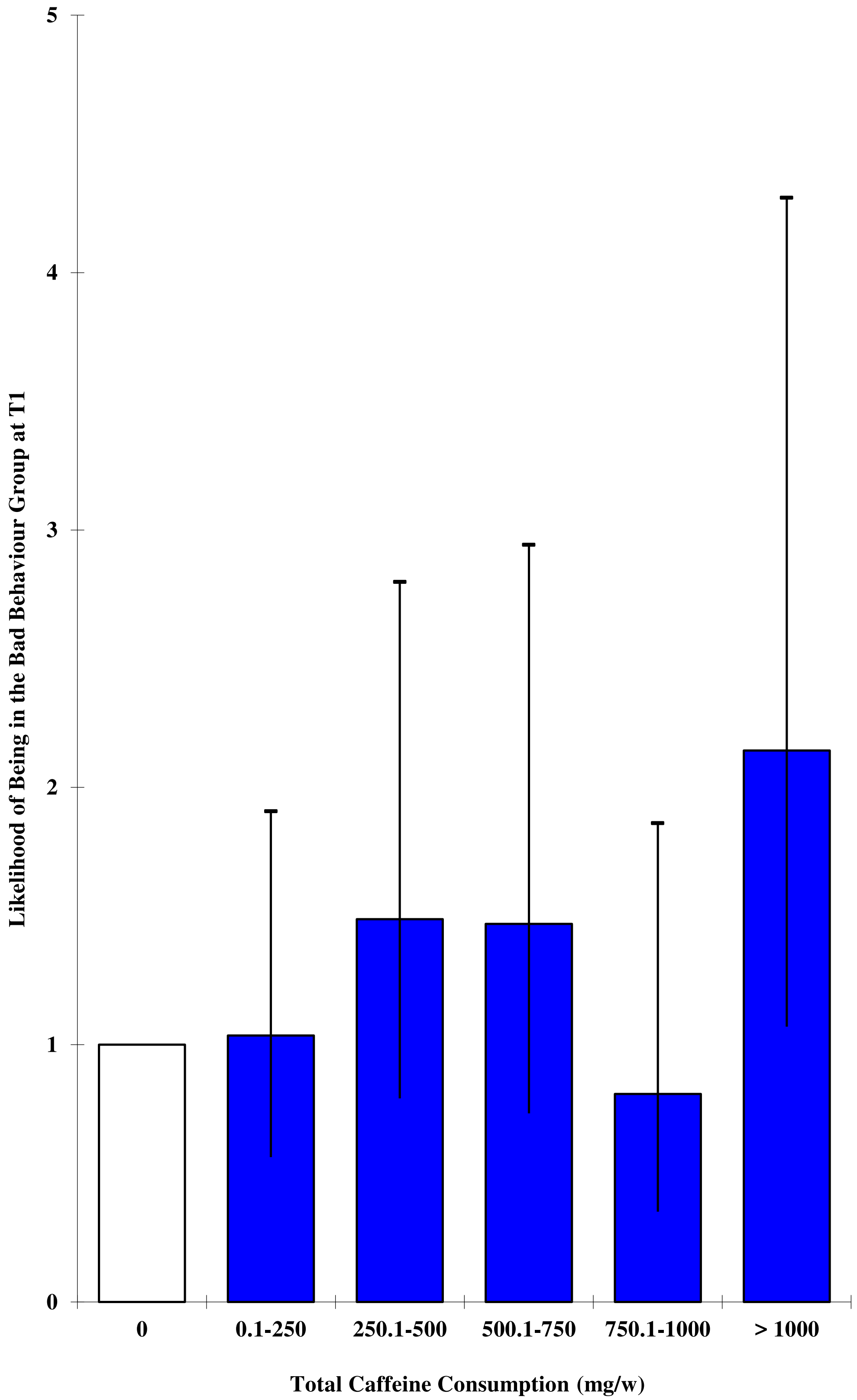

Figure 8.7. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and behavioural sanctions at T1.

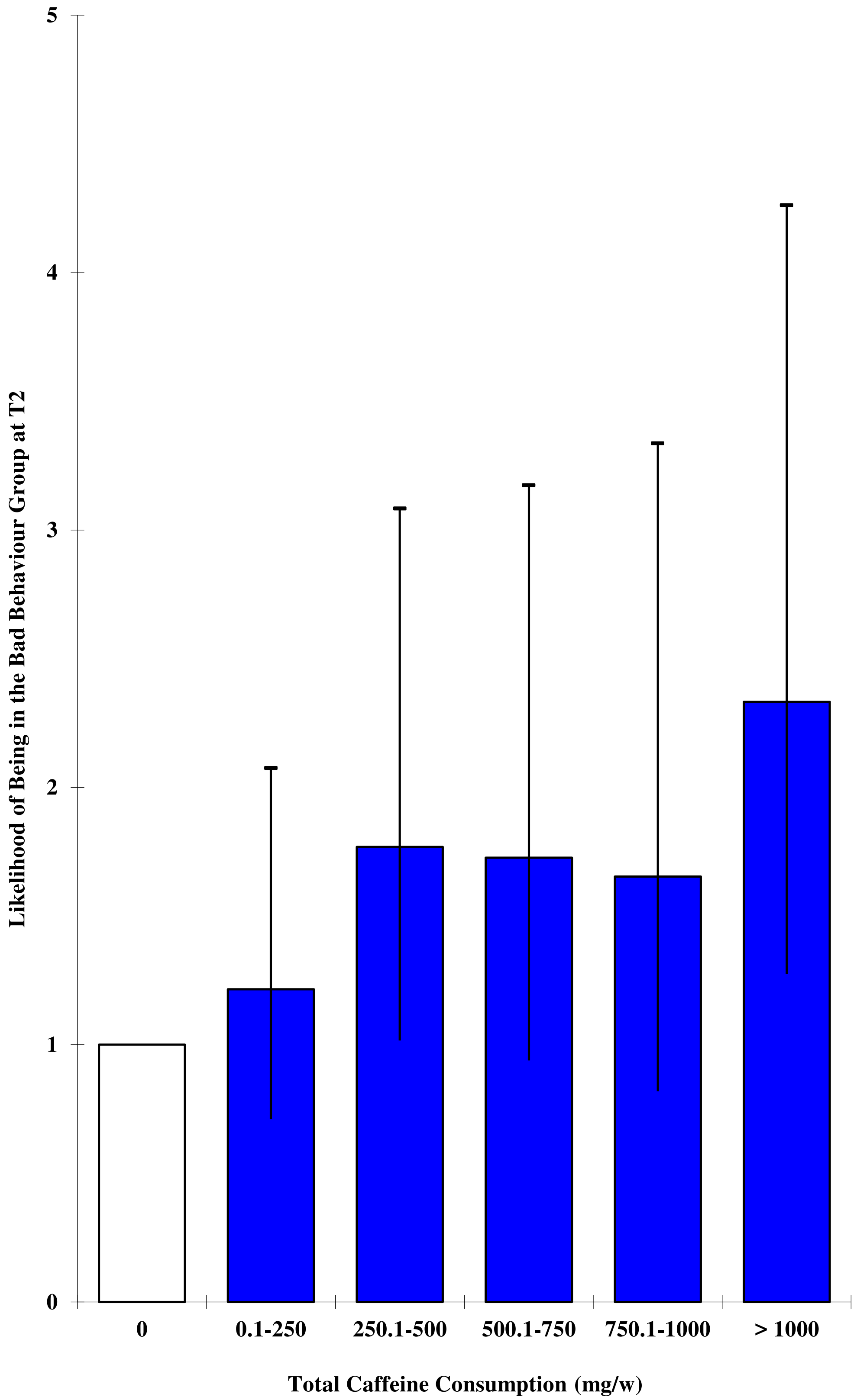

Figure 8.8. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake and behavioural sanctions at T2.

consumption, low consumption, high consumption) from Chapter 7 were again used here.

The main finding from these analyses was that caffeine consumption, from any source, was negatively associated with school performance. The associations were significant for all outcome variables at both time-points when the caffeine consumed came from energy drinks or cola, though some non-significant findings were made regarding caffeine consumed from tea or coffee. For $\chi 2$ and *p* values, as well as cross-tabulations between these variables and the school performance outcomes at T1 and T2, see Tables 8.4 and 8.5, respectively.

To investigate the effects of the individual caffeine sources further, they were entered together into binary logistic regression analyses along with the other covariates. Although consumption of each caffeine source was related to negative outcomes, of particular note was that caffeine from energy drinks was associated with each dependent variable other than school attendance at T1. Other than this, an intriguing relationship emerged in which both low and high caffeine consumption from coffee was associated with high maths attainment at T1, although no such associations had been observed at the univariate level.

High caffeine consumption from coffee at T2 was associated with bad behaviour (the overall effect being only marginally significant), with no effect being observed in the low consumption group. However, low caffeine consumption from coffee at T1 was associated with good behaviour, the overall effect also being marginally significant. Although inconsistencies were observed, the general findings from these analyses suggested, much like those at the univariate level, that high consumption of caffeine in general is associated with poor school performance outcomes, and so, total weekly consumption is likely to be the most useful indicator. For ORs, 95% CIs, and *p* values, see Tables 8.6 and 8.7 for T1 and T2, respectively.

8.3.1.3 Discussion of the Associations Between Caffeine Intake and School Performance

Initial univariate analyses of total weekly caffeine intake and school performance uncovered significant linear trends, by which higher intakes were

			Caffeine from energy drinks			Caffeine from cola			Caffeine from coffee			Caffeine from tea		
			0mg	0.1-133mg	> 133mg	0mg	0.1-25mg	> 25mg	0mg	0.1-160mg	> 160mg	0mg	0.1-120mg	> 120mg
School attendance	High	Count	605	217	179	346	344	307	725	142	137	435	278	288
		Expected count	581.9	217.4	201.7	332.8	332.8	331.3	709.3	138	156.7	421.5	279.7	299.8
		Row %	60.4%	21.7%	17.9%	34.7%	34.5%	30.8%	72.2%	14.1%	13.6%	43.5%	27.8%	28.8%
		Adjusted residual	2.1	.0	-2.5	1.3	1.1	-2.3	1.6	.5	-2.4	1.2	-.2	-1.2
	Low	Count	546	213	220	311	313	347	678	131	173	400	276	306
		Expected count	569.1	212.6	197.3	324.2	324.2	322.7	693.7	135	153.3	413.5	274.3	294.2
		Row %	55.8%	21.8%	22.5%	32%	32.2%	35.7%	69%	13.3%	17.6%	40.7%	28.1%	31.2%
		Adjusted residual	-2.1	.0	2.5	-1.3	-1.1	2.3	-1.6	-.5	2.4	-1.2	.2	1.2
		χ2 linear	6.64, p = .01			4.285, p = .038			4.52, p = .034			1.835, p = .176		
English attainment	High	Count	603	184	166	334	324	293	672	130	152	416	251	286
		Expected count	552.6	207.6	192.9	316.8	318.3	315.9	671.9	132.7	149.4	397.4	267.5	288.1
		Row %	63.3%	19.3%	17.4%	35.1%	34.1%	30.8%	70.4%	13.6%	15.9%	43.7%	26.3%	30%
		Adjusted residual	4.6	-2.6	-3	1.7	.5	-2.2	.0	-.4	.3	1.7	-1.7	-.2
	Low	Count	523	239	227	309	322	348	700	141	153	395	295	302
		Expected count	573.4	215.4	200.1	326.2	327.7	325.1	700.1	138.3	155.6	413.6	278.5	299.9
		Row %	52.9%	24.2%	23%	31.6%	32.9%	35.5%	70.4%	14.2%	15.4%	39.8%	29.7%	30.4%
		Adjusted residual	-4.6	2.6	3	-1.7	-.5	2.2	.0	.4	-.3	-1.7	1.7	.2
		χ2 linear	19.233, p < .001			4.987, p = .026			.024, p = .878			1.252, p = .263		
Maths attainment	High	Count	659	223	194	383	367	322	752	150	176	479	270	327
		Expected count	624.8	234.2	217.1	356.2	360.1	355.7	763.8	148	166.2	453.8	299.3	322.9
		Row %	61.2%	20.7%	18%	35.7%	34.2%	30%	69.8%	13.9%	16.3%	44.5%	25.1%	30.4%
		Adjusted residual	3.2	-1.2	-2.6	2.6	.7	-3.3	-1.2	.3	1.2	2.3	-3	.4
	Low	Count	475	202	200	262	285	322	636	119	126	346	274	260
		Expected count	509.2	190.8	176.9	288.8	291.9	288.3	624.2	121	135.8	371.2	244.7	264.1
		Row %	54.2%	23%	22.8%	30.1%	32.8%	37.1%	72.2%	13.5%	14.3%	39.3%	31.1%	29.5%
		Adjusted residual	-3.2	1.2	2.6	-2.6	-.7	3.3	1.2	-.3	-1.2	-2.3	3	-.4
		χ2 linear	10.631, p = .001			11.458, p = .001			1.733, p = .188			1.297, p = .255		
Behavioural sanctions	Good	Count	1037	346	317	586	560	547	1210	240	254	732	469	502
		Expected count	990.4	367.2	342.4	565.2	562.6	565.2	1202.7	234.4	266.9	717.5	475.2	510.3
		Row %	61%	20.4%	18.6%	34.6%	33.1%	32.3%	71%	14.1%	14.9%	43%	27.5%	29.5%
		Adjusted residual	6	-3.3	-4	2.8	-.4	-2.5	1	1	-2.3	1.9	-.9	-1.2
	Bad	Count	120	83	83	73	96	112	196	34	58	106	86	94
		Expected count	166.6	61.8	57.6	93.8	93.4	93.8	203.3	39.6	45.1	120.5	79.8	85.7
		Row %	42%	29%	29%	26%	34.2%	39.9%	68.1%	11.8%	20.1%	37.1%	30.1%	32.9%
		Adjusted residual	-6	3.3	4	-2.8	.4	2.5	-1	-1	2.3	-1.9	.9	1.2
		χ2 linear	33.15, p < .001			9.448, p = .002			2.943, p = .086			3.004, p = .083		

Table 8.4. Cross-tabulations between school performance, and weekly caffeine intake from energy drinks, cola, coffee, and tea at T1.

			Caffeine from energy drinks			**Caffeine from cola**			**Caffeine from coffee**			**Caffeine from tea**		
			0mg	0.1-133mg	> 133mg	0mg	0.1-25mg	> 25mg	0mg	0.1-160mg	> 160mg	0mg	0.1-120mg	> 120mg
School attendance	High	Count	748	270	170	422	413	348	884	157	150	529	333	333
		Expected count	704.6	261.7	221.7	402	400.4	380.5	849.9	163.5	177.5	496.4	321.8	376.8
		Row %	63%	22.7%	14.3%	35.7%	34.9%	29.4%	74.2%	13.2%	12.6%	44.3%	27.9%	27.9%
		Adjusted residual	3.8	.9	-5.7	1.8	1.1	-3	3.2	-.8	-3.3	2.8	1.1	-4
	Low	Count	558	215	241	326	332	360	696	147	180	392	264	366
		Expected count	601.4	223.3	189.3	346	344.6	327.5	730.1	140.5	152.5	424.6	275.2	322.2
		Row %	55%	21.2%	23.8%	32%	32.6%	35.4%	68%	14.4%	17.6%	38.4%	25.8%	35.8%
		Adjusted residual	-3.8	-.9	5.7	-1.8	-1.1	3	-3.2	.8	3.3	-2.8	-1.1	4
		χ2 linear	26.911, *p* < .001			7.615, *p* = .006			12.661, *p* < .001			14.672, *p* < .001		
English attainment	High	Count	716	214	140	420	340	304	778	137	155	467	243	361
		Expected count	634.9	236.6	198.4	362.9	358.1	343	764.3	146	159.7	443.4	288.5	339.1
		Row %	66.9%	20%	13.1%	39.5%	32%	28.6%	72.7%	12.8%	14.5%	43.6%	22.7%	33.7%
		Adjusted residual	7.1	-2.3	-6.4	5.2	-1.6	-3.6	1.3	-1.1	-.6	2	-4.4	2
	Low	Count	580	269	265	325	395	400	792	163	173	443	349	335
		Expected count	661.1	246.4	206.6	382.1	376.9	361	805.7	154	168.3	466.6	303.5	356.9
		Row %	52.1%	24.1%	23.8%	29%	35.3%	35.7%	70.2%	14.5%	15.3%	39.3%	31%	29.7%
		Adjusted residual	-7.1	2.3	6.4	-5.2	1.6	3.6	-1.3	1.1	.6	-2	4.4	-2
		χ2 linear	58.175, *p* < .001			25.473, *p* < .001			1.131, *p* = .288			.008, *p* = .931		
Maths attainment	High	Count	683	214	145	414	350	282	773	140	133	469	261	317
		Expected count	616.1	231.3	194.5	356.5	354.1	335.4	746.3	144.9	154.9	433.3	283	330.7
		Row %	65.5%	20.5%	13.9%	39.6%	33.5%	27%	73.9%	13.4%	12.7%	44.8%	24.9%	30.3%
		Adjusted residual	5.8	-1.8	-5.5	5.2	-.4	-4.9	2.5	-.6	-2.6	3.1	-2.1	-1.3
	Low	Count	606	270	262	329	388	417	793	164	192	439	332	376
		Expected count	672.9	252.7	212.5	386.5	383.9	363.6	819.7	159.1	170.1	474.7	310	362.3
		Row %	53.3%	23.7%	23%	29%	34.2%	36.8%	69%	14.3%	16.7%	38.3%	28.9%	32.8%
		Adjusted residual	-5.8	1.8	5.5	-5.2	.4	4.9	-2.5	.6	2.6	-3.1	2.1	1.3
		χ2 linear	40.544, *p* < .001			34.17, *p* < .001			7.963, *p* = .005			6.188, *p* = .013		
Behavioural sanctions	Good	Count	1094	379	257	630	589	514	1280	234	228	727	466	552
		Expected count	1024.3	383	322.6	588.4	587.6	557	1243.1	239.7	259.3	722.7	470.3	552
		Row %	63.2%	21.9%	14.9%	36.4%	34%	29.7%	73.5%	13.4%	13.1%	41.7%	26.7%	31.6%
		Adjusted residual	7.3	-.5	-8.7	4.6	.2	-4.8	4.2	-.8	-4.6	.5	-.5	.0
	Bad	Count	211	109	154	118	158	194	302	71	102	192	132	150
		Expected count	280.7	105	88.4	159.6	159.4	151	338.9	65.3	70.7	196.3	127.7	150
		Row %	44.5%	23%	32.5%	25.1%	33.6%	41.3%	63.6%	14.9%	21.5%	40.5%	27.8%	31.6%
		Adjusted residual	-7.3	.5	8.7	-4.6	-.2	4.8	-4.2	.8	4.6	-.5	.5	.0
		χ2 linear	80.051, *p* < .001			29.245, *p* < .001			22.949, *p* < .001			.07, *p* = .791		

Table 8.5. Cross-tabulations between school performance, and weekly caffeine intake from energy drinks, cola, coffee, and tea at T2.

	Caffeine source		OR	95% CI	*p*
School attendance	Energy drinks	Low	.978	.752, 1.274	.872
		High	1.098	.822, 1.466	.528
		Wald	.54, *p* = .763		
	Cola	Low	1.026	.79, 1.333	.845
		High	1.425	1.077, 1.885	.013
		Wald	8.105, *p* = .017		
	Coffee	Low	.823	.603, 1.123	.218
		High	1.156	.86, 1.554	.336
		Wald	3.027, *p* = .22		
	Tea	Low	1.063	.823, 1.373	.64
		High	1.127	.876, 1.448	.352
		Wald	.874, *p* = .646		
English attainment	Energy drinks	Low	1.642	1.231, 2.189	.001
		High	1.557	1.138, 2.131	.006
		Wald	14.622, *p* = .001		
	Cola	Low	.962	.725, 1.275	.787
		High	.993	.733, 1.345	.963
		Wald	.088, *p* = .957		
	Coffee	Low	.775	.551, 1.09	.143
		High	.777	.563, 1.072	.124
		Wald	3.769, *p* = .152		
	Tea	Low	1.205	.913, 1.591	.189
		High	1.135	.864, 1.49	.362
		Wald	1.881, *p* = .39		
Maths attainment	Energy drinks	Low	1.365	1.023, 1.823	.035
		High	1.533	1.12, 2.099	.008
		Wald	8.889, *p* = .012		
	Cola	Low	1.035	.778, 1.376	.813
		High	1.111	.819, 1.507	.498
		Wald	.484, *p* = .785		
	Coffee	Low	.633	.446, .896	.01
		High	.581	.415, .814	.002
		Wald	14.009, *p* = .001		
	Tea	Low	1.537	1.162, 2.034	.003
		High	1.125	.855, 1.48	.401
		Wald	9.282, *p* = .01		
Behavioural sanctions	Energy drinks	Low	1.806	1.251, 2.608	.002
		High	1.676	1.121, 2.506	.012
		Wald	11.859, *p* = .003		
	Cola	Low	1.029	.69, 1.535	.89
		High	1.045	.69, 1.581	.837
		Wald	.043, *p* = .979		
	Coffee	Low	.583	.352, .966	.036
		High	1.155	.778, 1.716	.475
		Wald	5.654, *p* = .059		
	Tea	Low	1.251	.858, 1.824	.244
		High	1.206	.838, 1.734	.313
		Wald	1.658, *p* = .436		

Table 8.6. Multivariate associations between individual sources of caffeine and school performance at T1.

	Caffeine source		OR	95% CI	*p*
School attendance	Energy drinks	Low	1.067	.814, 1.399	.636
		High	1.641	1.195, 2.254	.002
		Wald	9.681, *p* = .008		
	Cola	Low	1.197	.921, 1.557	.179
		High	1.326	1.003, 1.752	.047
		Wald	4.063, *p* = .131		
	Coffee	Low	1.109	.813, 1.515	.513
		High	1.14	.826, 1.573	.425
		Wald	.913, *p* = .634		
	Tea	Low	1.098	.845, 1.428	.484
		High	1.342	1.041, 1.73	.023
		Wald	5.228, *p* = .073		
English attainment	Energy drinks	Low	1.255	.958, 1.643	.099
		High	1.803	1.309, 2.482	< .001
		Wald	13.32, *p* = .001		
	Cola	Low	1.322	1.016, 1.719	.037
		High	1.401	1.061, 1.85	.018
		Wald	6.623, *p* = .036		
	Coffee	Low	.953	.694, 1.309	.767
		High	.911	.66, 1.257	.571
		Wald	.362, *p* = .834		
	Tea	Low	1.393	1.071, 1.812	.014
		High	.97	.752, 1.251	.813
		Wald	8.015, *p* = .018		
Maths attainment	Energy drinks	Low	1.263	.966, 1.653	.088
		High	1.67	1.215, 2.297	.002
		Wald	10.517, *p* = .005		
	Cola	Low	1.307	1.008, 1.695	.044
		High	1.627	1.235, 2.145	.001
		Wald	12.015, *p* = .002		
	Coffee	Low	.939	.687, 1.286	.696
		High	1.168	.848, 1.609	.341
		Wald	1.218, *p* = .544		
	Tea	Low	1.263	.973, 1.64	.079
		High	1.299	1.009, 1.673	.042
		Wald	5.122, *p* = .077		
Behavioural sanctions	Energy drinks	Low	1.043	.75, 1.451	.803
		High	1.729	1.227, 2.435	.002
		Wald	10.856, *p* = .004		
	Cola	Low	1.256	.903, 1.746	.175
		High	1.215	.863, 1.712	.265
		Wald	2.011, *p* = .366		
	Coffee	Low	1.247	.857, 1.814	.248
		High	1.459	1.03, 2.066	.033
		Wald	5.052, *p* = .08		
	Tea	Low	1.009	.734, 1.387	.955
		High	.849	.622, 1.16	.304
		Wald	1.331, *p* = .514		

Table 8.7. Multivariate associations between individual sources of caffeine and school performance at T2.

associated with lower school performance. This was observed for each outcome variable at both time-points (other than maths attainment at T1). When investigated at the multivariate level, other than for behavioural sanctions, significant effects were observed at T2 but not at T1. It is considered likely that these differences may have been dependent upon the observations already discussed in Chapter 6 (see sections 6.3.1.1 and 6.4.3), i.e. that the sample at T2 was larger, and contained a higher proportion of children with a SEN status compared to that of T1.

Low school attendance at T2 was associated with the groups that consumed 250.1-500mg/w, 500.1-750mg/w, and > 1000mg/w. Although the overall association between total caffeine intake and English attainment was not significant at either time-point, that observed at T2 was difficult to explain as each of the caffeine consumption groups were at increased risk of achieving below average attainment compared to the control group (though the effect in the 750.1-1000mg/w group was only marginally significant). Higher risk of achieving below average maths attainment at T2 was also associated with each of the caffeine consumption conditions relative to the control. Taken together, these findings are comparable to those of James et al. (2011), who, using structural equation modelling, investigated the effects of caffeine, along with nicotine and alcohol, on academic performance in a large-scale study of Icelandic schoolchildren (N = 7377). A strong inverse relationship between caffeine use and academic attainment was found to emerge, 32% of which was explained by mediating effects of daytime sleepiness and other licit substance use.

Although caffeine consumption remained significantly associated with behavioural sanctions at both time-points, the effects differed slightly. In both cases higher risk occurred in the > 1000mg/w group, though at T2 similar effects were also observed in the 250.1-500mg/w and 500.1-750mg/w conditions (the latter effect being marginally significant). These findings echo those of Kristjánsson, Sigsúsdóttir, Frost, and James (2013), who reported caffeine to be associated with behavioural problems in adolescents, such as self-reported violence and conduct disorder.

When individual sources of caffeine were investigated, negative associations were observed between each source and school performance outcomes, although multivariate level effects were observed at T1 to suggest that coffee consumption might have been beneficial regarding maths attainment and behavioural sanctions (the latter effect being only marginally significant). These findings aside, though the effects varied between outcomes and time-points, the results broadly pointed to high caffeine consumption in general being associated with low school performance. That being said, caffeine from energy drinks appeared to be a particularly strong predictor, with seven of eight effects remaining significant at the multivariate level.

Taken together, the findings presented in this section are similar to those relating to mental health reported in Chapter 7. As with those findings, the ones presented here provide evidence of negative linear relationships between total caffeine intake and the outcome measures investigated. A further similarity is that these trends mainly reflected benefits in abstainers and/or very low consumers, and detriments in very high consumers. However, a number of negative effects relating to school performance were also observed at lower levels of caffeine intake.

8.3.2 Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

As Chapter 7 reported associations between the consumption of energy drinks and breakfast and mental health outcomes in the data from the Cornish Academies Project, the current section aims to investigate whether such effects also occur in relation to school performance. As with the method used in Chapter 7, breakfast frequency was dichotomised as ‘every day’ vs. ‘not every day’, and energy drinks frequency was dichotomised as ‘once a week or more’ vs. ‘less than once a week’. These variables were initially investigated in relation to the dichotomous school performance outcomes using Chi-square tests.

8.3.2.1 Individual Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

It was found that frequent consumption of breakfast was associated with above average school attendance, English and maths attainment, and low occurrences of behavioural sanctions at T2. At T1, however, the only effect that was significant was an association between frequent breakfast consumption and above average school attendance. Frequent consumption of energy drinks, on the other hand, was associated with below average school attendance and English and maths attainment, and increased occurrences of behavioural sanctions at both time-points. For $\chi 2$ values and cross-tabulations between the frequency of breakfast and energy drink consumption and the school performance outcomes at T1 and T2, see Table 8.8. At the multivariate level all effects remained the same, except that the association between energy drinks and school attendance at T1 was no longer significant. For ORs, 95% CIs, and *p* values, see Table 8.9.

8.3.2.2 Combined Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

In order to examine the combined effects of breakfast and energy drinks, the same consumption groups reported in Chapter 7 (i.e. breakfast every day/energy drinks less than once a week, breakfast every day/energy drinks once a week or more, breakfast not every day/energy drinks less than once a week, breakfast not every day/energy drinks once a week or more) were investigated in relation to the school performance outcomes using Chi-square tests. In a similar manner, for ease of reporting, these distinctions for both variables will henceforth be referred to as ‘frequent’ or ‘infrequent’. The analyses conducted showed that the combined effect of breakfast and energy drinks was significant for each of the four dependent variables at both time-points. For cross-tabulations and $\chi 2$ and *p* values at T1 and T2, see Tables 8.10 and 8.11, respectively.

Membership of the frequent breakfast/infrequent energy drinks condition was associated with above average school attendance, English and maths attainment, and good behaviour at both time-points. Likewise, membership of the infrequent breakfast/frequent energy drinks condition was associated with below average attendance, attainment, and bad behaviour at both T1 and T2 (though the effect relating to maths attainment at T1 was not significant).

Some differences were observed between variables and time-points for the frequent breakfast/frequent energy drinks and infrequent breakfast/infrequent energy drinks conditions. The frequent breakfast/frequent energy drinks condition was associated with bad behaviour at both time-points; however, it was also associated with below average English and maths attainment at T1, whereas no such relationships were observed at T2.

			Breakfast T1		Energy drinks T1		Breakfast T2		Energy drinks T2	
			Every day	Not every day	≥ once a week	< once a week	Every day	Not every day	≥ once a week	< once a week
School attendance	High	Count	538	470	249	754	654	559	241	965
		Expected count	508.5	499.5	271.1	731.9	583.1	629.9	293.6	912.4
		Row %	53.4%	46.6%	24.8%	75.2%	53.9%	46.1%	20%	80%
	Low	Count	468	518	285	688	429	611	304	729
		Expected count	497.5	488.5	262.9	710.1	499.9	540.1	251.4	781.6
		Row %	47.5%	52.5%	29.3%	70.7%	41.2%	58.8%	29.4%	70.6%
		$\chi2$	6.961, $p = .008$		4.993, $p = .025$		35.984, $p < .001$		26.955, $p < .001$	
English attainment	High	Count	485	472	220	728	574	513	202	879
		Expected count	480	477	257.2	690.8	523.3	563.7	262.3	818.7
		Row %	50.7%	49.3%	23.2%	76.8%	52.8%	47.2%	18.7%	81.3%
	Low	Count	496	503	306	685	502	646	337	803
		Expected count	501	498	268.8	722.2	552.7	595.3	276.7	863.3
		Row %	49.6%	50.4%	30.9%	69.1%	43.7%	56.3%	29.6%	70.4%
		$\chi2$	.207, $p = .649$		14.423, $p < .001$		18.429, $p < .001$		35.705, $p < .001$	
Maths attainment	High	Count	556	526	261	811	567	495	198	861
		Expected count	544.6	537.4	290.4	781.6	511.2	550.8	258.4	800.6
		Row %	51.4%	48.6%	24.3%	75.7%	53.4%	46.6%	18.7%	81.3%
	Low	Count	434	451	267	610	507	662	343	815
		Expected count	445.4	439.6	237.6	639.4	562.8	606.2	282.6	875.4
		Row %	49%	51%	30.4%	69.6%	43.4%	56.6%	29.6%	70.4%
		$\chi2$	1.072, $p = .3$		9.08, $p = .003$		22.376, $p < .001$		35.776, $p < .001$	
Behavioural sanctions	Good	Count	872	839	416	1278	895	872	343	1413
		Expected count	862.3	848.7	456.4	1237.6	849	918	428.4	1327.6
		Row %	51%	49%	24.6%	75.4%	50.7%	49.3%	19.5%	80.5%
	Bad	Count	136	153	118	170	189	300	204	282
		Expected count	145.7	143.3	77.6	210.4	235	254	118.6	367.4
		Row %	47.1%	52.9%	41%	59%	38.7%	61.3%	42%	58%
		$\chi2$	1.509, $p = .219$		33.696, $p < .001$		22.097, $p < .001$		103.938, $p < .001$	

Table 8.8. Cross-tabulations and $\chi2$ values for frequency of breakfast and energy drink consumption and school performance outcomes at T1 and T2.

	Time-point	Dietary predictor	OR	95% CI	*p*
School attendance	T1	Breakfast	1.311	1.057, 1.626	.014
		Energy drinks	1.048	.818, 1.342	.711
	T2	Breakfast	1.59	1.276, 1.981	< .001
		Energy drinks	1.402	1.071, 1.835	.014
English attainment	T1	Breakfast	1.214	.962, 1.533	.103
		Energy drinks	1.432	1.096, 1.871	.008
	T2	Breakfast	1.59	1.273, 1.986	< .001
		Energy drinks	1.543	1.176, 2.024	.002
Maths attainment	T1	Breakfast	1.2	.95, 1.516	.126
		Energy drinks	1.31	1.003, 1.711	.047
	T2	Breakfast	1.277	1.025, 1.589	.029
		Energy drinks	1.631	1.244, 2.138	< .001
Behavioural sanctions	T1	Breakfast	1.116	.816, 1.525	.492
		Energy drinks	1.651	1.188, 2.295	.003
	T2	Breakfast	1.384	1.055, 1.814	.019
		Energy drinks	2.061	1.541, 2.756	< .001

Table 8.9. Multivariate associations between breakfast and energy drink consumption and school performance at T1 and T2.

			Frequent breakfast/ infrequent energy drinks	Frequent breakfast/ frequent energy drinks	Infrequent breakfast/ infrequent energy drinks	Infrequent breakfast/ frequent energy drinks
School attendance	High	Count	438	93	314	154
		Expected count	406.1	94.4	323.4	175.1
		Row %	43.8%	9.3%	31.4%	15.4%
		Adjusted residual	2.9	-.2	-.9	-2.5
	Low	Count	362	93	323	191
		Expected count	393.9	91.6	313.6	169.9
		Row %	37.4%	9.6%	33.3%	19.7%
		Adjusted residual	-2.9	.2	.9	2.5
		$\chi 2$	10.86, $p = .013$			
English attainment	High	Count	406	69	319	150
		Expected count	380.8	89	307.5	166.7
		Row %	43%	7.3%	33.8%	15.9%
		Adjusted residual	2.3	-3.1	1.1	-2
	Low	Count	373	113	310	191
		Expected count	398.2	93	321.5	174.3
		Row %	37.8%	11.4%	31.4%	19.4%
		Adjusted residual	-2.3	3.1	-1.1	2
		$\chi 2$	16.144, $p = .001$			
Maths attainment	High	Count	457	87	350	172
		Expected count	431.1	101.6	346.5	186.7
		Row %	42.9%	8.2%	32.8%	16.1%
		Adjusted residual	2.4	-2.3	.3	-1.8
	Low	Count	328	98	281	168
		Expected count	353.9	83.4	284.5	153.3
		Row %	37.5%	11.2%	32.1%	19.2%
		Adjusted residual	-2.4	2.3	-.3	1.8
		$\chi 2$	10.754, $p = .013$			
Behavioural sanctions	Good	Count	709	144	564	270
		Expected count	685.4	159	547.8	294.8
		Row %	42%	8.5%	33.4%	16%
		Adjusted residual	3.1	-3.3	2.2	-4.2
	Bad	Count	93	42	77	75
		Expected count	116.6	27	93.2	50.2
		Row %	32.4%	14.6%	26.8%	26.1%
		Adjusted residual	-3.1	3.3	-2.2	4.2
		$\chi 2$	32.959, $p < .001$			

Table 8.10. Cross-tabulations and $\chi 2$ values for breakfast and energy drink consumption combinations and school performance outcomes at T1.

			Frequent breakfast/ infrequent energy drinks	Frequent breakfast/ frequent energy drinks	Infrequent breakfast/ infrequent energy drinks	Infrequent breakfast/ frequent energy drinks
School attendance	High	Count	567	85	398	156
		Expected count	486.6	94.8	426.2	198.3
		Row %	47%	7%	33%	12.9%
		Adjusted residual	6.9	-1.6	-2.5	-4.8
	Low	Count	336	91	393	212
		Expected count	416.4	81.2	364.8	169.7
		Row %	32.6%	8.8%	38.1%	20.5%
		Adjusted residual	-6.9	1.6	2.5	4.8
		$\chi 2$	54.653, $p < .001$			
English attainment	High	Count	496	76	383	126
		Expected count	436.8	85.2	382.2	176.8
		Row %	45.9%	7%	35.4%	11.7%
		Adjusted residual	5.1	-1.5	.1	-5.8
	Low	Count	401	99	402	237
		Expected count	460.2	89.8	402.8	186.2
		Row %	35.2%	8.7%	35.3%	20.8%
		Adjusted residual	-5.1	1.5	-.1	5.8
		$\chi 2$	46.002, $p < .001$			
Maths attainment	High	Count	490	75	371	123
		Expected count	426.8	84.6	374.2	173.5
		Row %	46.3%	7.1%	35%	11.6%
		Adjusted residual	5.5	-1.5	-.3	-5.8
	Low	Count	403	102	412	240
		Expected count	466.2	92.4	408.8	189.5
		Row %	34.8%	8.8%	35.6%	20.7%
		Adjusted residual	-5.5	1.5	.3	5.8
		$\chi 2$	48.213, $p < .001$			
Behavioural sanctions	Good	Count	778	115	635	228
		Expected count	706.8	139.5	621.4	288.4
		Row %	44.3%	6.5%	36.2%	13%
		Adjusted residual	7.4	-4.6	1.5	-8.4
	Bad	Count	124	63	158	140
		Expected count	195.2	38.5	171.6	79.6
		Row %	25.6%	13%	32.6%	28.9%
		Adjusted residual	-7.4	4.6	-1.5	8.4
		$\chi 2$	112.755, $p < .001$			

Table 8.11. Cross-tabulations and $\chi 2$ values for breakfast and energy drink consumption combinations and school performance outcomes at T2.

The infrequent breakfast/infrequent energy drinks condition was associated with good behaviour at T1, although the effect was not significant at T2. At T2 however, this combination was associated with low school attendance, though no such effect was observed at T1. At the multivariate level, the combined effect of breakfast and energy drinks in relation to school attendance was not significant at T1, Wald = 5.067, p = .167, though the infrequent breakfast/infrequent energy drinks condition did achieve marginally lower attendance than did the control group, OR = 1.271, 95% CI [.99, 1.633], p = .06. At T2 the overall effect was significant, Wald = 22.939, $p <$ .001, and both groups that did not consume breakfast every day were at significantly increased risk of achieving below average attendance. In addition, the frequent breakfast/frequent energy drinks condition was also at increased risk, though the effect was only marginally significant, OR = 1.524, 95% CI [.993, 2.338], p = .054. For ORs and 95% CIs for the analyses of school attendance at T1 and T2, see Figures 8.9 and 8.10, respectively.

The combined effect of breakfast and energy drinks in relation to English attainment was significant at both T1, Wald = 10.744, p = .013, and T2, Wald = 23.98, p < .001. At T1, the effect reflected increased risk of below average English attainment occurring in each of the experimental groups compared to the control, though the effect relating to the infrequent breakfast/infrequent energy drinks condition was only marginally significant, OR = 1.307, 95% CI [.997, 1.713], p = .053. At T2, both groups that did not eat breakfast every day were at increased risk. For ORs and 95% CIs at T1 and T2, see Figures 8.11 and 8.12, respectively.

The combined effect of energy drinks and breakfast in relation to maths attainment was not significant at T1, Wald = 5.325, p = .149, though members of the infrequent breakfast/frequent energy drinks condition were at significantly higher risk of achieving low performance, OR = 1.467, 95% CI [1.042, 2.065], p = .028. At T2 the overall effect was significant, Wald = 15.23, p = .002. As with T1, the infrequent breakfast/frequent energy drinks condition was at significantly increased risk of low attainment. However, in this case the frequent breakfast/frequent energy drinks condition was also at increased risk, though the effect was marginally significant, OR = 1.513, 95% CI [.987, 2.319], p = .057. For ORs and 95% CIs for the multivariate analyses of maths attainment at T1 and T2, see Figures 8.13 and 8.14, respectively.

The effect relating to behavioural sanctions was significant at both T1, Wald = 8.957, p = .03, and T2, Wald = 27.492, p < .001. At T1 the effect reflected the frequent breakfast/frequent energy drinks and infrequent breakfast/frequent energy drinks groups being at increased risk of exhibiting bad behaviour, although the former effect was only marginally significant, OR = 1.607, 95% CI [.97, 2.662], p = .065. At T2, all three of the experimental conditions were at increased risk compared to the control, though the effect relating to the infrequent breakfast/infrequent energy drinks condition was only marginally significant, OR = 1.376, 95 CI [.994, 1.905], p = .055. For ORs and 95% CIs for the multivariate analyses of behavioural sanctions at T1 and T2, see Figures 8.15 and 8.16, respectively.

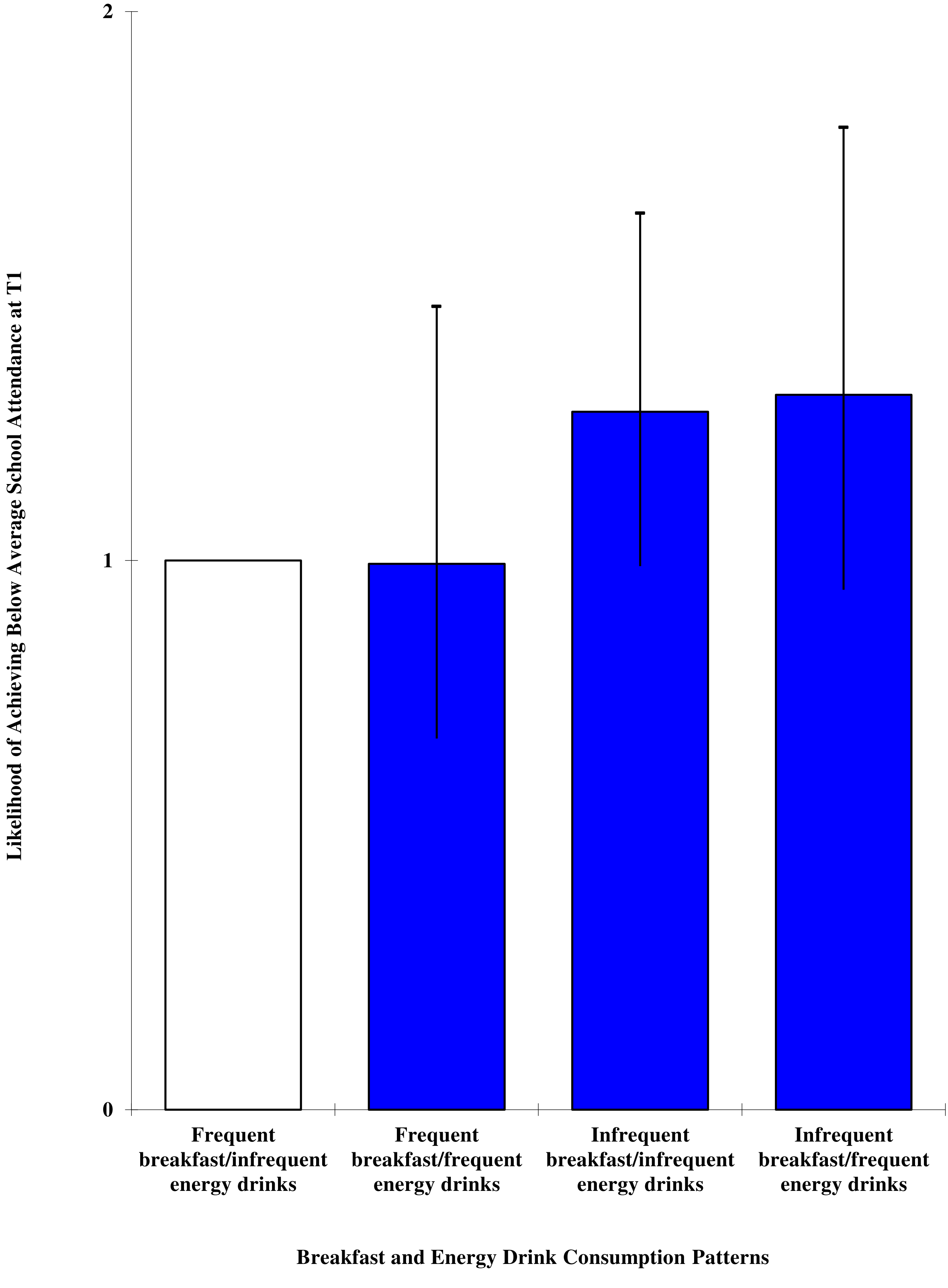

Figure 8.9. Likelihood of achieving below average school attendance as a function of breakfast and energy drink combinations at T1.

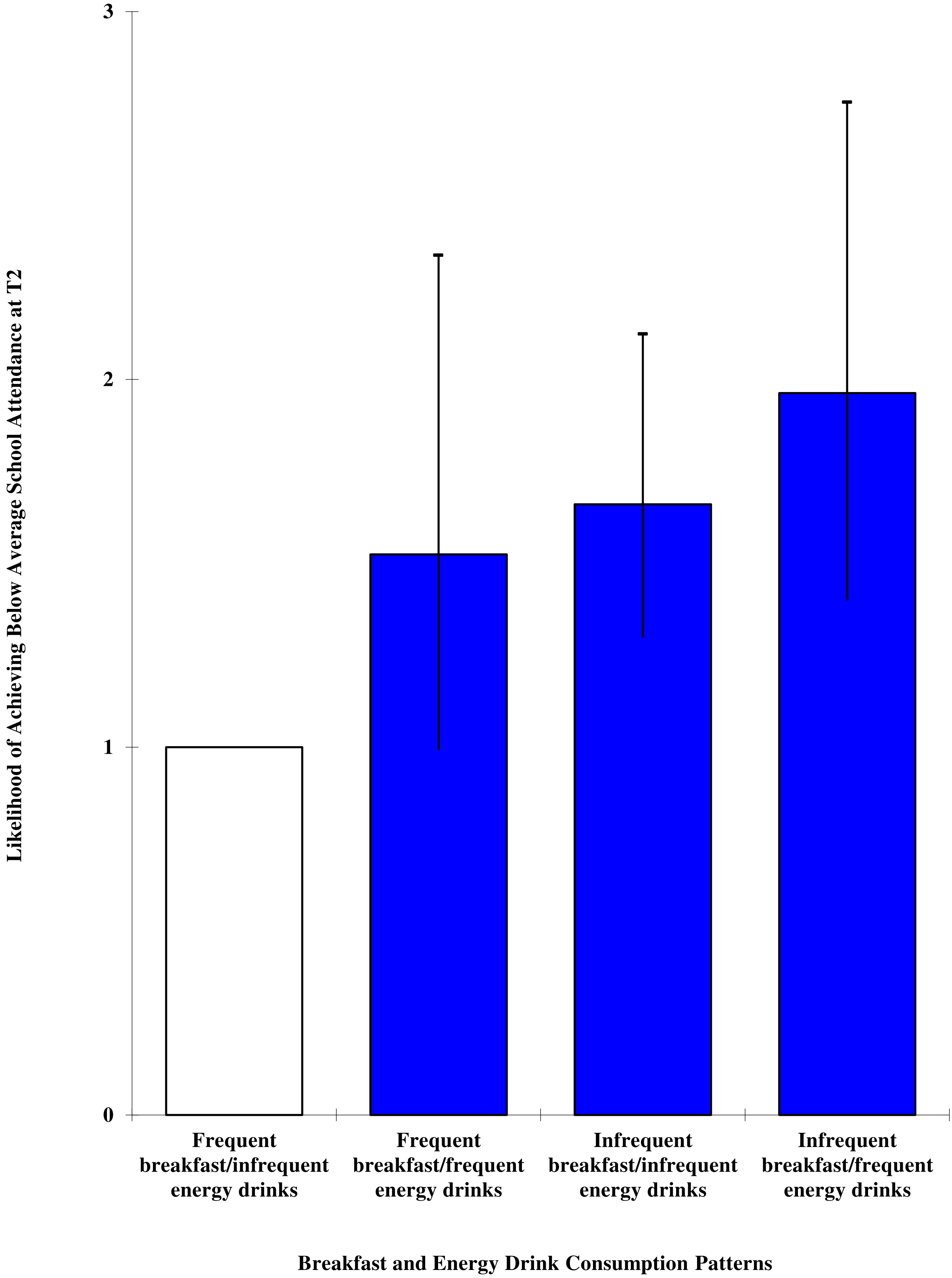

Figure 8.10. Likelihood of achieving below average school attendance as a function of breakfast and energy drink combinations at T2.

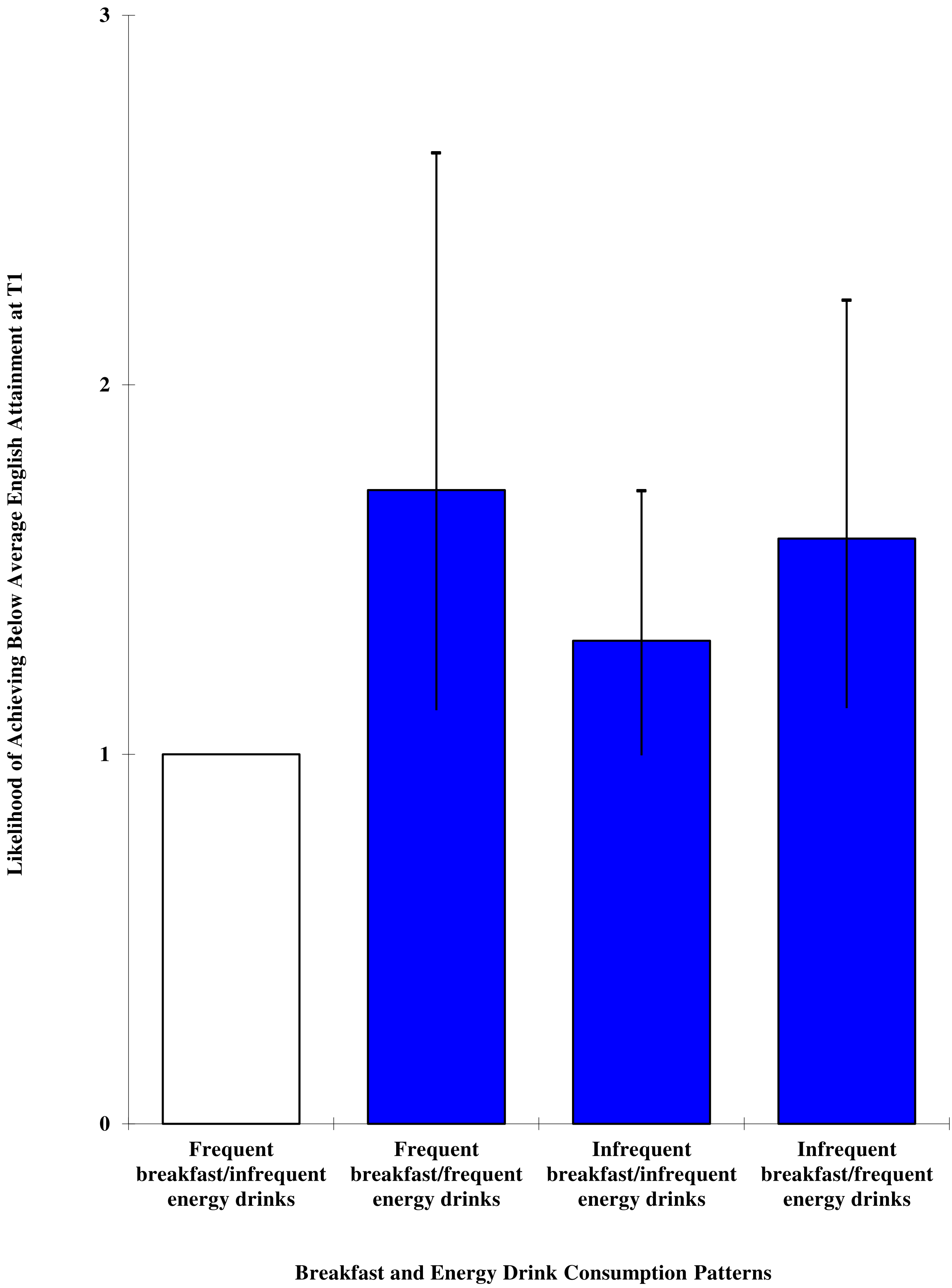

Figure 8.11. Likelihood of achieving below average English attainment as a function of breakfast and energy drink combinations at T1.

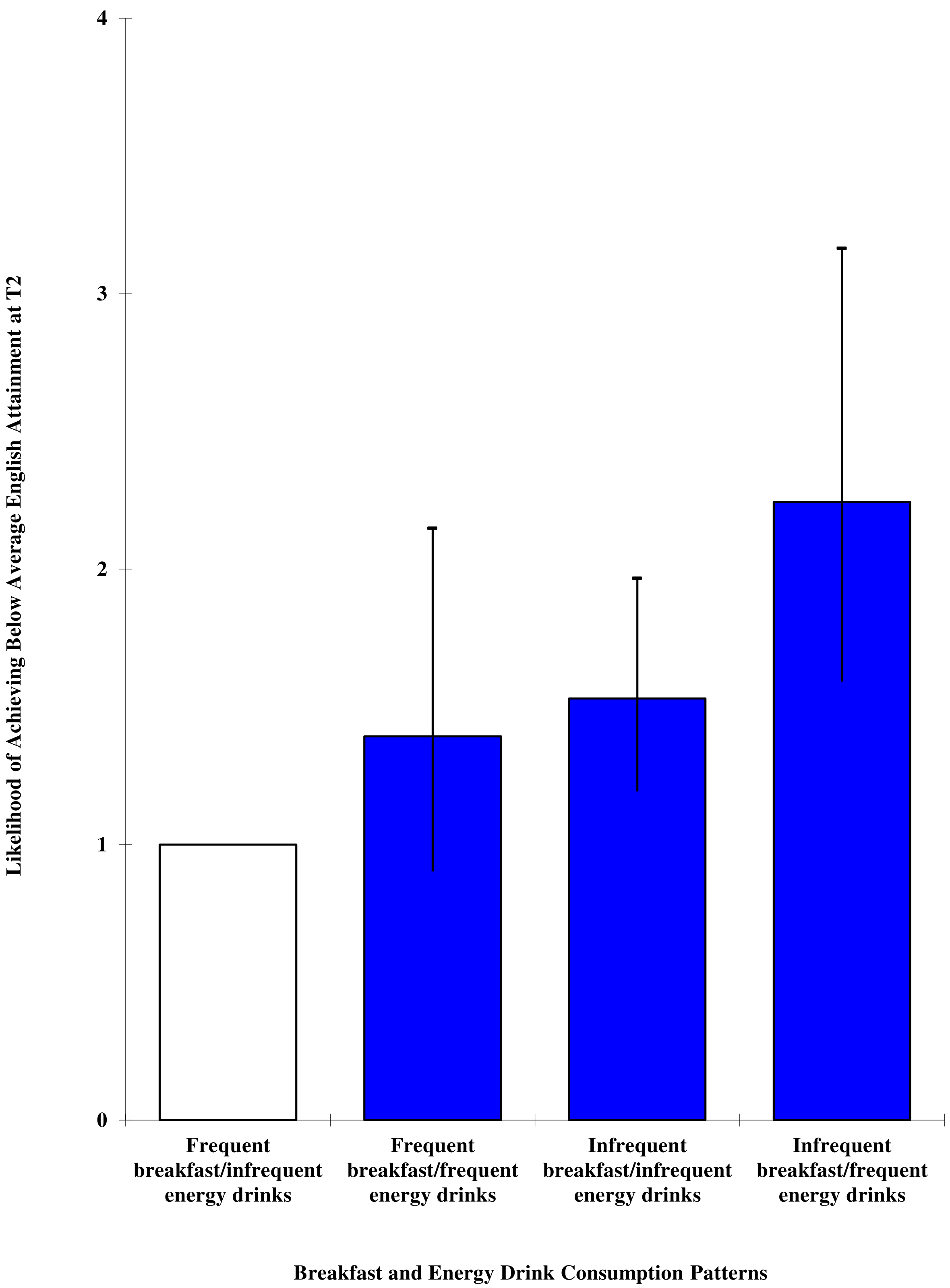

Figure 8.12. Likelihood of achieving below average English attainment as a function of breakfast and energy drink combinations at T2.

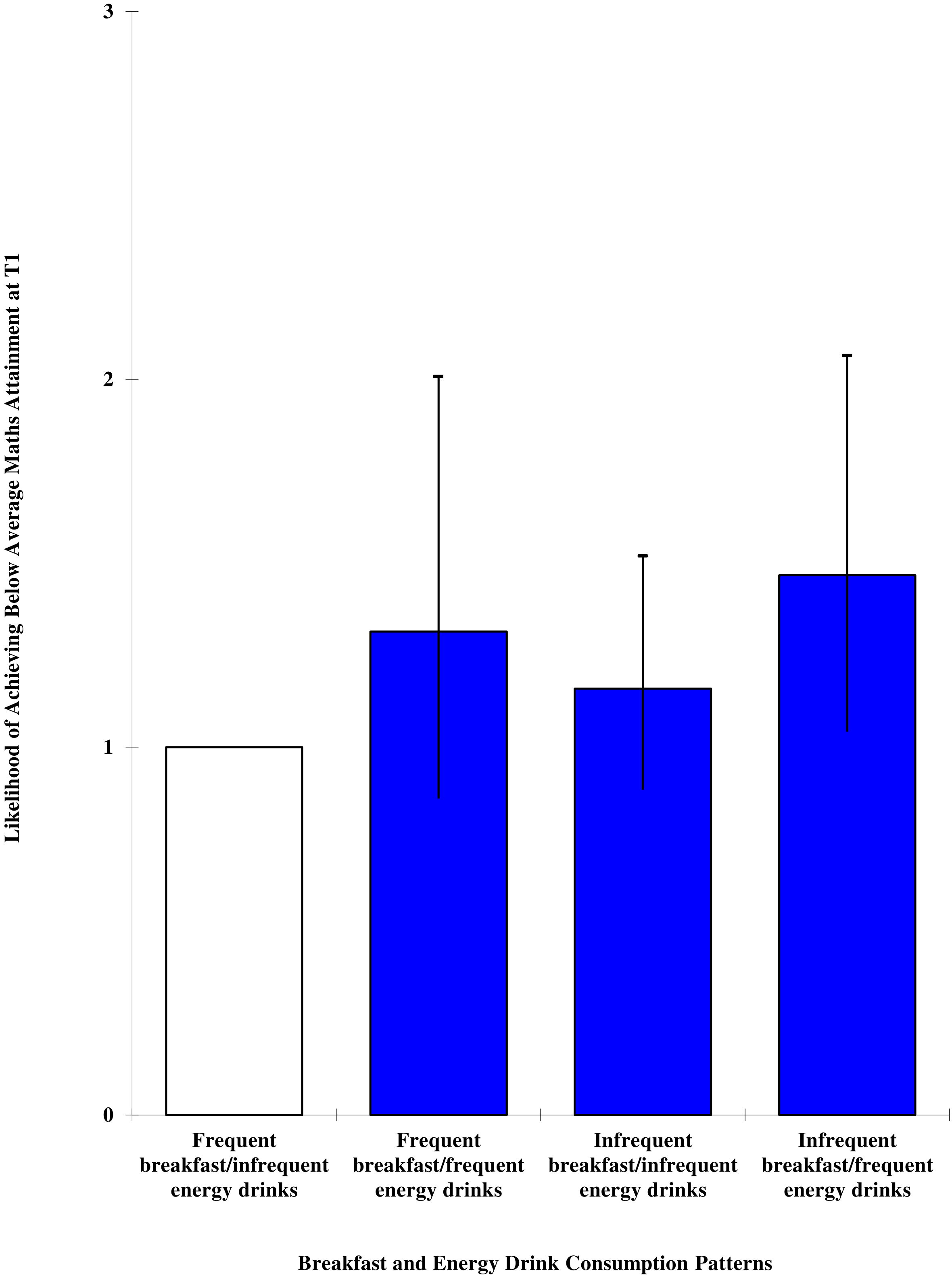

Figure 8.13. Likelihood of achieving below average maths attainment as a function of breakfast and energy drink combinations at T1.

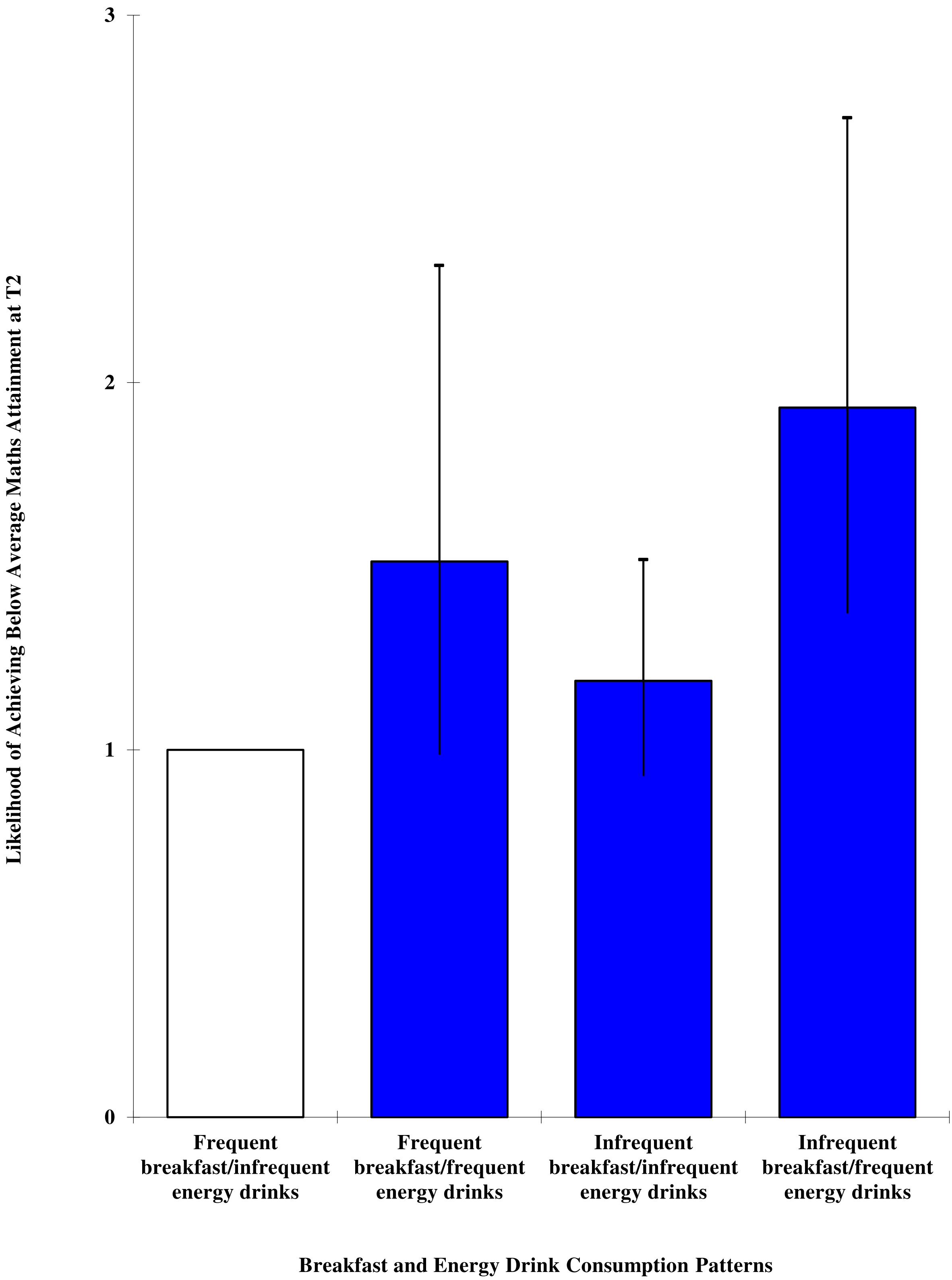

Figure 8.14. Likelihood of achieving below average maths attainment as a function of breakfast and energy drink combinations at T2.

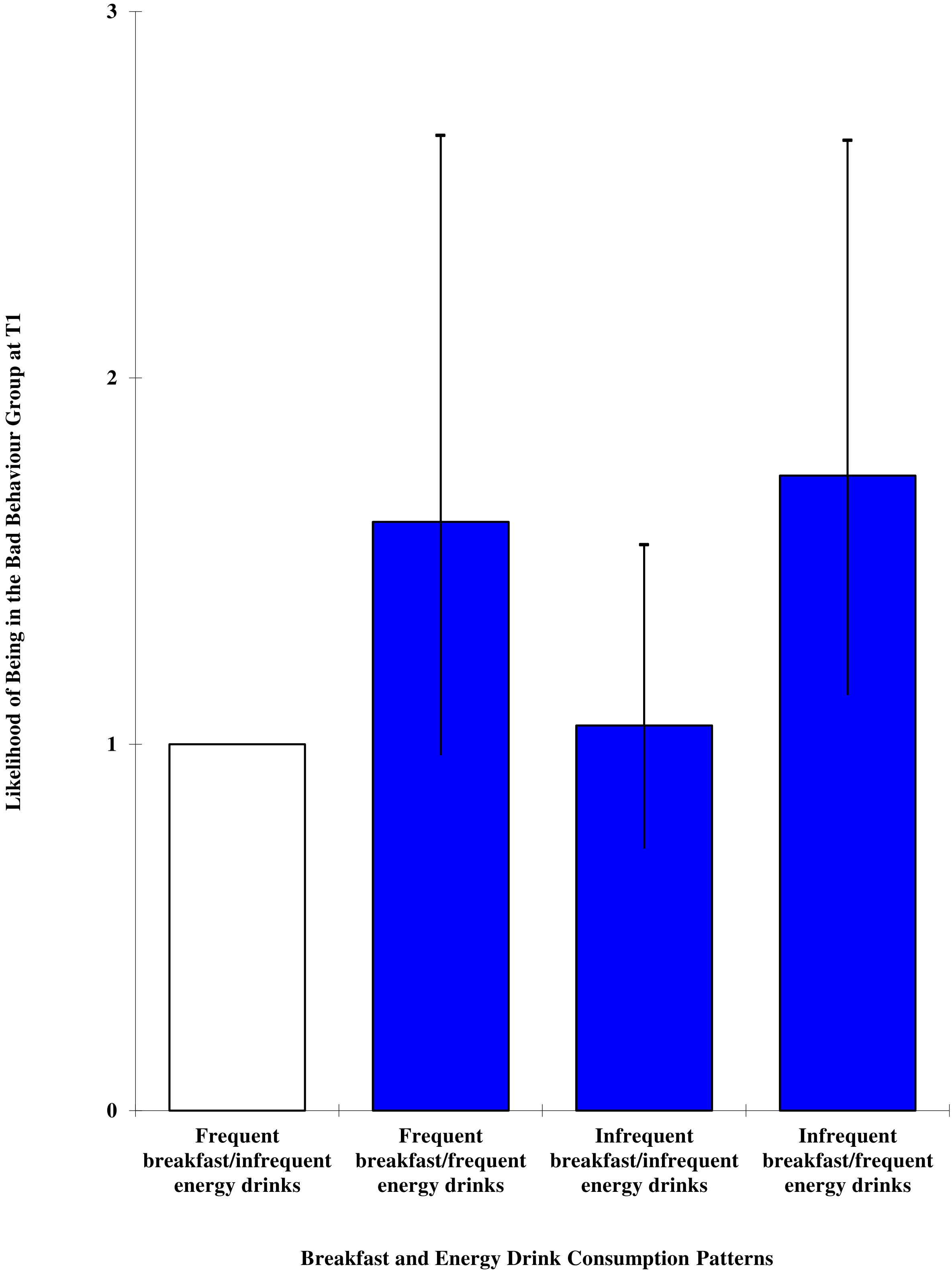

Figure 8.15. Likelihood of being a member of the bad behaviour group as a function of breakfast and energy drink combinations at T1.

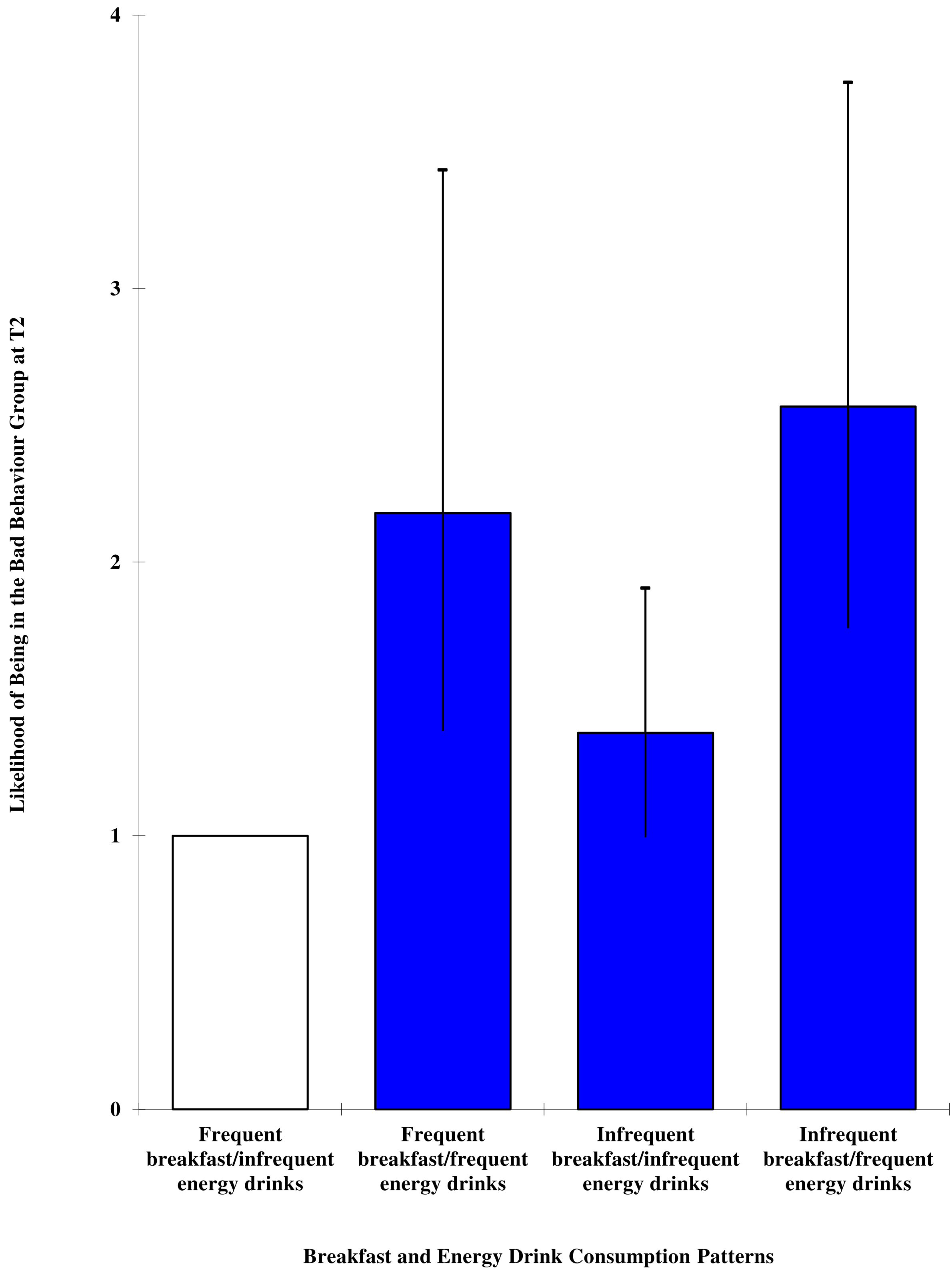

Figure 8.16. Likelihood of being a member of the bad behaviour group as a function of breakfast and energy drink combinations at T2.

8.3.2.3 Discussion of Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

Although there were inconsistencies between outcomes and across time-points, eating breakfast every day was associated with positive outcomes, whereas frequent energy drink use was associated with negative outcomes. The findings relating to breakfast likely reflect the generally beneficial effects associated with its consumption (see Hoyland et al., 2009). The observation that energy drink use was associated with low school attainment is similar to findings from literature discussed in Chapter 2 (i.e. Azagba, et al., 2014; Martz et al., 2015; Pettit & DeBarr, 2011).

A combined effect of energy drinks and breakfast was observed in relation to each school performance outcome at both time-points. All of these effects remained significant at the multivariate level except for those relating to school attendance and maths at T1. Taken together, although there were some inconsistencies between time-points, the general findings were that the omission of breakfast and the frequent consumption of energy drinks were both associated with undesirable school performance outcomes. Not surprisingly therefore, the infrequent breakfast/frequent energy drinks condition tended to be associated with the highest risk, suggesting that this pattern of diet may be a particular cause for concern.

It is possible that the effects observed here are indirect outcomes of insufficient sleep. Poor sleep duration and/or quality may lead to problems waking up in time to have breakfast before school, and children may then use energy drinks to help wake up, or as a substitute for breakfast itself (Richardson, 2013). Furthermore, as eating breakfast is generally associated with positive effects in children and adolescents (e.g. Mahoney et al., 2005), negative effects such as those observed here are likely to in part reflect a reversal of the benefits associated with its consumption.

8.3.3 Associations Between DABS Factors and School Performance

8.3.3.1 Univariate Associations Between DABS Factors and School Performance

In order to further investigate dietary associations with school performance, between-subjects t-tests were performed to determine whether consumption of the

DABS factors varied between the different school performance groups. The outcomes of these t-tests are provided in Table 8.12. The main observation of interest to the current research was that significantly higher consumption of Caffeinated Soft Drinks/Gum was found in each of the low school performance groups (other than low school attendance at T1).

		Junk Food		**Caffeinated Soft Drinks/Gum**		**Healthy Foods**		**Hot Caffeinated Beverages**	
		t	*p*	*t*	*p*	*t*	*p*	*t*	*p*
School attendance	T1	.492	.623	-1.449	.148	-.18	.857	-1.529	.127
	T2	2.873	.004	-5.928	< .001	2.959	.003	-4.853	< .001
English attainment	T1	-1.321	.187	-2.781	.005	-1.109	.268	.033	.974
	T2	-1.698	.09	-7.624	< .001	-.093	.926	-.224	.823
Maths attainment	T1	-1.195	.232	-3.721	< .001	-.803	.422	1.838	.066
	T2	-1.303	.193	-7.426	< .001	-.153	.878	-2.098	.036
Behavioural sanctions	T1	-3.207	.001	-4.892	< .001	1.307	.191	-1.777	.076
	T2	-1.349	.178	-9.368	< .001	1.542	.124	-3.241	.001

Table 8.12. Differences between DABS factor scores as a function of high and low school performance.

8.3.3.2 Multivariate Associations Between DABS Factors and School Performance

In order to explore the observed relationships between the DABS factors and school performance outcomes at the multivariate level, binary logistic regression analyses were conducted. These analyses found that each of the associations between Caffeinated Soft Drinks/Gum consumption that were observed at the univariate level remained significant once other dietary, demographic, and lifestyle covariates had been controlled for statistically. Furthermore, although no such univariate association had been observed, high consumption of Caffeinated Soft Drinks/Gum was marginally related to low school attendance at T1. For ORs, 95% CIs, and *p* values, see Table 8.13.

8.3.3.3 Discussion of Associations Between DABS Factors and School Performance

Chapter 7 reported that high consumption of the Caffeinated Soft Drinks/Gum factor (i.e. energy drinks, cola, and chewing gum) was associated with poor mental health outcomes. The current chapter found similar relationships with school performance in both cross-sections of data. At the multivariate level, each effect at each time-point was found to remain significant except for that of attendance at T1.

	Time-point	DABS factor	OR	95% CI	*p*
School attendance	T1	Junk Food	.971	.871, 1.084	.604
		Caffeinated Soft Drinks/Gum	1.108	.99, 1.24	.075
		Healthy Foods	1.01	.901, 1.131	.867
		Hot Caffeinated Beverages	1.056	.947, 1.178	.324
	T2	Junk Food	.852	.759, .956	.006
		Caffeinated Soft Drinks/Gum	1.295	1.149, 1.461	< .001
		Healthy Foods	.88	.781, .99	.034
		Hot Caffeinated Beverages	1.172	1.041, 1.318	.008
English attainment	T1	Junk Food	1.047	.93, 1.178	.45
		Caffeinated Soft Drinks/Gum	1.163	1.03, 1.312	.015
		Healthy Foods	.953	.842, 1.078	.444
		Hot Caffeinated Beverages	.99	.88, 1.113	.863
	T2	Junk Food	1.041	.926, 1.17	.502
		Caffeinated Soft Drinks/Gum	1.436	1.271, 1.622	< .001
		Healthy Foods	.963	.854, 1.087	.544
		Hot Caffeinated Beverages	1.018	.908, 1.14	.763
Maths attainment	T1	Junk Food	1.044	.928, 1.175	.471
		Caffeinated Soft Drinks/Gum	1.222	1.083, 1.379	.001
		Healthy Foods	1.041	.919, 1.179	.531
		Hot Caffeinated Beverages	.878	.778, .991	.035
	T2	Junk Food	1.063	.947, 1.194	.299
		Caffeinated Soft Drinks/Gum	1.423	1.259, 1.609	< .001
		Healthy Foods	1.024	.909, 1.153	.699
		Hot Caffeinated Beverages	1.11	.991, 1.244	.071
Behavioural sanctions	T1	Junk Food	1.142	.977, 1.335	.095
		Caffeinated Soft Drinks/Gum	1.42	1.22, 1.653	< .001
		Healthy Foods	.921	.785, 1.081	.312
		Hot Caffeinated Beverages	1.071	.923, 1.242	.367
	T2	Junk Food	1.001	.875, 1.145	.993
		Caffeinated Soft Drinks/Gum	1.503	1.313, 1.72	< .001
		Healthy Foods	.941	.816, 1.085	.403
		Hot Caffeinated Beverages	1.153	1.015, 1.31	.029

Table 8.13. Likelihood of achieving below average school performance as a function of intake of each DABS factor at T1 and T2.

8.3.4 Analysis of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the School Performance Outcomes

8.3.4.1 Chi-Square Analysis of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the School Performance Outcomes

As the previous section determined that high consumption of the Caffeinated Soft Drinks/Gum DABS factor was consistently associated with low school performance, it was deemed useful to examine the effects of its components separately, as well as in combination with each other. To do this, the variable used to assess the combined effects of low/high consumption of energy drinks, cola, and chewing gum described in Chapter 7 (see section 7.3.5.1) was again used here. For $\chi2$ values and cross-tabulations between energy drinks, cola, and gum combinations and school performance outcomes at T1 and T2, see Tables 8.14 and 8.15, respectively.

The major finding of these analyses was that being a low consumer of all three products was associated with above average school performance, and being a high consumer of all three products was associated with below average school performance. The only outcome for which this did not hold up was school attendance at T1, though it should also be noted that high consumption of all three products was only marginally associated with low maths attainment at T1. In addition, some other significant effects were observed. Being a high consumer of cola only was associated with good behaviour at both time-points. Being a high consumer of gum only was associated with above average English attainment, maths attainment, and good behaviour at T2, although trends in the same direction for attendance, English attainment, and behavioural sanctions at T1 were not significant. High consumption of energy drinks/cola was associated with bad behaviour at T2, though no such effect was observed at T1.

8.3.4.2 Discussion of the Individual Components of the Caffeinated Soft Drinks/Gum DABS Factor in Relation to the School Performance Outcomes

In a similar manner to analyses examining mental health outcomes presented in Chapter 7, the main finding from the current section was that a combination of low consumption of all three products comprising the Caffeinated Soft Drinks/Gum DABS factor was associated with above average school performance, whereas high consumption of all three was associated with below average school performance. Furthermore, as positive effects were associated with both high cola and high gum consumption in isolation from the other products, it may be that the individual components of the Caffeinated Soft Drinks/Gum factor are not themselves problematic per se. Of particular interest was the observation that the high gum only condition was associated with high English and maths attainment at T2, findings that

			Low in all	High energy drinks	High cola only	High gum only	Energy drinks & cola	Energy drinks & gum	Cola & gum	High in all
School attendance	High	Count	170	83	86	91	109	75	84	276
		Expected count	157.4	84.3	88.4	80.2	111.9	76.7	84.8	290.3
		Row %	17.5%	8.5%	8.8%	9.3%	11.2%	7.7%	8.6%	28.3%
		Adjusted residual	1.6	-.2	-.4	1.8	-.4	-.3	-.1	-1.4
	Low	Count	138	82	87	66	110	75	82	292
		Expected count	150.6	80.7	84.6	76.8	107.1	73.3	81.2	277.7
		Row %	14.8%	8.8%	9.3%	7.1%	11.8%	8%	8.8%	31.3%
		Adjusted residual	-1.6	.2	.4	-1.8	.4	.3	.1	1.4
		$\chi 2$	6.875, p = .442							
English attainment	High	Count	165	80	93	85	110	65	76	248
		Expected count	149	80.4	82.4	74.5	107	73	80.4	275.3
		Row %	17.9%	8.7%	10.1%	9.2%	11.9%	7%	8.2%	26.9%
		Adjusted residual	2	-.1	1.7	1.8	.4	-1.4	-.7	-2.8
	Low	Count	137	83	74	66	107	83	87	310
		Expected count	153	82.6	84.6	76.5	110	75	82.6	282.7
		Row %	14.5%	8.8%	7.8%	7%	11.3%	8.8%	9.2%	32.7%
		Adjusted residual	-2	.1	-1.7	-1.8	-.4	1.4	.7	2.8
		$\chi 2$	16.734, p = .019							
Maths attainment	High	Count	191	94	97	89	115	76	84	288
		Expected count	166.2	89.1	94.7	85.3	119.4	81.4	90.8	307.1
		Row %	18.5%	9.1%	9.4%	8.6%	11.1%	7.4%	8.1%	27.9%
		Adjusted residual	3.1	.8	.4	.6	-.6	-.9	-1.1	-1.9
	Low	Count	111	68	75	66	102	72	81	270
		Expected count	135.8	72.9	77.3	69.7	97.6	66.6	74.2	250.9
		Row %	13.1%	8%	8.9%	7.8%	12.1%	8.5%	9.6%	32%
		Adjusted residual	-3.1	-.8	-.4	-.6	.6	.9	1.1	1.9
		$\chi 2$	14.247, p = .047							
Behavioural sanctions	Good	Count	281	144	160	143	191	128	144	452
		Expected count	264.7	140.9	150.4	135.8	189	128.9	142.6	490.7
		Row %	17.1%	8.8%	9.7%	8.7%	11.6%	7.8%	8.8%	27.5%
		Adjusted residual	2.9	.7	2.2	1.7	.4	-.2	.3	-5.6
	Bad	Count	27	20	15	15	29	22	22	119
		Expected count	43.3	23.1	24.6	22.2	31	21.1	23.4	80.3
		Row %	10%	7.4%	5.6%	5.6%	10.8%	8.2%	8.2%	44.2%
		Adjusted residual	-2.9	-.7	-2.2	-1.7	-.4	.2	-.3	5.6
		$\chi 2$	36.687, p < .001							

Table 8.14. Cross-tabulations between energy drinks, cola, and chewing gum consumption combinations and school performance outcomes at T1.

			Low in all	High energy drinks	High cola only	High gum only	Energy drinks & cola	Energy drinks & gum	Cola & gum	High in all
School attendance	High	Count	222	84	117	108	128	107	111	270
		Expected count	197.6	82.9	110.9	100.7	138.9	112.5	99.1	304.3
		Row %	19.4%	7.3%	10.2%	9.4%	11.2%	9.3%	9.7%	23.5%
		Adjusted residual	2.8	.2	.9	1.1	-1.5	-.8	1.8	-3.4
	Low	Count	145	70	89	79	130	102	73	295
		Expected count	169.4	71.1	95.1	86.3	119.1	96.5	84.9	260.7
		Row %	14.8%	7.1%	9.1%	8%	13.2%	10.4%	7.4%	30%
		Adjusted residual	-2.8	-.2	-.9	-1.1	1.5	.8	-1.8	3.4
		$\chi 2$	22.325, $p = .002$							
English attainment	High	Count	226	72	109	108	122	94	97	213
		Expected count	179.2	75.3	100.9	91.6	125.1	102.9	90.1	275.8
		Row %	21.7%	6.9%	10.5%	10.4%	11.7%	9%	9.3%	20.5%
		Adjusted residual	5.4	-.6	1.2	2.5	-.4	-1.3	1.1	-6.2
	Low	Count	138	81	96	78	132	115	86	347
		Expected count	184.8	77.7	104.1	94.4	128.9	106.1	92.9	284.2
		Row %	12.9%	7.5%	8.9%	7.3%	12.3%	10.7%	8%	32.3%
		Adjusted residual	-5.4	.6	-1.2	-2.5	.4	1.3	-1.1	6.2
		$\chi 2$	62.226, $p < .001$							
Maths attainment	High	Count	225	78	107	103	111	99	89	208
		Expected count	175	74	98.6	89.9	122.8	101	87.5	271.2
		Row %	22.1%	7.6%	10.5%	10.1%	10.9%	9.7%	8.7%	20.4%
		Adjusted residual	5.8	.7	1.2	2	-1.6	-.3	.2	-6.2
	Low	Count	137	75	97	83	143	110	92	353
		Expected count	187	79	105.4	96.1	131.2	108	93.5	289.8
		Row %	12.6%	6.9%	8.9%	7.6%	13.1%	10.1%	8.4%	32.4%
		Adjusted residual	-5.8	-.7	-1.2	-2	1.6	.3	-.2	6.2
		$\chi 2$	63.978, $p < .001$							
Behavioural sanctions	Good	Count	331	122	177	164	189	163	151	379
		Expected count	288	122	161.3	146.4	203	165.2	144	446.1
		Row %	19.7%	7.3%	10.6%	9.8%	11.3%	9.7%	9%	22.6%
		Adjusted residual	6	.0	2.8	3.3	-2.3	-.4	1.3	-8
	Bad	Count	35	33	28	22	69	47	32	188
		Expected count	78	33	43.7	39.6	55	44.8	39	120.9
		Row %	7.7%	7.3%	6.2%	4.8%	15.2%	10.4%	7%	41.4%
		Adjusted residual	-6	.0	-2.8	-3.3	2.3	.4	-1.3	8
		$\chi 2$	100.972, $p < .001$							

Table 8.15. Cross-tabulations between energy drinks, cola, and chewing gum consumption combinations and school performance outcomes at T2.

echo previous reports that chewing gum might improve examination performance (Allen et al., 2006; Johnston et al., 2012). Taken together, these observations provide support for the idea put forward in Chapter 7, that the Caffeinated Soft Drinks/Gum factor represents a pervasive dietary/behavioural pattern that is associated with undesirable outcomes.

It should be noted that no benefits were associated with any of the conditions in which energy drinks were consumed in high amounts. This perhaps implies that energy drink use is more strongly associated with low school performance than are the high consumption of cola or gum. However, energy drink use in isolation was not related to any negative outcomes. Possible reasons for this are: 1) that high consumption of energy drinks in absence of the high consumption of either cola or gum was relatively uncommon (8.5% and 7.3% at T1 and T2, respectively), reducing the likelihood of observing significant effects, and 2) that the negative associations with school performance may reflect the result of a dietary/behavioural pattern rather than the influences of particular products. If this latter point is true, it might be that energy drink use is simply a stronger indication of adherence to this pattern than are the consumption of cola or chewing gum.

8.4 General Discussion

The current chapter aimed to investigate cross-sectional associations between diet and the school performance outcomes of attendance, English attainment, maths attainment, and number of behavioural sanctions accrued throughout the school year. As findings from Chapter 7 suggested that high weekly caffeine intake, a combination of energy drink consumption and breakfast omission, and high consumption of the Caffeinated Soft Drinks/Gum DABS factor may be associated with negative outcomes, particular attention was paid to these dietary patterns in the current chapter.

8.4.1 Dietary Patterns Associated With Poor School Performance

8.4.1.1 High Consumption of Caffeine

Consistent associations between total weekly caffeine intake and school performance were observed. These reflected positive outcomes in low/non consumers, and negative outcomes in high consumers. However, although consumption of > 1000mg/w tended to be associated with the highest risk of low performance, many of the effects were found to occur at lower intake levels, somewhat akin to the relationship between caffeine and depression reported in Chapter 7. In a similar manner to the relationships observed in Chapter 7, a further analysis suggested general caffeine consumption to be the strongest predictor, and that the source from which it was acquired was of less importance. That being said, consumption of caffeine from energy drinks was associated with all of the outcome measures at both time-points, and each relationship remained significant at the multivariate level other than that relating to school attendance at T1.

8.4.1.2 Energy Drink Consumption and Breakfast Omission

Although there were occasions on which effects were not significant, almost all univariate and multivariate analyses found breakfast omission and frequent energy drink consumption to be associated with poor school performance. Combined effects of these two dietary variables were also observed in relation to each of the school performance outcomes at both time-points, and all except those relating to attendance and maths at T1 remained significant after controlling for covariates. Some effects (e.g. school attendance) appeared to be associated more with the omission of breakfast, whereas others (e.g. maths attainment, behavioural sanctions) appeared to be associated more with the frequent consumption of energy drinks. The effects relating to English attainment were less clear, appearing to mainly reflect energy drink consumption at T1 and breakfast omission at T2. Taken together however, these findings suggest that both breakfast omission and frequent energy drink consumption may be cause for concern, and that a combination of the two practices is likely to be associated with the least desirable outcomes.

8.4.1.3 High Consumption of Caffeinated Soft Drinks/Gum

High consumption of the Caffeinated Soft Drinks/Gum DABS factor was consistently associated with poor school performance. In fact, significant univariate and multivariate associations were observed between this factor and each of the school performance outcomes at both time-points, other than attendance at T1. A closer inspection of the individual components suggested that a combination of high consumption of energy drinks, cola, and chewing gum was the strongest predictor of low school performance.

8.4.2 Limitations

The findings presented here incur the same methodological issues discussed in Chapter 7. These include that the samples examined were not entirely representative of the academies from which they came, that the findings may not be generalisable due to the homogeneity of the population investigated, and the inability to have effectively controlled for additional aspects of demography, such as ethnicity, whether English was spoken as an additional language, and whether children were cared for by a non-parental guardian.

A further issue with the current research, which became apparent at this point, is that the dietary effects detected were typically more likely to be significant at T2 than at T1. There are two likely reasons for this: 1) the sample size at T2 was slightly larger, and 2) a higher proportion of children with a SEN status were included at T2. Although the former observation may be explained, at least in part, by pupils joining and leaving the schools between the two time-points, it is more likely reliant on the presence/absence of certain pupils at the times of data collection. Furthermore, some pupils may not have realised that they had consented to take part until the second time-point. This could therefore explain the relatively higher response rate at T2 (88.4%) compared to T1 (77.8%). The latter observation, that a higher proportion of children with a SEN status took part at T2, may be due to teachers at two of the academies not administering the questionnaires to certain classes at T1. If this were indeed the case, it is a fairly serious limitation because SEN status was consistently associated with school performance, problem behaviour, and mental health, as well as with certain patterns of dietary consumption.

8.4.3 Conclusions

Findings from this chapter suggest that poor school performance and behavioural outcomes are associated with high weekly caffeine intake, a combination of breakfast omission and frequent energy drink use, and high consumption of the Caffeinated Soft Drinks Gum DABS factor. These observations are therefore similar to those reported in the previous chapter, which related these dietary patterns to a number of aspects of mental health. However, the major issue with the results so far presented from the Cornish Academies Project is that they are only cross-sectional, and so, causation cannot be inferred. For this reason, the next chapter will present longitudinal analyses, which attempt to establish if these dietary patterns are predictive of later school performance outcomes. In addition, associations between changes in diet and changes in school performance will be examined in order to better determine whether the effects observed thus far are likely to be causal.

Chapter 9: Longitudinal Associations Between Diet and School Performance

9.1 Introduction

Whereas findings reported in Chapters 7 and 8 were purely cross-sectional in nature, the current chapter aims to investigate effects longitudinally. The analyses presented can therefore be considered similar to those of Chapter 5, except that they relate to secondary school children rather than to university students. In addition, the analyses presented here are arguably more reliable for the following reasons: 1) they relate to a much larger sample, 2) the cross-sections of data were collected further apart (i.e. six months rather than 10 weeks), 3) a greater range of covariates were controlled for, and 4) change in the outcome variables as well as the predictor variables could be examined, whereas this was not the case in Chapter 5.

9.1.1 Aims of Chapter 9

The current chapter has two main aims. The first is to investigate whether consumption of dietary variables of interest (i.e. caffeine, breakfast, energy drinks, and the Caffeinated Soft Drinks/Gum DABS factor) is predictive of school attendance, attainment, and behavioural sanctions at six-month follow-up. The second is to investigate whether changes in consumption between T1 and T2 are associated with changes in school performance outcomes.

9.2 Method

9.2.1 Design

As with Chapter 8, the current chapter aims to investigate the effects of the following dietary predictors: 1) caffeine use (total weekly intake, as well as that acquired separately from energy drinks, cola, coffee, and tea), frequency of breakfast and energy drink consumption (in isolation and in combination), and consumption of the Caffeinated Soft Drinks/Gum DABS factor. The same school performance outcomes (i.e. school attendance, English attainment, maths attainment, and behavioural sanctions) were also used.

9.2.2 Statistical Analysis

Two types of analysis will be presented: cross-lag, and change-score. Cross-lag analyses will be used to establish whether diet at T1 can predict school performance outcomes six months later at T2, whereas change score analyses will be used to determine whether changes in diet between the two time-points are associated with changes in the outcome variables. These analyses were used to help determine whether the previously observed relationships might be causal in nature. All covariates entered are from T1, and are the same as those used in cross-sectional analyses of school performance presented in Chapter 8 (see Table 9.1).

9.3 Results & Discussion

9.3.1 Calculation of Change Scores

Positive correlations were observed for each predictor and outcome variable across the two time-points (see Table 9.2). Consumption of caffeine from tea was significantly higher at T2 than at T1, though no differences were detected for the other sources, or indeed for total weekly intake. Junk Food consumption was lower, and Hot Caffeinated Beverages consumption was higher at T2 compared to T1. Intake of Caffeinated Soft Drinks/Gum was also higher at T2 compared to T1, although the effect was only marginally significant. Frequency of breakfast consumption at T2 was slightly lower than at T1, though the difference was not significant. Participants were also more likely to be in the low maths and high behavioural sanctions conditions at T2 compared to at T1.

As with the method used in Chapter 5 (section 5.3.4.2), percentage change scores for each variable were calculated in the following manner: (T2 score − T1 score) ⁄ T1 score × 100. These variables were then recoded into three groups: ‘increase’, ‘decrease’, and ‘no change’ (for frequency data relating to these groups, see Table 9.3). These scores were then further dichotomised; each variable was coded as ‘increase’ vs. ‘no increase’, except for school attendance and breakfast

Predictor variable(s)	Type of analysis	Dietary covariates	Demographic covariates	Lifestyle covariates
Total Weekly Caffeine	Cross-lag	**Total caffeine (categorical variable with six consumption groups)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
	Change score	**Total caffeine change (increase vs. not increase)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Caffeine from Individual Sources	Cross-lag	**Caffeine from energy drinks (non/low/high consumption)** **Caffeine from cola (non/low/high consumption)** **Caffeine from coffee (non/low/high consumption)** **Caffeine from tea (non/low/high consumption)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
	Change score	**Caffeine from energy drinks (increase vs. not increase)** **Caffeine from cola (increase vs. not increase)** **Caffeine from coffee (increase vs. not increase)** **Caffeine from tea (increase vs. not increase)** Junk Food DABS subscale score Healthy Foods DABS subscale score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Breakfast	Cross-lag	**Breakfast (every day vs. not every day)** Junk Food DABS subscale score Healthy Foods DABS subscale score Total weekly caffeine (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
	Change-score	**Breakfast change (decrease vs. not decrease)** Junk Food DABS subscale score Healthy Foods DABS subscale score Total weekly caffeine (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)

Predictor variable(s)	Type of analysis	Dietary covariates	Demographic covariates	Lifestyle covariates
Energy drinks	Cross-lag	**Energy drinks (once a week or more vs. less than once a week)** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
	Change-score	**Energy drinks change (increase vs. not increase)** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance (high vs. low)
Energy drinks/breakfast combinations	Cross-lag	**Combinations of frequent/infrequent consumption of breakfast and energy drinks** Junk Food DABS subscale score Healthy Foods DABS subscale score Caffeine from cola (continuous variable) Caffeine From coffee (continuous variable) Caffeine From tea (continuous variable)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance
Caffeinated Soft Drinks/Gum	Cross-lag	Junk Food DABS factor score **Caffeinated Soft Drinks/Gum DABS factor score** Healthy Foods DABS factor score Hot Caffeinated Beverages DABS factor score	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance
	Change score	Junk Food DABS subscale change (increase vs. not increase) **Caffeinated Soft Drinks/Gum DABS subscale change (increase vs. not increase)** Healthy Foods DABS subscale change (increase vs. not increase) Hot Caffeinated Beverages DABS subscale change (increase vs. not increase)	Sex School School year Presence/absence of SEN status Eligibility/ineligibility to receive FSM	Sleep hours Exercise frequency factor score School attendance

Table 9.1. Covariates entered into longitudinal multivariate analyses of school performance.
Note. Predictor variables are highlighted in bold in the dietary covariates column. School attendance was not entered as a covariate when school attendance (or school attendance change) was also the outcome.

		Association		Difference	
		r	*p*	*t*	*p*
Predictors	Total caffeine	.383	< .001	-.736	.462
	Caffeine from energy drinks	.254	< .001	-.513	.608
	Caffeine from cola	.328	< .001	.436	.663
	Caffeine from coffee	.407	< .001	.337	.736
	Caffeine from tea	.398	< .001	-2.081	.038
		rho	*p*	*Z*	*p*
	Breakfast	.361	< .001	-1.795	.073
	Energy drinks	.368	< .001	-1.646	.1
		r	*p*	*t*	*p*
	Junk Food	.413	< .001	2.987	.003
	Caffeinated Soft Drinks/Gum	.398	< .001	1.938	.053
	Healthy Foods	.295	< .001	1.638	.102
	Hot Caffeinated Beverages	.475	< .001	16.911	< .001
		r	*p*	*t*	*p*
Outcomes	School attendance	.629	< .001	15.702	< .001
		$\chi 2$	*p*	$\chi 2$	*p*
	English attainment	776.609	< .001	.175	.676
	Maths attainment	777.013	< .001	78.115	< .001
	Behavioural sanctions	884.988	< .001	122.826	< .001

Table 9.2. Correlations between predictor variables and school performance between T1 and T2.
Note. All correlations are Pearson's, other than for breakfast and energy drinks, which are Spearman's; tests of difference for breakfast and energy drinks, and English, maths, and behavioural sanctions are Wilcoxon's signed ranks, and McNemar's, respectively. DABS factor variables are subscale scores.

		No change	Decrease	Increase
Predictors	Total caffeine	140 (9%)	682 (44.1%)	726 (46.9%)
	Caffeine from energy drinks	836 (52%)	383 (23.8%)	390 (24.2%)
	Caffeine from cola	593 (37.1%)	516 (32.3%)	489 (30.6%)
	Caffeine from coffee	1009 (62.3%)	317 (19.6%)	294 (18.1%)
	Caffeine from tea	588 (36.3%)	499 (30.8%)	532 (32.9%)
	Breakfast	771 (46.7%)	467 (28.3%)	414 (25.1%)
	Energy drinks	780 (47.8%)	453 (27.8%)	399 (24.4%)
	Junk Food	236 (15.6%)	701 (46.2%)	579 (38.2%)
	Caffeinated Soft Drinks/Gum	310 (20.1%)	584 (37.8%)	650 (42.1%)
	Healthy Foods	363 (23.6%)	618 (40.2%)	556 (36.2%)
	Hot Caffeinated Beverages	196 (12.3%)	337 (21.1%)	1063 (66.6%)
Outcomes	School attendance	36 (1.2%)	1994 (66.8%)	955 (32%)
	English attainment	666 (23.1%)	361 (12.5%)	1855 (64.4%
	Maths attainment	831 (28.7%)	611 (21.1%)	1455 (50.2%)

Table 9.3. Frequency data for changes in dietary predictor variables and school performance outcomes between T1 and T2.
Note. Due to the nature of the variable for change in behavioural sanctions, it was only possible to code as 'not increase' (N = 2322; 77.6%) and 'increase' (N = 671; 22.4%).

consumption, which were coded as 'decrease' vs. 'no decrease'. The reason for dichotomising the school performance variables in this manner was that attainment is expected to increase throughout secondary school education, whereas attendance is not: therefore, the undesirable outcomes were not increasing in English and maths attainment, but actively decreasing in school attendance. Breakfast was dichotomised as 'no increase' vs. 'decrease', as decreasing consumption of this variable was considered to be an undesirable practice. This method provided a consistent approach by which the occurrence of negative outcomes could be compared against the more desirable outcomes.

Due to Academy 1 and Academy 2 specifying exact numbers of detentions, whereas Academy 3 provided numbers of behavioural points, the behavioural sanctions change score variable was coded in a slightly different way to those discussed above. For the two academies that provided numbers of detentions received, four groups were formed: 1) T1 no detention/T2 no detention, 2) T1 no detention/T2 detention, 3) T1 detention/T2 no detention, 4) T1 detention/T2 detention. Groups 1, 3, and 4 were then collapsed to create a 'no increase' group, and group 2 made up the 'increase' group. The behavioural points variable from Academy 3 was then sorted into three groups: 1) decrease 2) no change, 3) increase. Groups 1 and 2 were combined to provide a 'no increase' group and group 3 made up the 'increase' group. The 'increase' and 'no increase' groups for each of the three academies were then combined into a single dichotomous variable. As with the other school performance outcomes discussed in the above paragraph, this coding allowed for the undesirable outcome (i.e. increasing in behavioural sanctions) to be compared with the more desirable outcomes (i.e. decreasing or not changing in behavioural sanctions).

9.3.2 Longitudinal Associations Between Caffeine Intake and School Performance

9.3.2.1 Cross-Lag Associations Between Total Weekly Caffeine Intake and School Performance

Total weekly caffeine intake at T1 was investigated in relation to the dichotomous school performance outcomes at T2 (see Table 9.4). Significant $\chi 2$ linear associations between caffeine intake at T1 and school attendance and

			Total weekly caffeine intake T1					
			0mg/w	0.1-250mg/w	250.1-500mg/w	500.1-750mg/w	750.1-1000mg/w	> 1000mg/w
School attendance T2	High	Count	111	406	206	98	61	88
		Expected count	104.1	383.2	209.6	108.1	63.5	101.6
		Column %	53.4%	53%	49.2%	45.4%	48%	43.3%
		Adjusted residual	1	2.1	-.4	-1.5	-.5	-2
	Low	Count	97	360	213	118	66	115
		Expected count	103.9	382.8	209.4	107.9	63.5	101.4
		Column %	46.6%	47%	50.8%	54.6%	52%	56.7%
		Adjusted residual	-1	-2.1	.4	1.5	.5	2
		$\chi2$ linear	8.251, p = .004					
English attainment T2	High	Count	119	374	196	103	58	96
		Expected count	101.5	373	205.9	104.4	61.8	99.5
		Column %	12.6%	39.5%	20.7%	10.9%	6.1%	10.1%
		Adjusted residual	2.6	.1	-1.1	-.2	-.7	-.5
	Low	Count	88	387	224	110	68	107
		Expected count	105.5	388	214.1	108.6	64.2	103.5
		Column %	8.9%	39.3%	22.8%	11.2%	6.9%	10.9%
		Adjusted residual	-2.6	-.1	1.1	.2	.7	.5
		$\chi2$ linear	2.984, p = .084					
Maths attainment T2	High	Count	108	366	191	93	61	88
		Expected count	97.3	357.9	197.4	100.6	59.5	94.4
		Column %	11.9%	40.4%	21.1%	10.3%	6.7%	9.7%
		Adjusted residual	1.6	.8	-.7	-1.1	.3	-1
	Low	Count	98	392	227	120	65	112
		Expected count	108.7	400.1	220.6	112.4	66.5	105.6
		Column %	9.7%	38.7%	22.4%	11.8%	6.4%	11%
		Adjusted residual	-1.6	-.8	.7	1.1	-.3	1
		$\chi2$ linear	2.796, p = .094					
Behavioural sanctions T2	Good	Count	169	622	308	155	88	142
		Expected count	159.4	584.9	322.6	164.7	96.8	155.6
		Column %	80.9%	81.1%	72.8%	71.8%	69.3%	69.6%
		Adjusted residual	1.7	4	-1.9	-1.6	-1.9	-2.4
	Bad	Count	40	145	115	61	39	62
		Expected count	49.6	182.1	100.4	51.3	30.2	48.4
		Column %	19.1%	18.9%	27.2%	28.2%	30.7%	30.4%
		Adjusted residual	-1.7	-4	1.9	1.6	1.9	2.4
		$\chi2$ linear	20.567, $p < .001$					

Table 9.4. Cross-tabulations between total weekly caffeine intake at T1 and school performance outcomes at T2.

behavioural sanctions at T2 were observed, with both relationships reflecting protective effects in non-consumers/low consumers, and detrimental effects in high consumers. Negative linear trends were also observed for both English and maths attainment, but they were only marginally significant.

At the multivariate level, no associations were observed between caffeine intake at T1 and attendance, Wald = .864, p = .973, English attainment, Wald = 6.204, p = .287, or maths attainment at T2, Wald = 2.053, p = .842. However, a marginally significant trend for those in the 750.1-1000mg/w group at T1 to achieve below average English attainment at T2 was noted, OR = 1.669, 95% CI [.975, 2.856], p = .062. In addition, there was a significant association between caffeine intake at T1 and behavioural sanctions at T2, Wald = 12.152, p = .033 (see Figure 9.1). However, this effect was difficult to interpret, as no significant differences between any of the caffeine consumption groups and the control condition were observed, though it appeared to reflect general caffeine consumption, relative to non-consumption, being associated with a high occurrence of behavioural sanctions.

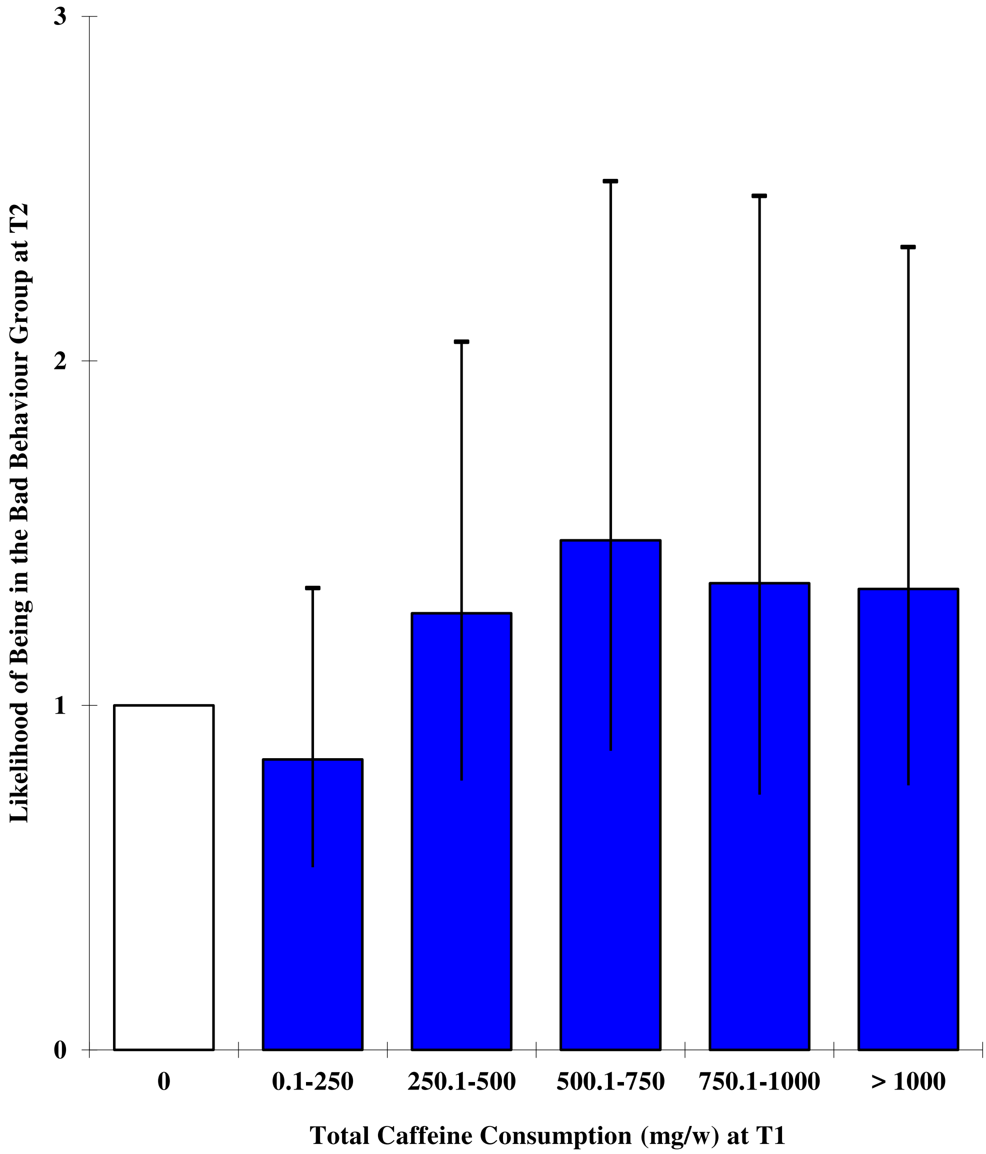

Figure 9.1. Odds ratios and 95% confidence intervals for multivariate associations between total weekly caffeine intake at T1 and behavioural sanctions at T2.

9.3.2.2 Cross-Lag Associations Between Individual Sources of Caffeine and School Performance

Univariate level cross-lag analyses of individual caffeine sources produced similar results to those observed at the cross-sectional level. Essentially, although not every relationship was significant, each of the four sources was negatively associated with school performance. Results generally reflected above average school performance in the non-consumption group and low school performance in the high consumption group. Of particular interest was the observation that significant negative associations existed between caffeine consumed from energy drinks at T1 and each of the four school performance outcomes at T2. For cross-tabulations, $\chi 2$, and *p* values, see Table 9.5.

At the multivariate level, most of the significant relationships disappeared (for ORs, 95% CIs, and *p* values, see Table 9.6). However, caffeine consumed from energy drinks at T1 remained significantly associated with maths attainment and bad behaviour at T2. High consumption of this source at T1 was a predictor of low maths attainment at T2, whereas both low and high consumption at T1 were predictive of bad behaviour at T2. In addition, although the overall effect was not significant, low consumers of caffeine from energy drinks at T1 were more likely to achieve low English attainment at T2 compared to the control group.

Consumption of caffeine from tea at T1 remained associated with school attendance and English attainment at T2. In both cases, the low and high groups were at higher risk of achieving low performance compared to the control, although the association between the high consumption group and English attainment was only marginally significant. Caffeine consumed from cola at T1 did not remain significantly associated with any of the outcomes at T2, though its high consumption was marginally more likely to occur in those who achieved low school attendance at T2. Caffeine consumed from coffee at T1 was also marginally associated with English attainment at T2. This reflected the low consumption group being more likely to achieve high attainment compared to the control; this was interesting because no such effect had been observed at the univariate level.

			Caffeine from energy drinks T1			Caffeine from cola T1			Caffeine from coffee T1			Caffeine from tea T1		
			0mg	0.1-133mg	> 133mg	0mg	0.1-25mg	> 25mg	0mg	0.1-160mg	> 160mg	0mg	0.1-120mg	> 120mg
School attendance T2	High	Count	606	210	165	343	338	299	689	146	150	446	265	275
		Expected count	570.8	212.6	197.6	326	328.5	325.5	694.8	135.9	154.3	413.6	274.9	297.5
		Row %	61.8%	21.4%	16.8%	35%	34.5%	30.5%	69.9%	14.8%	15.2%	45.2%	26.9%	27.9%
		Adjusted residual	3.2	-.3	-3.7	1.6	.9	-2.5	-.6	1.3	-.5	3	-1	-2.2
	Low	Count	538	216	231	307	317	350	702	126	159	380	284	319
		Expected count	573.2	213.4	198.4	324	326.5	323.5	696.2	136.1	154.7	412.4	274.1	296.5
		Row %	54.6%	21.9%	23.5%	31.5%	32.5%	35.9%	71.1%	12.8%	16.1%	38.7%	28.9%	32.5%
		Adjusted residual	-3.2	.3	3.7	-1.6	-.9	2.5	.6	-1.3	.5	-3	1	2.2
		χ^2 linear	14.622, p < .001			5.823, p = .016			.008, p = .93			8.628, p = .003		
English attainment T2	High	Count	587	187	188	343	316	296	685	133	146	440	246	276
		Expected count	557.9	208.4	195.6	317.2	319.2	318.7	680.2	134.1	149.8	403.5	267.5	291.1
		Row %	61%	19.4%	19.5%	35.9%	33.1%	31%	71.1%	13.8%	15.1%	45.7%	25.6%	28.7%
		Adjusted residual	2.7	-2.4	-.9	2.5	-.3	-2.2	.5	-.1	-.5	3.3	-2.2	-1.5
	Low	Count	548	237	210	303	334	353	700	140	159	382	299	317
		Expected count	577.1	215.6	202.4	328.8	330.8	330.3	704.8	138.9	155.2	418.5	277.5	301.9
		Row %	55.1%	23.8%	21.1%	30.6%	33.7%	35.7%	70.1%	14%	15.9%	38.3%	30%	31.8%
		Adjusted residual	-2.7	2.4	.9	-2.5	.3	2.2	-.5	.1	.5	-3.3	2.2	1.5
		χ^2 linear	4.294, p = .038			7.256, p = .007			.272, p = .602			7.671, p = .006		
Maths attainment T2	High	Count	567	187	161	323	303	290	663	120	137	407	235	276
		Expected count	531.2	198.7	185.1	305.2	306.1	304.7	648.8	127.1	144.1	384	256.9	277.1
		Row %	62%	20.4%	17.6%	35.3%	33.1%	31.7%	72.1%	13%	14.9%	44.3%	25.6%	30.1%
		Adjusted residual	3.3	-1.3	-2.7	1.7	-.3	-1.4	1.4	-.9	-.9	2.1	-2.2	-.1
	Low	Count	564	236	233	322	344	354	715	150	169	409	311	313
		Expected count	599.8	224.3	208.9	339.8	340.9	339.3	729.2	142.9	161.9	432	289.1	311.9
		Row %	54.6%	22.8%	22.6%	31.6%	33.7%	34.7%	69.1%	14.5%	16.3%	39.6%	30.1%	30.3%
		Adjusted residual	-3.3	1.3	2.7	-1.7	.3	1.4	-1.4	.9	.9	-2.1	2.2	.1
		χ^2 linear	11.523, p = .001			3.291, p = .07			1.656, p = .198				1.703, p = .192	
Behavioural sanctions T2	Good	Count	929	300	274	511	495	488	1082	206	217	649	413	442
		Expected count	873	326	304	496	499	499	1061.6	209.1	234.2	630.2	418.6	455.2
		Row %	61.8%	20%	18.2%	34.2%	33.1%	32.7%	71.9%	13.7%	14.4%	43.2%	27.5%	29.4%
		Adjusted residual	6	-3.3	-3.9	1.7	-.5	-1.2	2.4	-.5	-2.5	2	-.7	-1.5
	Bad	Count	217	128	125	140	160	167	314	69	91	179	137	156
		Expected count	273	102	95	155	156	156	334.4	65.9	73.8	197.8	131.4	142.8
		Row %	46.2%	27.2%	26.6%	30%	34.3%	35.8%	66.2%	14.6%	19.2%	37.9%	29%	33.1%
		Adjusted residual	-6	3.3	3.9	-1.7	.5	1.2	-2.4	.5	2.5	-2	.7	1.5
		χ^2 linear	32.235, p < .001			2.862, p = .091			7.012, p = .008			4.008, p = .045		

Table 9.5. Cross-tabulations between weekly caffeine intake from energy drinks, cola, coffee, and tea at T1 and school performance outcomes at T2.

	Caffeine source T1		OR	95% CI	*p*
School attendance T2	Energy drinks	Low	1.114	.846, 1.467	.442
		High	1.179	.868, 1.602	.291
		Wald	1.331, *p* = .514		
	Cola	Low	1.117	.852, 1.465	.424
		High	1.298	.97, 1.737	.079
		Wald	3.112, *p* = .211		
	Coffee	Low	.864	.624, 1.196	.379
		High	.804	.586, 1.102	.175
		Wald	2.232, *p* = .328		
	Tea	Low	1.375	1.053, 1.796	.019
		High	1.342	1.031, 1.747	.029
		Wald	7.239, *p* = .027		
English attainment T2	Energy drinks	Low	1.333	1.012, 1.755	.041
		High	1.089	.805, 1.472	.581
		Wald	4.182, *p* = .124		
	Cola	Low	1.19	.908, 1.56	.209
		High	1.223	.914, 1.636	.175
		Wald	2.222, *p* = .329		
	Coffee	Low	.666	.479, .925	.015
		High	.9	.661, 1.225	.504
		Wald	5.908, *p* = .052		
	Tea	Low	1.429	1.093, 1.868	.009
		High	1.283	.989, 1.664	.061
		Wald	7.548, *p* = .023		
Maths attainment T2	Energy drinks	Low	1.248	.949, 1.641	.113
		High	1.477	1.092, 1.998	.011
		Wald	7.134, *p* = .028		
	Cola	Low	1.157	.884, 1.514	.289
		High	1.073	.803, 1.434	.632
		Wald	1.138, *p* = .566		
	Coffee	Low	.768	.555, 1.064	.112
		High	.852	.625, 1.162	.312
		Wald	3.034, *p* = .219		
	Tea	Low	1.189	.912, 1.552	.201
		High	1.086	.838, 1.408	.533
		Wald	1.645, *p* = .439		
Behavioural sanctions T2	Energy drinks	Low	1.629	1.205, 2.201	.002
		High	1.504	1.078, 2.098	.016
		Wald	11.851, *p* = .003		
	Cola	Low	1.012	.737, 1.389	.941
		High	.971	.694, 1.359	.864
		Wald	.074, *p* = .964		
	Coffee	Low	.881	.608, 1.277	.504
		High	1.242	.892, 1.73	.2
		Wald	2.555, *p* = .279		
	Tea	Low	1.097	.806, 1.494	.555
		High	1.206	.897, 1.62	.215
		Wald	1.543, *p* = .462		

Table 9.6. Multivariate associations between individual sources of caffeine at T1 and school performance outcomes at T2.

9.3.2.3 Associations Between Changes in Total Weekly Caffeine Intake and Changes in School Performance

Chi-square tests were performed to examine associations between change in caffeine intake and change in each of the school performance outcomes. Trends were detected for increasing total weekly consumption to be associated with decreasing in school attendance and not increasing in English attainment, but neither effect achieved statistical significance. No associations were observed in relation to maths attainment or behavioural sanctions. For $\chi2$ values and cross-tabulations between total weekly caffeine change and change in the school performance outcomes, see Table 9.7.

			Total caffeine consumption	
			No increase	Increase
School attendance	No decrease	Count	297	232
		Expected count	281.4	247.6
		Row %	56.1%	43.9%
	Decrease	Count	519	486
		Expected count	534.6	470.4
		Row %	51.6%	48.4%
		$\chi2$	2.821, $p = .093$	
English attainment	Increase	Count	536	441
		Expected count	519.1	457.9
		Row %	54.9%	45.1%
	No increase	Count	261	262
		Expected count	277.9	245.1
		Row %	49.9%	50.1%
		$\chi2$	3.362, $p = .067$	
Maths attainment	Increase	Count	419	350
		Expected count	409	360
		Row %	54.5%	45.5%
	No increase	Count	383	356
		Expected count	393	346
		Row %	51.8%	48.2%
		$\chi2$	1.071, $p = .301$	
Behavioural sanctions	No increase	Count	670	573
		Expected count	660.3	582.7
		Row %	53.9%	46.1%
	Increase	Count	147	148
		Expected count	156.7	138.3
		Row %	49.8%	50.2%
		$\chi2$	1.587, $p = .208$	

Table 9.7. $\chi2$ values and cross-tabulations between change in total weekly caffeine intake and change in school performance outcomes.

At the multivariate level, increasing in caffeine consumption was associated with decreasing in school attendance, OR = 1.307, 95% CI [1.001, 1.705], p = .049, though no significant effects were observed in relation to English attainment, OR = .992, 95% CI [.756, 1.3], p = .952, maths attainment, OR = .915, 95% CI [.697, 1.202], p = .524, or behavioural sanctions, OR = 1.167, 95% CI [.837, 1.627], p = .363.

9.3.2.4 Associations Between Changes in Consumption of Individual Sources of Caffeine and Changes in School Performance

Chi-square analyses indicated that increasing consumption of caffeine from energy drinks was associated with not increasing in English and maths attainment (though the former relationship was only marginally significant), and with increasing in behavioural sanctions between the two time-points. This same pattern of results was observed for increasing in consumption of caffeine from coffee, although in this case each relationship was statistically significant. Increasing in consumption of caffeine from cola was also associated with increasing behavioural sanctions, and increasing in caffeine consumption from tea was related to not increasing in English and maths attainment. Taken together, these findings suggest that increasing in caffeine consumption from any of the four sources investigated is associated with decreasing school performance. For cross-tabulations, $\chi2$ and p values, see Table 9.8.

At the multivariate level only one relationship was significant: increasing caffeine consumption from cola was related to increasing in English attainment. This relationship appeared somewhat counterintuitive considering that every other relationship so far observed in this section was negative rather than positive. Further doubt is cast on the validity of this finding considering that no such effect was observed at the univariate level. The only other effect of note from this analysis was that increasing consumption of caffeine from coffee remained associated with an increase in behavioural sanctions, though the effect was only marginally significant. For ORs, 95% CIs, and p values from these multivariate analyses see Table 9.9.

			Caffeine from energy drinks		Caffeine from cola		Caffeine from coffee		Caffeine from tea	
			No increase	Increase	No increase	Increase	No increase	Increase	No increase	Increase
School attendance	No decrease	Count	413	134	375	170	458	95	371	180
		Expected count	415.1	131.9	378.5	166.5	451.9	101.1	370.8	180.2
		Row %	75.5%	24.5%	68.8%	31.2%	82.8%	17.2%	67.3%	32.7%
	Decrease	Count	796	250	723	313	852	198	707	344
		Expected count	793.9	252.1	719.5	316.5	858.1	191.9	707.2	343.8
		Row %	76.1%	23.9%	69.8%	30.2%	81.1%	18.9%	67.3%	32.7%
		$\chi2$	.07, p = .791		.162, p = .688		.683, p = .409		.001, p = .98	
English attainment	Increase	Count	785	232	699	311	864	163	713	308
		Expected count	771.6	245.4	703.1	306.9	839.9	187.1	687.2	333.8
		Row %	77.2%	22.8%	69.2%	30.8%	84.1%	15.9%	69.8%	30.2%
	No increase	Count	397	144	378	159	420	123	341	204
		Expected count	410.4	130.6	373.9	163.1	444.1	98.9	366.8	178.2
		Row %	73.4%	26.6%	70.4%	29.6%	77.3%	22.7%	62.6%	37.4%
		$\chi2$	2.793, p = .095		.232, p = .63		10.961, p = .001		8.522, p = .004	
Maths attainment	Increase	Count	627	172	563	229	688	120	563	238
		Expected count	605.4	193.6	548.2	243.8	661.6	146.4	539.1	261.9
		Row %	78.5%	21.5%	71.1%	28.9%	85.1%	14.9%	70.3%	29.7%
	No increase	Count	558	207	512	249	604	166	495	276
		Expected count	579.6	185.4	526.8	234.2	630.4	139.6	518.9	252.1
		Row %	72.9%	27.1%	67.3%	32.7%	78.4%	21.6%	64.2%	35.8%
		$\chi2$	6.514, p = .011		2.639, p = .104		11.952, p = .001		6.61, p = .01	
Behavioural sanctions	No increase	Count	987	296	904	370	1078	217	867	422
		Expected count	972.1	310.9	884.4	389.6	1059.2	235.8	868.4	420.6
		Row %	76.9%	23.1%	71%	29%	83.2%	16.8%	67.3%	32.7%
	Increase	Count	223	91	197	115	238	76	215	102
		Expected count	237.9	76.1	216.6	95.4	256.8	57.2	213.6	103.4
		Row %	71%	29%	63.1%	36.9%	75.8%	24.2%	67.8%	32.2%
		$\chi2$	4.799, p = .028		7.213, p = .007		9.41, p = .002		.037, p = .848	

Table 9.8. Cross-tabulations and $\chi2$ values for associations between changes in consumption of individual sources of caffeine and changes in school performance.

	Caffeine source T1	OR	95% CI	*p*
School attendance	Energy drinks	1.158	.844, 1.588	.364
	Cola	1.114	.836, 1.484	.462
	Coffee	1.181	.832, 1.675	.351
	Tea	1.095	.825, 1.452	.529
English attainment	Energy drinks	1.185	.857, 1.64	.304
	Cola	.681	.504, .919	.012
	Coffee	1.114	.785, 1.581	.546
	Tea	1.098	.824, 1.462	.524
Maths attainment	Energy drinks	.933	.674, 1.292	.676
	Cola	.921	.686, 1.237	.584
	Coffee	1.227	.856, 1.76	.265
	Tea	1.185	.887, 1.582	.251
Behavioural sanctions	Energy drinks	1.081	.737, 1.585	.689
	Cola	1.215	.853, 1.729	.281
	Coffee	1.412	.947, 2.104	.09
	Tea	.917	.645, 1.304	.63

Table 9.9. Multivariate associations between changes in consumption of individual sources of caffeine and changes in school performance.

9.3.2.5 Discussion of Longitudinal Associations Between Caffeine Intake and School Performance

When investigating the effects of caffeine longitudinally, significant linear relationships were observed between weekly intake at T1 and school attendance and behavioural sanctions at T2. Although trends were also observed for English and maths attainment, they did not achieve statistical significance, and the only effect to remain significant at the multivariate level was an association between caffeine intake at T1 and behavioural sanctions at T2. However, though this effect appeared to reflect caffeine consumption in general being associated with higher risk of bad behaviour, it was difficult to interpret because none of the individual consumption groups actually differed significantly from the control. When examined separately, each of the four sources of caffeine were associated with low school performance, though most of the effects disappeared after controlling for covariates.

A change-score analysis indicated that increasing total caffeine consumption between the two time-points was associated with decreasing school attendance and not increasing in English attainment, though both effects were only marginally significant. Although the effect relating to English attainment disappeared altogether at the multivariate level, that relating to school attendance became statistically significant. An examination of individual caffeine sources showed that increasing in any of the four different sources was associated with undesirable changes in school performance, though these effects were generally lost at the multivariate level. The only significant association after controlling for covariates was between increasing in consumption of caffeine from cola and increasing in English attainment. This effect had not been detected at the univariate level, and, in light of those others observed, appeared somewhat counterintuitive.

Although the effects observed in this section were not always consistent, taken together they suggest that increasing caffeine intake between T1 and T2 was generally associated with reductions in school performance, implying the possibility of causal relationships. However, to determine whether this is indeed the case, further research (i.e. intervention studies) is required. A potential mechanism by which these effects could occur is through caffeine consumption being associated with delayed sleep onset and reduced sleep duration (see Roehrs & Roth, 2008), leading to an inability to wake up in the morning ready for school. This could also have further effects on attention, leading to problems regarding attainment and in-class behaviour.

9.3.3 Longitudinal Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

9.3.3.1 Cross-Lag Associations Between Energy Drink Consumption, Breakfast Omission, and School Performance

9.3.3.1.1 Individual Effects of Breakfast and Energy Drinks

To investigate whether frequency of consumption of breakfast and energy drinks at T1 was predictive of school performance at T2, a cross-lag analysis was conducted. Eating breakfast every day at T1 was predictive of above average school attendance, and was also marginally associated with good behaviour at T2. Frequently consuming energy drinks at T1 predicted poor school attendance, below average maths attainment, and bad behaviour at T2. For cross-tabulations, $\chi 2$ and p values, see Table 9.10. At the multivariate level (see Table 9.11) only two effects

			Breakfast T1		Energy drinks T1	
			Every day	Not every day	≥ once a week	< once a week
School attendance T2	High	Count	555	437	231	755
		Expected count	501.5	490.5	266.4	719.6
		Row %	55.9%	44.1%	23.4%	76.6%
	Low	Count	446	542	299	677
		Expected count	499.5	488.5	263.6	712.4
		Row %	45.1%	54.9%	30.6%	69.4%
		$\chi 2$	23.123, $p < .001$		12.922, $p < .001$	
English attainment T2	High	Count	488	479	254	705
		Expected count	486	481	261.9	697.1
		Row %	50.5%	49.5%	26.5%	73.5%
	Low	Count	503	502	280	716
		Expected count	505	500	272.1	723.9
		Row %	50%	50%	28.1%	71.9%
		$\chi 2$	.034, $p = .854$		.651, $p = .42$	
Maths attainment T2	High	Count	473	451	228	689
		Expected count	464.4	459.6	249.4	667.6
		Row %	51.2%	48.8%	24.9%	75.1%
	Low	Count	513	525	301	727
		Expected count	521.6	516.4	279.6	748.4
		Row %	49.4%	50.6%	29.3%	70.7%
		$\chi 2$	.612, $p = .434$		4.774, $p = .029$	
Behavioural sanctions T2	Good	Count	779	732	370	1124
		Expected count	762	749	405.9	1088.1
		Row %	51.6%	48.4%	24.8%	75.2%
	Bad	Count	223	253	165	310
		Expected count	240	236	129.1	345.9
		Row %	46.8%	53.2%	34.7%	65.3%
		$\chi 2$	3.207, $p = .073$		18.108, $p < .001$	

Table 9.10. Cross-tabulations and $\chi 2$ values for frequency of breakfast and energy drink consumption at T1 and school performance outcomes at T2.

	Dietary predictor	OR	95% CI	*p*
School attendance T2	Breakfast T1	1.592	1.271, 1.994	< .001
	Energy drinks T1	1.155	.891, 1.496	.276
English attainment T2	Breakfast T1	1.12	.896, 1.4	.321
	Energy drinks T1	1.014	.785, 1.309	.916
Maths attainment T2	Breakfast T1	1.122	.898, 1.402	.31
	Energy drinks T1	1.162	.9, 1.5	.25
Behavioural sanctions T2	Breakfast T1	1.171	.907, 1.511	.227
	Energy drinks T1	1.359	1.03, 1.793	.03

Table 9.11. Multivariate associations between breakfast and energy drink consumption at T1 and school performance at T2.

remained significant: breakfast omission at T1 was predictive of low school attendance at T2, and frequent energy drink use at T1 was associated with bad behaviour at T2.

9.3.3.1.2 Combined Effects of Breakfast and Energy Drinks

The four groups of frequent/infrequent breakfast and energy drink consumption used in cross-sectional analyses presented in Chapters 7 and 8 were once again used here. Chi-square tests determined that the combined breakfast and energy drinks variable at T1 was significantly associated with school attendance, maths attainment, and behavioural sanctions at T2, although no effect was observed regarding English attainment. These analyses showed that the frequent breakfast/infrequent energy drinks condition at T1 was associated with high attendance, high maths attainment, and good behaviour at T2. Conversely, the infrequent breakfast/frequent energy drinks condition at T1 was associated with low attendance and bad behaviour at T2. In addition, the frequent breakfast/frequent energy drinks condition at T1 was associated with low maths attainment and bad behaviour at T2. For $\chi 2$ values and cross-tabulations between breakfast and energy drinks combinations at T1 and school performance outcomes at T2, see Table 9.12.

After controlling for covariates, no significant effects were observed regarding English attainment, Wald = 2.455, p = .483, or maths attainment, Wald = 2.827, p = .419, and none of the experimental conditions differed significantly from the control. However, the association between breakfast/energy drinks at T1 and attendance at T2 remained significant, Wald = 20.55, p < .001. This reflected increased risk of low attendance occurring in both the groups that did not eat breakfast every day: infrequent breakfast/infrequent energy drinks, OR = 1.345, 95% [1.037, 1.744], p = .025; infrequent breakfast/frequent energy drinks, OR = 1.837, 95% CI [1.311, 2.574], p < .001. In addition to this, a marginally significant effect was observed regarding behavioural sanctions, Wald = 6.599, p = .086, which reflected higher risk of bad behaviour at T2 occurring in those who were in either the frequent breakfast/frequent energy drinks condition, OR = 1.573, 95% CI [1.029, 2.404], p = .036, or the infrequent breakfast/frequent energy drinks condition at T1, OR = 1.456, 95% CI [1.014, 2.09], p = .042.

			Frequent breakfast/ infrequent energy drink T1	Frequent breakfast/ frequent energy drink T1	Infrequent breakfast/ infrequent energy drink T1	Infrequent breakfast/ frequent energy drink T1
School attendance T2	High	Count	444	102	308	128
		Expected count	399.5	93.5	317.6	171.4
		Row %	45.2%	10.4%	31.4%	13%
		Adjusted residual	4.1	1.3	-.9	-5.2
	Low	Count	351	84	324	213
		Expected count	395.5	92.5	314.4	169.6
		Row %	36.1%	8.6%	33.3%	21.9%
		Adjusted residual	-4.1	-1.3	.9	5.2
		$\chi 2$	34.164, $p < .001$			
English attainment T2	High	Count	396	81	305	172
		Expected count	384.4	91.6	309	169
		Row %	41.5%	8.5%	32%	18%
		Adjusted residual	1.1	-1.6	-.4	.4
	Low	Count	389	106	326	173
		Expected count	400.6	95.4	322	176
		Row %	39.1%	10.7%	32.8%	17.4%
		Adjusted residual	-1.1	1.6	.4	-.4
		$\chi 2$	3.286, $p = .35$			
Maths attainment T2	High	Count	391	72	295	154
		Expected count	367.7	87.1	296.6	160.6
		Row %	42.9%	7.9%	32.3%	16.9%
		Adjusted residual	2.2	-2.3	-.2	-.8
	Low	Count	390	113	335	187
		Expected count	413.3	97.9	333.4	180.4
		Row %	38%	11%	32.7%	18.2%
		Adjusted residual	-2.2	2.3	.2	.8
		$\chi 2$	8.257, $p = .041$			
Behavioural sanctions T2	Good	Count	634	126	485	242
		Expected count	602.8	141.8	480.8	261.6
		Row %	42.6%	8.5%	32.6%	16.3%
		Adjusted residual	3.3	-2.8	.5	-2.7
	Bad	Count	161	61	149	103
		Expected count	192.2	45.2	153.2	83.4
		Row %	34%	12.9%	31.4%	21.7%
		Adjusted residual	-3.3	2.8	-.5	2.7
		$\chi 2$	20.183, $p < .001$			

Table 9.12. Cross-tabulations and $\chi 2$ values for breakfast and energy drink consumption combinations at T1 and school performance outcomes at T2.

9.3.3.2 Associations Between Changes in Breakfast and Energy Drink Consumption and Changes in School Performance

Decreasing in breakfast consumption was strongly associated with increasing in energy drink consumption, $\chi 2$ (1, N = 1624) = 29.355, $p < .001$. Both of these dietary patterns were associated with not increasing in English and maths attainment, and also with increasing in behavioural sanctions. Conversely, decreasing in breakfast consumption was associated with not decreasing in school attendance. For cross-tabulations between changes in breakfast and energy drink consumption and changes in school performance, see Table 9.13.

At the multivariate level, a number of the associations originally observed disappeared. However, both decreasing in breakfast and increasing in energy drink consumption between the two time-points remained significantly associated with increasing in behavioural sanctions. In addition, increasing in energy drink consumption also remained associated with not increasing in English attainment, although the effect was only marginally significant. For ORs, 95% CIs, and *p* values, see Table 9.14.

			Breakfast		**Energy drinks**	
			No decrease	Decrease	No increase	Increase
School attendance	No decrease	Count	382	178	418	136
		Expected count	401	159	419.4	134.6
		Row %	68.2%	31.8%	75.5%	24.5%
	Decrease	Count	788	286	804	256
		Expected count	769	305	802.6	257.4
		Row %	73.4%	26.6%	75.8%	24.2%
		$\chi 2$	4.813, $p = .028$		.031, $p = .86$	
English attainment	Increase	Count	767	275	808	221
		Expected count	745.7	296.3	779.1	249.9
		Row %	73.6%	26.4%	78.5%	21.5%
	No increase	Count	378	180	389	163
		Expected count	399.3	158.7	417.9	134.1
		Row %	67.7%	32.3%	70.5%	29.5%
		$\chi 2$	6.146, $p = .013$		12.666, $p < .001$	
Maths attainment	Increase	Count	632	189	650	161
		Expected count	589.8	231.2	613.1	197.9
		Row %	77%	23%	80.1%	19.9%
	No increase	Count	521	263	549	226
		Expected count	563.2	220.8	585.9	189.1
		Row %	66.5%	33.5%	70.8%	29.2%
		$\chi 2$	21.96, $p < .001$		18.618, $p < .001$	
Behavioural sanctions	No increase	Count	969	343	1021	275
		Expected count	941.4	370.6	982.2	313.8
		Row %	73.9%	26.1%	78.8%	21.2%
	Increase	Count	207	120	206	117
		Expected count	234.6	92.4	244.8	78.2
		Row %	63.3%	36.7%	63.8%	36.2%
		$\chi 2$	14.385, $p < .001$		31.719, $p < .001$	

Table 9.13. Cross-tabulations and $\chi 2$ values for associations between changes in consumption of breakfast and energy drinks and changes in school performance.

	Dietary predictor	OR	95% CI	*p*
School attendance	Breakfast	.893	.67, 1.19	.439
	Energy drinks	1.163	.856, 1.579	.335
English attainment	Breakfast	.943	.7, 1.271	.702
	Energy drinks	1.316	.962, 1.801	.086
Maths attainment	Breakfast	1.086	.806, 1.464	.587
	Energy drinks	.956	.695, 1.315	.783
Behavioural sanctions	Breakfast	1.615	1.146, 2.275	.006
	Energy drinks	1.919	1.343, 2.744	< .001

Table 9.14. Multivariate associations between changes in breakfast and energy drink consumption and changes in school performance.

9.3.3.3 Discussion of Longitudinal Associations Between Energy Drinks, Breakfast and School Performance

Cross-lag analyses initially observed a number of relationships between breakfast and energy drink consumption at T1 and school performance at T2. However, only two remained significant after controlling for covariates: breakfast omission at T1 predicted low school attendance at T2, and frequent energy drink use at T1 predicted a high occurrence of behavioural sanctions at T2. Similar effects were observed when breakfast and energy drinks were examined in combination. Initially effects were observed regarding attendance, maths attainment, and behavioural sanctions. At the multivariate level the effect relating to school attendance remained significant, and appeared mainly to reflect breakfast omission at T1 predicting low attendance at T2. A marginally significant effect was also observed regarding behavioural sanctions, and appeared to reflect frequent consumption of energy drinks at T1 predicting a high occurrence of behavioural sanctions at T2.

Although it was unfeasible to investigate changes in the breakfast/energy drinks consumption groups, change score analyses were conducted for each component individually. These analyses initially observed associations between decreasing breakfast consumption and increasing energy drink consumption and undesirable changes to school performance. One relationship was observed in the opposite direction, however: decreasing in breakfast consumption was associated with not decreasing in school attendance. A possible explanation for this effect is that children that missed a lot of school in the previous term, perhaps through illness, might have eaten breakfast more often due to staying at home. A subsequent decrease in breakfast could then be associated with their returning to school, for instance due to being in a rush in the morning when getting ready. At the multivariate level, however, this effect disappeared. The only effects that remained significant were associations between both decreasing breakfast and increasing energy drink consumption and increasing in behavioural sanctions. Taken together, the effects reported in this section mainly echo those observed cross-sectionally. Of particular interest, however, was the observation that decreasing in breakfast consumption was strongly associated with increasing in energy drink consumption, which provides support for the idea that the latter may be used as a replacement for the former (i.e. Richardson, 2013).

9.3.4 Longitudinal Associations Between DABS Factors and School Performance

9.3.4.1 Cross-Lag Associations Between DABS Factors at T1 and School Performance at T2

In order to determine whether consumption of the DABS factors at T1 was related to subsequent school performance at T2, a cross-lag analysis was conducted. In the current context, the main finding of interest was that consumption of Caffeinated Soft Drinks/Gum at T1 was significantly higher in each of the low school performance groups at T2. For all t and p values, see Table 9.15. At the multivariate level each of these relationships were again detected, though those relating to attendance and maths attainment were only marginally significant. For ORs, 95% CIs, and p values, see Table 9.16.

	Junk Food T1		**Caffeinated Soft Drinks/Gum T1**		**Healthy Foods T1**		**Hot Caffeinated Beverages T1**	
	t	*p*	*t*	*p*	*t*	*p*	*t*	*p*
School attendance T2	2.48	.013	-5.067	< .001	3.884	< .001	-3.149	.002
English attainment T2	-2.378	.018	-7.478	< .001	-.865	.387	1.476	.14
Maths attainment T2	-2.341	.019	-7.056	< .001	-.911	.363	1.619	.106
Behavioural sanctions T2	-2.157	.032	-9.622	< .001	-.409	.683	-2.881	.004

Table 9.15. Differences between DABS factor scores at T1 as a function of high and low school performance at T2.

	DABS factor T1	OR	95% CI	*p*
School attendance T2	Junk Food	1.088	.968, 1.222	.16
	Caffeinated Soft Drinks/Gum	1.111	.987, 1.252	.082
	Healthy Foods	1.096	.972, 1.235	.135
	Hot Caffeinated Beverages	.983	.875, 1.105	.778
English attainment T2	Junk Food	.963	.86, 1.078	.509
	Caffeinated Soft Drinks/Gum	1.137	1.013, 1.276	.029
	Healthy Foods	1.021	.908, 1.149	.726
	Hot Caffeinated Beverages	1	.894, 1.119	.996
Maths attainment T2	Junk Food	.982	.877. 1.099	.754
	Caffeinated Soft Drinks/Gum	1.114	.992, 1.251	.067
	Healthy Foods	1.025	.911, 1.153	.686
	Hot Caffeinated Beverages	.944	.843, 1.057	.318
Behavioural sanctions T2	Junk Food	1.009	.886, 1.148	.897
	Caffeinated Soft Drinks/Gum	1.218	1.073, 1.383	.002
	Healthy Foods	.948	.831, 1.082	.431
	Hot Caffeinated Beverages	1.114	.985, 1.26	.087

Table 9.16. Multivariate associations between consumption of each DABS factor at T1 and school performance at T2.

9.3.4.2 Associations Between Changes in Consumption of DABS Factors and Changes in School Performance

Chi-square analyses were performed to investigate whether increasing in consumption of the DABS factors between T1 and T2 was associated with changes in the school performance outcomes. Of interest to the current research was the finding that increasing consumption of Caffeinated Soft Drinks/Gum was significantly associated with not increasing in English and maths attainment, and also with increasing in the occurrence of behavioural sanctions. For cross-tabulations, and $\chi 2$ and *p* values, see Table 9.17.

At the multivariate level, only one of the above relationships remained significant: increasing consumption of Caffeinated Soft Drinks/Gum predicted not increasing in English attainment. Interestingly, the only other effect of note from this analysis was increasing consumption of Healthy Foods being associated with not increasing in maths attainment. However, this effect was only marginally significant, as it was at the univariate level. For all ORs, 95% CIs, and *p* values, see Table 9.18.

			Junk Food		Caffeinated Soft Drinks/Gum		Healthy Foods		Hot Caffeinated Beverages	
			No increase	Increase	No increase	Increase	No increase	Increase	No increase	Increase
School attendance	No decrease	Count	295	217	301	230	325	198	204	341
		Expected count	316.6	195.4	306.5	224.5	334.7	188.3	181.1	363.9
		Row %	57.6%	42.4%	56.7%	43.3%	62.1%	37.9%	37.4%	62.6%
	Decrease	Count	632	355	581	416	647	349	321	714
		Expected count	610.4	376.6	575.5	421.5	637.3	358.7	343.9	691.1
		Row %	64%	36%	58.3%	41.7%	65%	35%	31%	69%
		$\chi2$	5.879, p = .015		.359, p = .549		1.182, p = .277		6.625, p = .01	
English attainment	Increase	Count	613	347	585	387	610	363	332	675
		Expected count	591.6	368.4	561.4	410.6	622.7	350.3	336.8	670.2
		Row %	63.9%	36.1%	60.2%	39.8%	62.7%	37.3%	33%	67%
	No increase	Count	291	216	279	245	341	172	185	354
		Expected count	312.4	194.6	302.6	221.4	328.3	184.7	180.2	358.8
		Row %	57.4%	42.6%	53.2%	46.8%	66.5%	33.5%	34.3%	65.7%
		$\chi2$	5.85, p = .016		6.723, p = .01		2.082, p = .149		.289, p = .591	
Maths attainment	Increase	Count	476	275	470	296	505	263	243	550
		Expected count	463.6	287.4	441.4	324.6	489.5	278.5	264.8	528.2
		Row %	63.4%	36.6%	61.4%	38.6%	65.8%	34.2%	30.6%	69.4%
	No increase	Count	432	288	395	340	446	278	276	485
		Expected count	444.4	275.6	423.6	311.4	461.5	262.5	254.2	506.8
		Row %	60%	40%	53.7%	46.3%	61.6%	38.4%	36.3%	63.7%
		$\chi2$	1.78, p = .182		8.91, p = .003		2.781, p = .095		5.524, p = .019	
Behavioural sanctions	No increase	Count	761	452	733	499	784	438	421	853
		Expected count	750.1	462.9	712.5	519.5	779.4	442.6	426	848
		Row %	62.7%	37.3%	59.5%	40.5%	64.2%	35.8%	33%	67%
	Increase	Count	169	122	153	147	188	114	109	202
		Expected count	179.9	111.1	173.5	126.5	192.6	109.4	104	207
		Row %	58.1%	41.9%	51%	49%	62.3%	37.7%	35%	65%
		$\chi2$	2.161, p = .142		7.142, p = .008		.381, p = .537		.45, p = .502	

Table 9.17. $\chi2$ values and cross-tabulations between change in consumption of the DABS factors (subscale scores) and change in school performance outcomes.

	DABS factor	OR	95% CI	p
School attendance (decrease vs. no decrease)	Junk Food	.829	.625, 1.099	.829
	Caffeinated Soft Drinks/Gum	1.066	.806, 1.41	.655
	Healthy Foods	1.157	.867, 1.542	.322
	Hot Caffeinated Beverages	1.203	.899, 1.608	.213
English attainment (no increase vs. increase)	Junk Food	1.23	.919, 1.647	.163
	Caffeinated Soft Drinks/Gum	1.349	1.012, 1.798	.041
	Healthy Foods	.912	.68, 1.223	.537
	Hot Caffeinated Beverages	1.002	.743, 1.352	.99
Maths attainment (no increase vs. increase)	Junk Food	.818	.608, 1.099	.182
	Caffeinated Soft Drinks/Gum	1.08	.808, 1.444	.601
	Healthy Foods	1.327	.989, 1.782	.059
	Hot Caffeinated Beverages	1.055	.782, 1.425	.725
Behavioural sanctions (increase vs. no increase)	Junk Food	1.079	.757, 1.539	.675
	Caffeinated Soft Drinks/Gum	1.315	.923, 1.874	.13
	Healthy Foods	1.343	.938, 1.922	.107
	Hot Caffeinated Beverages	.865	.598, 1.249	.439

Table 9.18. Multivariate associations between change in consumption of the DABS factors (subscale scores) and change in school performance outcomes.

9.3.4.3 Discussion of Longitudinal Associations Between DABS Factors and School Performance

A cross-lag analysis showed consumption of Caffeinated Soft Drinks/Gum at T1 to be significantly higher in each of the low school performance groups at T2. These effects also remained once additional covariates had been controlled for, though those relating to school attendance and maths attainment were only marginally significant at this stage. Although it may be that such effects occurred due to the dietary patterns correlating between the two time-points, it is also possible that some negative outcomes incurred through consuming large amounts of energy drinks, cola and chewing gum are persistent over time.

A univariate level change score analysis found that increasing consumption of Caffeinated Soft Drinks/Gum between T1 and T2 was associated with not increasing in English and maths attainment, and with increasing in behavioural sanctions. Although at the multivariate level the effects relating to maths and behavioural sanctions disappeared, that relating to English attainment remained significant. These results therefore suggest that increasing consumption of the products comprising the Caffeinated Soft Drinks/Gum factor may be a cause for concern.

Taken together, the findings from this section suggest that high consumption of the Caffeinated Soft Drinks/Gum DABS factor is predictive of low school performance outcomes at six-month follow-up, and that increasing its consumption is associated with detriments to school performance. However, although significant findings from some of the change-score analyses imply that the effects might be causal, intervention studies are needed to gain a better understanding of the relationships observed. Such effects may, for instance, be explainable by social factors. An example of this is how a group that consumes high amounts of energy drinks, cola, and chewing gum, and performs poorly at school, might encourage subsequent changes in both of these variables in new group members.

9.4 General Discussion

Previous chapters have presented data from the Cornish Academies Project that suggest high caffeine intake, breakfast omission, frequent energy drink use, and a high consumption of the Caffeinated Soft Drinks/Gum DABS factor to be associated with undesirable outcomes. The current chapter has therefore examined such effects longitudinally, in order to determine whether they might be causal in nature. Although as a whole the effects observed here were less consistent, they generally did reflect the cross-sectional associations between diet and school performance presented in Chapter 8. Cross-lag analyses demonstrated that some such associations could be detected at six-month follow-up, potentially implying that the effects of diet on school performance are pervasive over time. Change score analyses also showed that changes in dietary consumption between the two time-points were often associated with changes in school performance, implying the possibility that such effects might be causal in nature.

9.4.1 Dietary Predictors of School Performance

9.4.1.1 Caffeine Intake

Although there was evidence of negative associations between total caffeine consumption at T1 and each of the school performance outcomes at T2, only those effects relating to attendance and behavioural sanctions were statistically significant. At the multivariate level, only the effect relating to behavioural sanctions remained, and, although this effect appeared to reflect general caffeine consumption increasing the risk of subsequent behavioural sanctions, it was difficult to interpret because, though the overall effect was significant, none of the individual caffeine consumption conditions differed significantly from the control. When investigating individual sources of caffeine, negative associations were observed that related to each of the four sources. However, of considerable interest was the finding that consumption of caffeine from energy drinks at T1 remained a significant predictor of low English attainment, low maths attainment, and high occurrences of behavioural sanctions at T2.

Increasing caffeine consumption between T1 and T2 was associated with decreasing school attendance, and with not increasing in English attainment, though both effects were only marginally significant. At the multivariate level, however, increasing in caffeine consumption was significantly associated with decreasing school attendance, suggesting that this dietary practice may be a particular cause for concern. In a similar manner to the cross-lag analysis, increases in consumption of any of the four individual sources were associated with reductions in school performance. Of particular interest was the finding that increasing consumption of either caffeine from energy drinks or caffeine from coffee was predictive of not increasing in English and maths attainment, and also with increasing in behavioural sanctions (though the effect relating to energy drinks and English attainment was not statistically significant). However, these effects did not remain at the multivariate level; the only significant effect observed at this point was an association between increasing in consumption of caffeine from cola and increasing in English attainment. Although other positive effects relating to cola consumption have been reported in previous chapters, this effect appears counterintuitive, and, considering that no such association was observed at the univariate level, likely represents a Type 1 error.

9.4.1.2 Breakfast and Energy Drinks

While not all effects were significant, univariate analyses showed that breakfast omission and frequent energy drink consumption at T1 were consistently associated with low school performance at T2. However, only two effects remained significant after controlling for covariates. Breakfast omission at T1 remained predictive of low school attendance at T2, and frequent energy drink use at T1 remained predictive of a high occurrence of behavioural sanctions at T2. When investigating these dietary variables in combination, significant effects were initially observed for each of the school performance outcomes other than maths attainment. At the multivariate level, the effect of breakfast/energy drinks at T1 remained a significant predictor of school attendance at T2, and appeared mainly to reflect the omission of breakfast. In addition, although the overall effect was not significant, being a frequent consumer of energy drinks at T1 appeared to be a stronger predictor of behavioural sanctions at T2 than was breakfast omission.

Further concern regarding these dietary practices was provided via change-score analyses. At the univariate level, decreasing in breakfast and increasing in energy drink consumption were both significantly associated with not increasing in English and maths attainment, and with increasing in behavioural sanctions. Both effects relating to behavioural sanctions also remained significant at the multivariate level. In addition, a univariate association between decreasing in breakfast consumption and increasing in school attendance was observed. This appeared somewhat counterintuitive, though might reflect children returning to school after illness being less likely to have breakfast than when remaining at home under the care of their parents/guardians. This effect also disappeared once covariates had been controlled for.

9.4.1.3 Caffeinated Soft Drinks/Gum

High consumption of Caffeinated Soft Drinks/Gum at T1 was associated with low English and maths attainment and high occurrence of behavioural sanctions at T2. Each of these effects remained at the multivariate level, except that those relating to attendance and maths were only marginally significant. In addition, increasing consumption of this dietary factor was associated with not increasing in English and maths attainment, and with increasing behavioural sanctions. Although at the multivariate level the only effect that remained significant was that relating to English attainment, these findings, like those discussed in earlier sections, imply the possibility of causal associations between diet and school performance.

9.4.2 Limitations

Due to the longitudinal nature of the analyses, some additional limitations not encountered in Chapters 6, 7, and 8 should be acknowledged here. One such problem is that only six months separated the collection of the two cross-sections of data. Although this is an obvious improvement upon the 10-week longitudinal study presented in Chapter 5, it still makes it difficult to determine whether results observed in the cross-lag analyses presented here genuinely reflect long-lasting effects of diet, or whether they were simply dependent on correlations between dietary practices across the two time-points. Future research could address this issue by conducting longitudinal studies that leave a greater amount of time between initial data collection and subsequent follow-up.

Another limitation of the current study is that the statistical power was considerably reduced due to the number of participants taking part at both time-points being diminished. Although this is a common problem in longitudinal research, it was particularly pertinent in the current study because the samples at T1 and T2 differed more than was expected. As cross-sectional analyses presented in Chapter 8 showed that some effects were more readily detectable at T2, some of the non-significant findings reported here might also reflect this observation.

Another issue is that cross-sectional effects reported in Chapter 8 often appeared to relate to specific subgroups/extremes in the distribution (i.e. those consuming > 1000mg/w of caffeine, those who frequently used energy drinks and missed breakfast, and those who consumed high amounts of energy drinks, cola and chewing gum). As the numbers of these respective subgroups were relatively small, the change score analyses were confounded somewhat in that relatively few participants are likely to have either joined or left these groups during the six months separating the two cross-sections of data. Change score analyses were also further limited because relatively few participants decreased in attainment or behavioural sanctions between T1 and T2. These issues are difficult to address for the simple observation that the occurrence of behavioural problems/delinquency is known to escalate throughout puberty (e.g. Najman et al., 2009), and students' grades are expected to improve.

9.4.3 Conclusions

Results from this chapter show that each dietary variable investigated was associated with school performance outcomes at six-month follow-up, suggesting that effects of diet on school performance may be pervasive over time. In addition, changes in consumption were often predictive of changes in school performance. Although a considerable number of null-findings were also observed, many of these may be explained by certain methodological weaknesses (e.g. the sample at T1 being considerably different from that of T2, reduced statistical power etc.) Taken together, the findings therefore suggest that some of the dietary associations already reported in this thesis might be of a causal nature. In particular, the analyses presented here suggest that high/increasing caffeine intake, breakfast omission, energy drink consumption, and a combination of energy drinks, cola, and chewing gum, are of potential cause for concern.

The effects described in this thesis have so far all related to general patterns of dietary intake. It is therefore considered important to also investigate effects that might occur at specific times. In order to address this issue, Chapter 10 will present data from a subset of secondary school children from the Cornish Academies Project to investigate whether breakfast omission and energy drink consumption are predictive of acute occurrences of problem behaviour.

Chapter 10: Acute Effects of Breakfast and Energy Drink Consumption on the Likelihood of Receiving Detentions

10.1 Introduction

Whereas the rest of this thesis has examined general dietary consumption patterns, the current chapter presents findings from a study investigating acute effects. The reason for this is that anecdotal reports, along with findings presented in Chapter 9, suggest that the consumption of energy drinks and omission of breakfast might have potential to cause or exacerbate problem behaviour in school children. In order to provide a preliminary investigation into such claims, the current chapter presents additional data that were collected from all pupils in the Cornish Academies Project who were given detention during a weeklong period of December 2013.

It was considered plausible that secondary school children in detention were more likely to have consumed an energy drink that day compared to a control day later in the same week. In addition, the current study examined whether missing breakfast would be associated with behavioural problems, and whether effects of this and consuming energy drinks would be additive. To assess whether such effects may be related to insufficient sleep, associations between energy drink usage and average number of sleep hours were investigated in the cohort of schoolchildren that the detentions subsample came from. However, it should at this point be reiterated that the findings presented in this chapter are necessarily preliminary, and that they aim to provide a basis for further research.

10.2 Method

10.2.1 Participants

Forty secondary school children from the Cornish Academies Project took part in the current study (Academy 1 N = 20, Academy 2 N = 9, Academy 3 N = 11). Several participants were given more than one detention within the same week (eight were given detention twice, one was given three detentions), and only data relating to their first detention were included in the analysis. Thirty-five of the 40 participants were male, five were female, and an age range of 11-16 years was observed (M = 13.53, SD = 1.19).

10.2.2 Apparatus/Materials

A short questionnaire was used to record whether or not participants had consumed an energy drink and eaten breakfast that day. Both questions were answered by ticking a box to indicate 'yes' or 'no'. SIMS data relating to the rest of the cohort (from T1) were also used to investigate how representative those who received a detention were of the larger population from which they came. In addition to this, 25 of the 40 participants in the current study also responded to the questionnaires along with the rest of the cohort, so these data are used to provide an indication of the typical patterns of sleep, and breakfast and energy drink consumption found in the detentions subsample.

10.2.3 Design

The current study utilised a within-subjects design. The dependent variables were the consumption of energy drinks and breakfast, and the independent variable was the day on which the participants responded (either the day they received a detention or the control day on which they did not).

10.2.4 Procedure

All pupils who were given a detention during a weeklong period of 2013 were asked by their schoolteachers to state whether or not they had consumed an energy drink and eaten breakfast that day. These pupils were then followed-up on a separate day later in the same week (on which they did not receive a detention) to answer the same questions again. Data relating to participants' backgrounds and school performance were collected from SIMS, and stored in an anonymised database at Cardiff University. This information included participants' age, sex, academy attended, school year, ethnicity, attendance, whether or not they were cared for by a non-parental guardian, the presence/absence of a SEN status, the eligibility/ineligibility to receive FSM, the number of behavioural sanctions incurred throughout the school year, and their attainment at Key Stage 3/Key Stage 4 English and maths.

10.3 Results

10.3.1 Characteristics of the Sample

The forty pupils who received a detention during the week of data collection were compared to the rest of the cohort from which they came (i.e. the Cornish Academies Project data from T1). It was found that the academy and school year that the pupils came from were related to their likelihood of receiving a detention. Significantly more pupils than expected in the detentions subsample came from Academy 1, and significantly fewer than expected came from Academy 2, $\chi 2$ (2, N = 3071) = 9.194, p = .01; more than expected came from Year 9, and fewer than expected came from Year 11, $\chi 2$ (4, N = 3040) = 12.867, p = .012. Those who received detentions were also more likely to be male, $\chi 2$ (1, N = 3040) = 21.471, p < .001, to be eligible to receive FSM, $\chi 2$ (1, N = 3040) = 10.308, p = .001, and to have a SEN status, $\chi 2$ (1, N = 3068) = 26.19, p < .001. Furthermore, pupils in detention were significantly more likely to achieve below average school attendance, $\chi 2$ (1, N = 3040) = 4.947, p = .026, and attainment at Key Stage 3/Key Stage 4 English, $\chi 2$ (1, N = 2941) = 15.818, p < .001, and maths, $\chi 2$ (1, N = 2960) = 5.594, p = .018. As might be expected, the sample of pupils in detention during the week of data collection were also found to receive significantly more behavioural sanctions throughout the course of the school year compared to the rest of their cohort, $\chi 2$ (1, N = 3040) = 87.624, p < .001.

10.3.2 Detentions, Energy Drinks, and Breakfast Consumption

The mean number of energy drinks consumed per week was 2.67 (SD = 5.11) in the detention subsample and .97 (SD = 1.88) in the rest of the cohort. It should at this point be noted that response rates to these measures were relatively low in the detention subsample. This is likely because these data were collected at a different time from the detention/control days, and those in the detention subsample achieved significantly lower school attendance than did the rest of the cohort.

The frequency of consumption measures for breakfast and energy drinks were recoded into dichotomous variables. Breakfast frequency was recoded as 'sometimes' vs. 'never' (answers 2, 3, 4, and 5 vs. answer 1), and energy drink consumption was recoded into 'three times a week or more' vs. 'less than three times a week' (answers 4, and 5, vs. answers 1, 2, and 3). Compared to the rest of the cohort, those in detention were significantly more likely to never eat breakfast, $\chi 2$ (1, N = 2022) = 7.717, p = .005, and to consume energy drinks three times a week or more, $\chi 2$ (1, N = 2004) = 14.173, p < .001. Although there was no relationship observed between energy drink consumption and sleep hours in the detention subsample, $\chi 2$ (1, N = 23) = .212, p = .645, analysis of the rest of the cohort showed that those who consumed energy drinks three times a week or more were significantly more likely to achieve fewer than nine hours of sleep per night, $\chi 2$ (1, N = 1899) = 17.804, p < .001. For the frequency of breakfast and energy drink consumption, and the number of sleep hours for the detention subsample and the cohort as a whole, see Table 10.1.

		Detentions subsample		**Rest of cohort**	
		N	%	*N*	%
Breakfast	Never	6	24%	167	8.4%
	Once a month	0	0%	95	4.8%
	Once or twice a week	4	16%	313	15.7%
	Most days (3-6)	4	16%	413	20.7%
	Every day	11	44%	1009	50.5%
Energy drinks	Never	9	39.1%	874	44.1%
	Once a month	4	17.4%	576	29.1%
	Once or twice a week	2	8.7%	325	16.4%
	Most days (3-6)	5	21.7%	152	7.7%
	Every day	3	13%	54	2.7%
Sleep	< 7 hours	3	12%	147	7.7%
	7 hours	2	8%	207	10.8%
	8 hours	6	24%	518	26.9%
	9 hours	6	24%	520	27%
	10 hours	4	16%	378	19.7%
	> 10 hours	4	16%	153	7.9%

Table 10.1. Frequency of breakfast and energy drink consumption and average number of sleep hours for the detentions subsample and the rest of the cohort.

10.3.3 Detention and Control Day Consumption

In order to examine the combined effects of breakfast and energy drink consumption, participants were organised into four groups: 1) breakfast/no energy drink, 2) breakfast/energy drink, 3) no breakfast/no energy drink, 4) no breakfast/energy drink. For distributions of these four groups on the detention day and control day, see Figure 10.1. An exact McNemar's test demonstrated that not eating breakfast combined with the consumption of an energy drink was significantly associated with being in detention, p = .006.

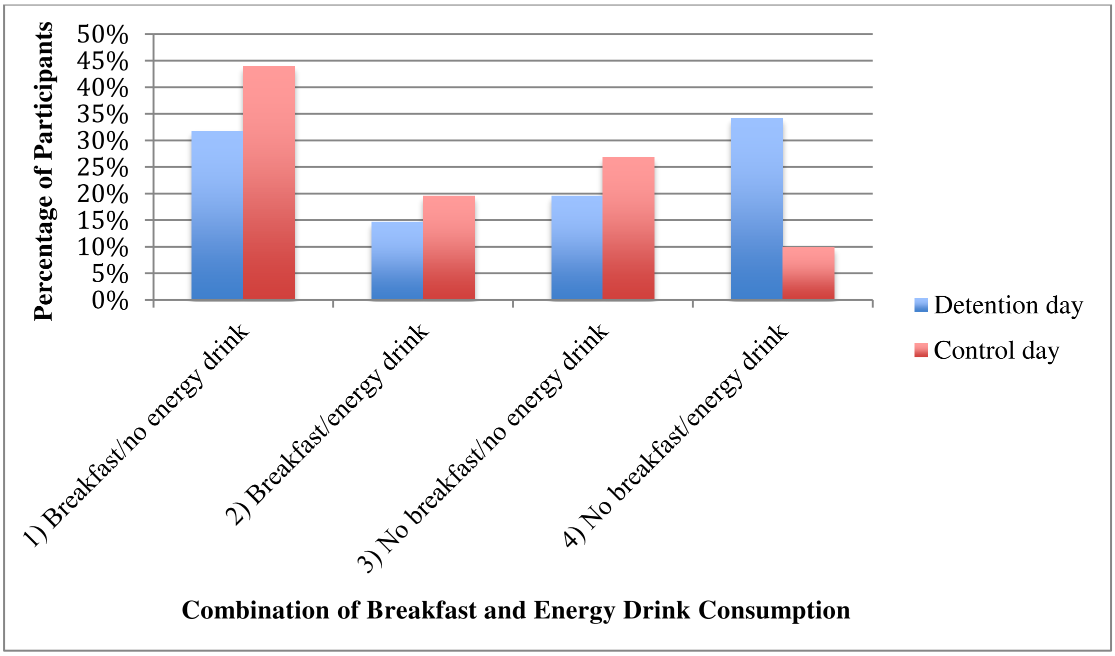

Figure 10.1. Distribution of breakfast and energy drink consumption combinations on the detention day and control day.

10.4 Discussion

The current chapter set out to assess whether consuming energy drinks can exert acute effects on problem behaviour in the school environment. To investigate this, all children from three academies in the South West of England who were given a detention during a weeklong period of 2013 were asked to state whether or not they had consumed an energy drink that day. In addition, the consumption/omission of breakfast was also recorded. The pupils were then followed-up and asked the same questions on a control day in which they had not received a detention.

10.4.1 Breakfast Omission and Energy Drink Consumption

When in detention, pupils were significantly more likely to have consumed an energy drink compared to on the control day. Being that it appears to be the main psychoactive substance present in energy drinks (McLellan & Lieberman, 2012), caffeine may be responsible, at least in part, for behavioural changes that lead to disruptive and problematic incidents resulting in detention. However, as caffeine is also known to have acute positive effects on attention (Einöther & Giesbrecht, 2013), and negative effects of energy drinks have been observed throughout this thesis, it may be that the consumption of energy drinks actually increases as a direct compensation for having skipped breakfast. This idea is supported by the observation that breakfast omission combined with energy drink consumption was significantly more frequent on detention than control days. Equally, missing breakfast may also be the result of waking up late due to insufficient sleep. Subsequent energy drink consumption might therefore reflect a compensatory effect for having achieved poor sleep, an idea supported by the fact that frequent energy drink use in the cohort that the detentions subsample came from was associated with below average sleep hours.

Previous research has generally demonstrated that eating breakfast exerts positive effects on cognitive functioning, memory, and attention in children and adolescents (Cooper, Bandelow, & Nevill, 2011; Pivik, Tennal, Chapman, & Gu, 2012; Wesnes, Pincock, Richardson, Helm, & Hails, 2003; Wesnes, Pincock, & Scholey, 2012; Widenhorn-Müller, Hille, Klenk, & Weiland, 2008). It can therefore be proposed that breakfast omission may lead to behavioural problems caused by a reduced capacity to attend during class, and possibly also due to pupils getting off-task through inability to retain relevant information. Such cognitive effects of breakfast consumption/omission might therefore partly explain the efficacy of breakfast intervention programmes in improving academic performance (Rampersaud et al., 2005) and psychosocial functioning (Murphy et al., 1998).

Considering the observation of James et al. (2011) that academic performance is inversely related to caffeine consumption, and that the relationship is partially mediated by licit substance use (i.e. nicotine and alcohol) and daytime sleepiness, the following cycle can be proposed to explain the relationships observed between missing breakfast, consuming energy drinks, and receiving detentions: 1) poor sleep leads to inability to wake up with sufficient time to eat breakfast, 2) energy drinks are consumed as a compensation for missing breakfast, and as a means to remain awake at school, 3) behavioural problems occur due to daytime sleepiness and inability to pay attention and retain information during class, 4) high caffeine intake causes sleep disturbances the following night, 5) the sequence is repeated. This cycle may be somewhat akin to 'delayed sleep phase disorder' (DSPD), a condition depicted by persistent inability to fall asleep at earlier times and difficulty waking in the morning (see Micic et al., 2016). Lovato, Gradisar, Short, Dohnt, and Micic (2013) also reported DSPD to be associated with higher caffeine intake from tea and coffee, although the effect observed was only marginally significant (p = .08), and no such finding was made in relation to soda. However, DSPS is of further relevance to the current research, as it is know to be related to poor scholastic performance, truancy and behavioural problems (Thorpy, Korman, Spielman, & Glovinsky, 1988), as well as depression (Kripke et al., 2008; Thorpy et al., 1988).

It is possible that the long-term associations between breakfast omission, energy drink consumption, mental health, and school performance reported in previous chapters are explainable in terms of repetitions of the above-discussed cycle. In fact, support for this idea has recently been provided by Koivusilta, Kuoppamäki, and Rimpelä (2016, p. 305), who stated that "Energy drink consumption creates a risk of a negative cycle of disrupted sleep, increased consumption of energy drinks and an increased number of health complaints." In a large-scale study (N = 9446) of 7th graders from Helsinki, these authors also demonstrated that: 1) energy drink use had direct effects on caffeine-induced health complaints (headache, sleeping problems, irritation, and tiredness/fatigue), 2) that these effects were dose dependent, 3) that energy drink use also had a direct effect on late bedtime (defined as 11pm or later, indicating fewer than eight hours of sleep), 4) that late bedtime had a direct effect on health complaints, and 5) that late bedtime partially mediated the relationship between energy drink use and health complaints.

10.4.2 Methodological Limitations

It should at this point be reiterated that the study presented in this chapter is necessarily preliminary in nature, and that it aims to form the basis for future research. Some methodological weaknesses therefore need to be acknowledged, and should be taken into account when interpreting the findings. Firstly, although the results suggest energy drink consumption occurs in the mornings to counteract the effects of poor sleep and breakfast omission, the results can only be considered correlational rather than causational. It could be, for instance, that energy drink consumption at night causes sleep disturbances, which are in turn responsible for behavioural problems observed the following day. Support for this idea is provided by Calamaro et al. (2009), who observed that middle school and high school children often use caffeinated products to stay awake into the night when using media-related technology, inevitably resulting in sleep loss. This study also reported that 33% of teenagers admitted to having fallen asleep at school, and that the caffeine consumption of these individuals was 76% higher than that of those who did not fall asleep at school. Due to such findings, research into the timing of energy drink consumption is necessary to better understand the relationships observed here.

A further limitation of the current study is that the sample size was relatively small. However, from three academies, together consisting of 3071 pupils, it was realistically unfeasible to acquire more data during a weeklong period of collection. Furthermore, as made obvious by the fact that nearly 20% of the sample received more than one detention during this week, it is highly likely that further data collection would have yielded considerable amounts of redundant data from these same individuals. In addition to this issue, it cannot be determined from the data available whether children could have received detentions for either having energy drinks or being late to school (the latter of which could itself be related to sleep loss/energy drink use). If this were indeed the case, it is an obvious and considerable confound to the analysis presented here.

Another problem encountered is that the detentions subsample cannot be deemed fully representative of the schools from which it came. However, intuition would deem this to be expected. Variation in the amount of detentions accrued by each academy and school year are likely to reflect different policies and teaching styles, and sex differences in problem behaviour are already well established in the literature (e.g. Lahey et al., 2000). What is of greater interest to the current research is that children receiving FSM, and those with a SEN status, were more likely to receive detentions. Although low SES and SEN are already known to be predictors of problem school behaviour, given that the current study utilised a within-subjects design it is considered that, though the detentions subsample may have been at greater risk in the first place, these were not the only factors in play. What is possible therefore is that those receiving detentions in the current study represent a subgroup of children who exert antecedents of problem behaviour, and that the omission of breakfast and consumption of energy drinks can act as a catalyst for its manifestation.

Although the current study found that consuming energy drinks three times a week or more was associated with fewer than nine hours of sleep in the rest of the cohort, no such association was observed within the detentions subsample itself. A potential reason for this is that the instrument used to measure sleep duration may not have been sensitive enough. It is noted, for instance, that the study by James et al. (2011) used Chan et al.'s (2009) modified version of the Epworth Sleepiness Scale, an eight-item questionnaire to assess daytime sleepiness, whereas the Cornish Academies Project used a single-item to measure the average number of hours slept per night. Not only is the scale used by James et al. (2011) likely to be more sensitive, but it is in fact also used to measure a different, though related, concept: daytime sleepiness rather than average sleep hours. It is therefore proposed that future work examining links between energy drink usage and problem behaviour should investigate the effects of sleep in greater detail, as well as assess whether acute sleep loss can lead to subsequent behavioural problems.

A further methodological weakness of the current study is that the design did not allow for the use of a placebo control. In addition to this, the control condition (i.e. the day on which pupils did not receive detention) was preceded by the experimental condition (i.e. the day on which pupils did receive detention). It is therefore possible that pupils may have changed their in-class behaviour and dietary practices due to having been questioned by their teachers about their consumption of breakfast and energy drinks on the day that they received a detention. As the design of the study could not accommodate double-blinding procedures, it is also possible that teachers might have acted differently towards pupils after knowing that they were enrolled in the study. This could potentially have altered the pupils' chances of receiving another detention later that week.

10.4.3 Conclusions

Previous chapters have provided evidence to suggest that a combination of breakfast omission and energy drink consumption may be associated with undesirable mental health and school performance outcomes. The study presented here has built upon these findings by presenting preliminary evidence that this dietary pattern may also exert acute effects on the likelihood of secondary school children receiving detentions, and that such effects might rely upon a failure to achieve sufficient sleep. As the children in detention were also found to underperform regarding school attendance, attainment, and behavioural sanctions throughout the rest of the school year, it is considered plausible that they represent a subgroup of problem children whose disruptive in-class behaviour is likely to reoccur. However, due to methodological limitations, such as the study design not permitting the use of a placebo control or double-blinding procedures, the conclusions must remain tentative.

Evidence has been provided throughout this thesis to suggest that certain dietary practices, namely breakfast omission, and the high consumption of caffeine, energy drinks, and the Caffeinated Soft Drinks/Gum DABS factor (itself comprised of energy drinks, cola, and chewing gum), are associated with a number of undesirable effects relating to mental health, academic performance, and problem behaviour. The final chapter will therefore provide a general discussion of these findings, and suggest some ideas for future directions of research.

Chapter 11: General Discussion

11.1 Summary and Critique

11.1.1 Brief Overview

Previous research, as well as a considerable number of reports in the mainstream media, has suggested that energy drink consumption may be associated with undesirable effects in young consumers, and that these effects could rely upon caffeine as their mechanism of action. This thesis has therefore aimed to investigate relationships between energy drink use and academic performance, mental health, and problem behaviour by conducting a series of empirical studies in populations of adolescents and young adults.

Evidence for the potentially deleterious nature of energy drinks was provided, as their consumption, alone and in combination with certain other dietary variables (i.e. breakfast omission, high consumption of cola and chewing gum), was consistently associated with undesirable outcomes throughout this thesis. The effects often appeared to reflect differences at the extremes of the distributions, and, although the majority of significant effects were observed cross-sectionally, evidence for causality was provided through longitudinal analyses. Furthermore, though the claim that the main active component in energy drinks is caffeine (e.g. McLellan & Lieberman, 2012) was not disputed, many of the effects observed appeared to occur independently.

The overwhelming evidence for negative effects of energy drinks came from studies of secondary school children (i.e. Chapters 7, 8, 9, and 10), with relatively few significant findings being made in relation to university students (i.e. Chapters 3, 4, and 5). Although there were marked differences between the demographic groups studied, the likely reason for the lack of significant effects observed in the student data is that the sample sizes were much smaller, implying that the studies might have lacked statistical power, particularly when utilising multivariate approaches to data analysis.

11.1.2 Evaluation of the Objectives of the Thesis

11.1.2.1 Objective 1: To Review the Literature Relating to Associations Between Energy Drink Use and Mental Health and Academic Attainment

Chapter 2 addressed the first object of the thesis by presenting a systematic literature review of energy drinks, mental health, and academic attainment. The main findings from this review were that 1) short-term mood effects of energy drinks are often positive, 2) long-term associations between energy drink use and mental health outcomes are generally negative, 3) low academic attainment is associated with high consumption of energy drinks, 4) methods between studies vary considerably, making comparisons difficult, and 5) there is a distinct lack of longitudinal research, making it impossible to adequately infer causation from the information currently available. It is also hoped that the systematic review of energy drink consumption and mental health will have impact beyond helping determine the direction of this thesis, as it has now been published in a peer-reviewed article in the *Journal of Caffeine Research* (see Richards & Smith, 2016a).

11.1.2.2 Objective 2: To Develop a Questionnaire for Recording the Frequency and Amount of Consumption of Common Foods and Drinks That May Have Effects on Psychological Outcomes

A 29-item questionnaire (the Diet and Behaviour Scale; DABS) was developed in order to provide an easy to administer indication of the frequency and amount of intake of commonly consumed dietary products, with a focus upon foods and drinks that may affect psychological processes. This questionnaire, which has since been published in the *Journal of Food Research* (see Richards, Malthouse, & Smith, 2015), was presented in Chapter 3 and subsequently used throughout the rest of the thesis.

Although inconsistencies in the factor structures associated with the DABS were observed in the studies presented in Chapters 3, 4, and 5, they are considered likely to have been a result of the relatively small samples examined. In the data collected for the Cornish Academies Project (see Chapter 6) the DABS was associated with a four-factor structure labelled ‘Junk Food’, ‘Caffeinated Soft

Drinks/Gum', 'Healthy Foods', and 'Hot Caffeinated Beverages'. This factor structure was also found at both time-points of the study, as well as within each of the three academies individually, meaning that it was reliably observed in eight separate factor analyses. The items loading strongly onto each factor were then used to compute subscales, which were found to have acceptable (or better) levels of internal consistency, to correlate strongly with their respective factor scores, and to correlate positively between time-points. These findings were important as it meant that the subscales could be used as covariates to control for additional dietary influences whilst avoiding the unnecessary inclusion of shared variance with other predictor variables. These subscales also made it possible to investigate the effects of dietary change over time by providing variables that, unlike factor scores, were stable across time-points.

The research presented in this thesis suggests that the DABS can be a useful measure of dietary variance, and that it provides a reliable and fast assessment of both frequency and amount of consumption. However, due to the preliminary nature of the research, further studies using this questionnaire are required to increase its validity. In order to address this issue, research using the scale is currently being conducted in further samples of students and working adults.

11.1.2.3 Objective 3: To Assess Consumption Patterns of Energy Drinks, As Well As Their Correlates

As much research has operated around the use of single-item measures of dietary products of interest, an aim of this thesis was to assess the effects of energy drinks in relation to other dietary products with which their consumption naturally correlates. Such dietary variables were identified through factor analysis: in the secondary school children, energy drink use was associated with cola and chewing gum; in university students, factors were extracted in which energy drinks were differentially associated with cola, coffee, and the absence of breakfast. This latter observation was also however noted in the secondary school children, as breakfast consumption was found to correlate negatively with energy drink use: it was simply not included as an item in the Caffeinated Soft Drinks/Gum subscale due to the factor loading score being below the arbitrarily designated cut-off point. Although it is difficult to draw comparisons between the studies presented, the different structures observed could imply that school children and university students use energy drinks for different purposes. This might reflect university students using caffeinated products for coping with stress (e.g. Ríos et al., 2013), staying awake whilst completing coursework and studying for exams (Maier, et al., 2013; Malinauskas et al., 2007), and for mixing with alcohol while partying (e.g. O'Brien et al., 2008), whereas school children use them, amongst other things, as a replacement for breakfast (Richardson, 2013) and for waking up in the morning and remaining alert at school.

11.1.2.4 Objective 4: To Investigate Whether Energy Drink Consumption Is Associated With Mental Health, Academic Attainment, and Problem Behaviour

Evidence for negative associations between energy drink use and mental health and academic performance was provided throughout this thesis, though was generally stronger in studies of school children than studies of university students. In the Cornish Academies Project, negative outcomes were consistently associated with high consumption of caffeine, energy drinks, and Caffeinated Soft Drinks/Gum (i.e. energy drinks, cola and chewing gum), as well as with breakfast omission. Although some similar effects were observed in the student studies, most did not remain statistically significant once covariates had been controlled for. However, the findings presented here generally support previous reports in the academic literature and mainstream media.

11.1.2.5 Objective 5: To Determine Whether Associations Between Energy Drink Use and Mental Health, Academic Attainment, and Problem Behaviour Rely Primarily on the Action of Caffeine

Although negative associations between both energy drinks and caffeine and mental health and academic performance variables have been reported in the literature, it has not been made clear whether these effects are one and the same, or whether they rely upon different mechanisms. Though the current research found evidence of both types of effect, as caffeine consumption was controlled for in multivariate analyses of the effects of energy drinks, it appears likely that they are, at least to some extent, independent. A possible explanation is that caffeine may have an effect in itself, but that the high consumption of energy drinks (and associated dietary products) is an outcome of negative behaviour/personality factors. Although this thesis has gone a certain way to untangling these variables, further research should be conducted for definitive conclusions to be drawn. It should also be noted that a positive relationship between caffeine use and work efficiency was observed in students, suggesting that the substance can be associated with both positive and negative outcomes in this population.

11.1.2.6 Objective 6: To Investigate Whether Energy Drink Consumption Is a Cause or Outcome of Poor Mental Health, Low Academic Attainment, and Problem Behaviour, or Whether the Variables Are Merely Correlated

Although there are accounts in the literature linking energy drink consumption to negative outcomes regarding school performance (Azagba et al., 2014; Champlin et al., 2016; Martz et al., 2015; Pettit & DeBarr, 2011) and mental health (e.g. Azagba et al., 2014; Stasio et al., 2011; Trapp et al., 2014), the vast majority of reports are correlational, with few longitudinal or intervention studies having so far been published. One of the aims of the current research was therefore to assess whether such relationships are likely to be causal or correlational.

It was only possible/feasible to carry out change-score analyses at certain points in this thesis, though some evidence was provided to suggest that causal links might exist. Although little evidence of dietary change having effects on mental health and academic outcomes was observed in university students, decreasing consumption of breakfast, and increasing consumption of caffeine, energy drinks, and Caffeinated Soft Drinks/Gum over a six-month period were all associated with undesirable changes in school performance in secondary school children (i.e. decreasing attendance, not increasing in attainment, and increasing in behavioural sanctions). It should also be noted, however, that a considerable number of null-findings were made. A likely reason why many such effects were detected at the univariate level yet did not remain significant after controlling for covariates is that they are typically small, that they relate mainly to extremes in the distribution, and that the cross-sections of data collected in the Cornish Academies Project were spaced only six months apart.

Although evidence of potential causality has been provided here, further research is needed for firm conclusions to be drawn. In order to address this issue, it is suggested that future research utilises interventions (i.e. randomised-controlled trials), as well as additional longitudinal studies in which the time-points are spaced more than six months apart.

11.2 Potential Mechanisms for Energy Drink Action

There are several ways in which associations between the use of energy drinks and mental health and academic/school performance may be explained. However, it is likely that the results observed reflect a combination of these effects, as well as potentially other, as of yet unidentified factors.

11.2.1 Caffeine

Due to the high concentrations present in energy drink products (e.g. Reissig et al., 2009), and its associations with a number of negative outcomes (see Lara, 2010), an obvious candidate as a causative agent is caffeine. However, though effects in concordance with this were observed in the present research, many associations involving energy drink consumption remained significant after other sources of caffeine had been controlled for statistically. Therefore, although high caffeine intake appears to be associated with these outcomes, it is unlikely to account for the relationships in their entirety, meaning that other explanations must be sought.

11.2.2 Sleep Disruption and Breakfast Omission

Evidence for associations between a combination of breakfast omission and energy drink consumption and mental health, academic attainment, and problem behaviour was provided throughout this thesis. A proposed model for how these variables may combine to produce negative effects was put forward in Chapter 10 (see section 10.4.1). This explanation essentially suggested that poor sleep quality/duration may cause problems waking up in the morning, leading to breakfast being skipped, energy drinks being consumed, and high caffeine use producing subsequent sleep problems. However, the nature of this model could not be tested using the research methodology adopted here. In order to do this, qualitative studies should be conducted to better determine the reasons for energy drink use in secondary school children and university students. In addition, the timing of consumption should be investigated. For instance, energy drinks could be consumed in the mornings to counteract the effects of tiredness, in the evenings to delay sleep onset when playing video games/watching television etc. (e.g. Calamaro et al., 2009), or both. Whatever the reasons, evidence was provided to suggest that their use, alone or in combination with the omission of breakfast, is predictive of undesirable outcomes in both secondary school children and university students.

11.2.3 Personality Factors/Social Image

Although personality factors were controlled for in the student studies, the relevant information was not available in those of secondary school children. As more convincing results were generally provided by the latter, it is therefore difficult to state with conviction that the effects observed were not attributable to personality characteristics. For instance, some people with mental health problems appear to ‘self-medicate’ with both licit and illicit substances (e.g. Bolton, Cox, Clara, & Sareen, 2006). Therefore, it is not possible to discount the idea that this was the reason for some (or indeed all) of the dietary effects observed in the Cornish Academies Project.

Miller (2008a) has linked energy drink use in US university students to a ‘toxic jock’ identity, and it is possible that a similar concept exists within British universities and secondary schools. Evidence for this idea was provided by the observation that the Caffeinated Soft Drinks/Gum factor reported in the Cornish Academies Project was consistently associated with negative outcomes, and that the strongest predictor of these outcomes tended to be the high consumption of all three product types, even though this included chewing gum, which has itself been associated with a number of positive effects on mental health, attention, and stress (see Allen & Smith, 2011). It is possible that high consumption of this dietary factor actually reflects a more pervasive behavioural pattern, and a social image akin to that of the ‘toxic jock’. The effects observed might therefore be attributable to personality traits associated with those who consume the products, rather than to the products themselves. For this reason, personality factors should be investigated further in future studies of energy drink use in British populations.

11.2.4 General Bad Lifestyle

As with the points made in the above section, a problem with research into diet in general is that dietary products, as well as other aspects of lifestyle, are strongly inter-correlated (e.g. French et al., 2000; Northstone et al., 2005). Evidence of relationships between bad diet (e.g. Caffeinated Soft Drinks/Gum, Junk Food etc.) and poor lifestyle (e.g. infrequent exercise, low sleep hours) was observed in all studies reported in this thesis. Although a multivariate approach to data analysis was utilised, it is impossible to disregard the idea that additional lifestyle factors may have accounted for the relationships observed between the dietary variables and outcomes.

11.3 Future Research

The research presented in this thesis has highlighted the efficacy of using multivariate approaches to data analysis when investigating associations between diet and psychological outcomes. It is therefore suggested that future studies should continue with this approach, and particularly so in regards to controlling for additional dietary variance. However, although the work presented here has helped to address the general lack of longitudinal studies into the effects of energy drinks, more research of a similar nature is required. A weakness of the two longitudinal studies reported in this thesis was that the cross-sections were collected in relatively close temporal proximity. Further research should therefore aim to collect datasets that can be used to investigate the effects of diet over a longer timeframe (e.g. over the course of a year or more). Such investigations could help determine whether the cross-lag effects observed in this thesis are explainable by correlations between the two time-points, or whether they may reflect pervasive, long-lasting effects of diet.

Although a certain amount of evidence for causal relationships between dietary patterns and school performance was observed in the Cornish Academies Project, further research is needed to better determine their nature. An example of a study design that may be useful comes from Wing et al. (2015), who conducted an intervention involving sleep education. Those in the intervention condition improved in terms of mental health and, additionally, reduced their energy drink intake. Further studies of this nature could avoid ethical concerns regarding administering energy drink products to participants whilst furthering our knowledge of how sleep, energy drink use, and mental health and school performance outcomes are related. Such interventions could of course then be used to actively promote better sleep hygiene and reduce undesirable dietary habits should sufficient evidence of causality be provided.

More research into dietary effects on academic performance and mental health in undergraduate students/young adults is necessary to determine whether energy drinks should be considered a genuine danger, or whether their use is merely a correlate of certain undesirable outcomes. Although the results of the studies presented in Chapters 3, 4, and 5 were undermined for a number of reasons (i.e. small sample sizes, homogeneous populations etc.), they have provided limited evidence to suggest that high consumption of caffeine and energy drinks is generally related to negative outcomes in this population. Studies that investigate these phenomena in larger and more representative samples are therefore required to better our understanding of such effects.

11.4 Conclusions and Final Thoughts

Although further research is clearly required in this area, a number of tentative conclusions can be drawn from the current findings. Firstly, the absence of breakfast and frequent consumption of energy drinks were consistently associated with negative effects, with a combination of the two tending to provide the strongest predictor of undesirable outcomes. The preliminary study reported in Chapter 10 also suggested that this dietary pattern might be associated with acute behavioural effects, though it remains unclear upon which mechanism(s) it may rely. Although a potential explanation was provided, which suggests breakfast omission and energy drink use to be related to sleep disturbances, this account currently remains speculative. It is also unclear whether breakfast omission, energy drink use, sleep problems, or a combination of these factors may be the cause(s) of behavioural problems, or whether these variables are simply correlates of another, as yet unidentified causal agent. Until further research is able to answer such questions, it is suggested that breakfast omission and energy drink use should not be encouraged in children and adolescents, and that achieving good sleep hygiene is paramount.

A combination of high consumption of energy drinks, cola, and chewing gum was consistently associated with poor school performance and mental health in secondary school children. However, though some evidence was provided to suggest that increasing consumption of this dietary pattern was associated with detriments to school performance, the same dietary pattern did not emerge in the samples of university students that were investigated in Chapters 3, 4, and 5. Although this latter observation is likely to have reflected differences in sample sizes, another potential reason is that secondary school children and university students use energy drinks for different purposes. For this reason it is difficult to adequately compare the effects observed between these two populations.

High consumption of caffeine was generally associated with undesirable outcomes in both secondary school children and university students, though it should be noted that a positive cross-sectional relationship between total weekly intake and work efficiency was reported in Chapter 4. Although changing consumption was not significantly associated with academic attainment or problem behaviour, a relationship between increasing consumption and decreasing school attendance was observed in Chapter 9, which suggests that this dietary pattern may be a cause for concern.

In conclusion, this thesis has presented evidence to suggest that a number of dietary patterns that include the high consumption of caffeinated energy drinks are associated with undesirable outcomes in adolescents and young adults. However, although evidence was provided that some of these effects might be causal, the findings alone may not be sufficient to advocate policy change. Prior to making such suggestions, further rigorous investigation into a range of different populations is required. Any decision to ban the sale of energy drinks to those under the age of 16, for instance, should be considered in light of the observation that doing so may create other problems, such as a subsequent emergence of black markets in secondary schools.

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Appendix A: Alternative Factor Analysis From the Longitudinal Student Survey (T2)

Because the factor structures extracted from the DABS clearly differed between T1 and T2 of the longitudinal student survey, it was considered useful to investigate the matter further. The reason for this was that the factor analysis presented in Chapter 3, which related to the second cross-section of data (T2) included participants who were in their second year of study, and who were not included in the initial sample. It was therefore considered likely that this may have, at least in part, explained the differences between the two analyses. A factor analysis of the second cross-section of data in which these additional participants were excluded was therefore conducted (see Table A.1). However, although a four-factor structure

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Q1. How often did you eat breakfast?	.021	.136	-.011	.198
Q2. How often did you eat chocolate?	.445	-.069	.182	-.185
Q3. How often did you eat crisps?	**.714**	-.213	-.167	.012
Q4. How often did you eat five pieces of fruit or veg?	-.420	.431	-.405	.08
Q5. How often did you drink coffee?	.045	**.815**	.195	.078
Q6. How often did you drink tea?	.072	.261	-.212	**.654**
Q7. How often did you drink cola?	**.59**	-.049	.395	-.275
Q8. How often did you drink energy drinks?	.279	.339	-.284	**-.542**
Q9. How often did you chew gum?	-.035	.198	**.643**	.096
Q10. How often did you eat sweets?	**.487**	.175	.072	-.196
Q11. How often did you eat fast-food?	**.632**	-.087	.043	.12
Q12. How often did you eat takeaway?	**.483**	.245	-.035	.05
Q13. How often did you eat pies or pasties?	.429	.214	.088	.38
Q14. How often did you eat processed meat?	.383	.02	.282	.19
Q15. How often did you eat fried fish?	.218	.216	-.013	.058
Q16. How often did you eat oily fish?	-.046	.445	-.109	.032
Q17. How often did you eat chips?	**.502**	-.174	.018	-.15
Q18. How often did you eat beans or peas?	-.034	.146	-.411	.097
Q19. Cans of energy drink per week	.173	.282	-.296	**-.541**
Q20. Cans of cola per week	.426	-.234	**.471**	-.301
Q21. Cups of coffee per week	.042	**.768**	.188	-.006
Q22. Cups of tea per week	-.005	-.006	-.252	**.706**
Q23. Packets of crisps per week	**.694**	-.035	-.071	.044
Q24. Bars of chocolate per week	**.527**	-.016	.236	-.186
Q25. Burgers/hot dogs per week	**.615**	.054	.044	.091
Q26. Packs of chewing gum per week	.029	.117	**.61**	-.049
Q27. Pieces of fruit per day	-.276	.237	-.219	-.07
Q28. Portions of vegetables per day	-.331	.401	-.427	.081
Q29. Pints of water per day	-.267	.328	-.145	.03
Initial eigenvalue	5.037	2.636	2.018	1.826
Percentage of variance explained	15.28%	9.13%	8.04%	7.26%

Table A.1. Exploratory factor analysis of DABS items from T2 of the longitudinal student survey (excluding participants who did not take part at T1).
Note. Factor scores are the product of varimax (orthogonal) rotation; those > .45 (or < -.45) are displayed in bold.

was once again extracted, it was found to differ somewhat from each of those previously observed. For this reason it is considered more likely that the factor structures between T1 and T2 differed due to the relatively small sample sizes present rather than because of the inclusion of second year students in the latter cross-section.

Appendix B: Alternative Factor Analysis From the Cornish Academies Project

An exploratory analysis of the DABS was conducted for the data from the Cornish Academies Project in which only the frequency items were entered. This produced a two-factor solution that essentially sorted dietary items into those that are healthy and those that are not (for factor loading scores, initial eigenvalues, and percentages of variance explained by each factor, see Table B.1). This model may be considered somewhat akin to the ‘wholefoods’ and ‘processed foods’ (Akbaraly et al., 2009) and ‘healthy/prudent dietary pattern’ and ‘Western pattern’ (Ambrosini et al., 2011; Hu et al., 1999) previously described in the literature. However, in the context of the present research this model was not considered to be as useful as the four-factor model (Junk Food, Caffeinated Soft Drinks/Gum, Healthy Foods, Hot Caffeinated Beverages) utilised in Chapters 6, 7, 8, and 9, as it may have obscured the effects of energy drinks. In addition to this, relatively few items were found to load particularly strongly upon either factor.

	Factor 1: Unhealthy		Factor 2: Healthy	
	T1	T2	T1	T2
Q1. How often did you eat breakfast?	-.211	-.199	.44	.413
Q2. How often did you eat chocolate?	**.524**	.464	-.006	-.002
Q3. How often did you eat crisps?	.459	.466	-.011	-.011
Q4. How often did you eat five pieces of fruit or veg?	-.249	-.298	**.512**	.47
Q5. How often did you drink coffee?	.236	.192	.057	.175
Q6. How often did you drink tea?	.194	.144	.134	.226
Q7. How often did you drink cola?	**.665**	**.646**	-.124	-.11
Q8. How often did you drink energy drinks?	**.619**	**.594**	-.166	-.038
Q9. How often did you chew gum?	.49	.42	-.114	-.012
Q10. How often did you eat sweets?	**.634**	**.619**	-.004	.061
Q11. How often did you eat fast-food?	**.604**	**.649**	-.034	-.02
Q12. How often did you eat takeaway?	.499	.472	.201	.2
Q13. How often did you eat pies or pasties?	.441	.424	.406	.397
Q14. How often did you eat processed meat?	.292	.283	.217	.243
Q15. How often did you eat fried fish?	.224	.175	**.619**	**.665**
Q16. How often did you eat oily fish?	.008	-.011	**.648**	**.658**
Q17. How often did you eat chips?	**.577**	**.538**	.018	.048
Q18. How often did you eat beans or peas?	.039	-.031	**.567**	**.542**
Initial eigenvalue	3.738	3.489	1.963	1.917
% variance explained	20.6%	18.94%	11.07%	11.09%

Table B.1. Two-factor exploratory analysis of the DABS frequency of consumption items from T1 and T2 of the Cornish Academies Project.

Note. Factor scores are the product of varimax (orthogonal) rotation; those > .5 are displayed in bold. Total percentage of variance explained was 31.67% at T1 and 30.03% at T2.

Appendix C: Model Fit Statistics and Percentages of Variance Explained by the Multivariate Analyses Presented in Chapters 7, 8, and 9

The omnibus tests of model coefficients, along with the percentages of variance explained by each of the multivariate analyses from Chapter 7 are shown in Table C.1. Those from T1 and T2 from Chapter 8 are shown in Tables C.2 and C.3, respectively. Finally, those relating to the cross-lag and change-score analyses presented in Chapter 9 are displayed in Tables C.4 and C.5, respectively. The model fit statistics for each of the multivariate analyses presented in Chapters 7, 8, and 9 were significant (all $p < .001$). For models investigating mental health outcomes, the percentage of variance explained was fairly small (smallest Cox and Snell R^2 value

Predictor variable	Outcome	Omnibus tests of model coefficients			Model summary		
		$\chi 2$	df	p	Cox & Snell R^2	Nagelkerke R^2	Correctly predicted
Total weekly caffeine	General health T1	226.615	19	< .001	.131	.19	74.3%
	General health T2	184.132	19	< .001	.104	.148	72.8%
	Stress	112.69	19	< .001	.065	.089	64.8%
	Anxiety	147.319	19	< .001	.084	.113	63.2%
	Depression	102.02	19	< .001	.059	.082	68.6%
Individual sources of caffeine	General health T1	236.418	22	< .001	.136	.197	75%
	General health T2	190.889	22	< .001	.107	.153	72.7%
	Stress	122.428	22	< .001	.07	.096	65.5%
	Anxiety	143.85	22	< .001	.082	.111	64.6%
	Depression	102.955	22	< .001	.06	.083	69.2%
Breakfast	General health T1	241.769	16	< .001	.14	.202	74.7%
	General health T2	204.763	16	< .001	.115	.164	72.3%
	Stress	112.603	16	< .001	.065	.089	64.8%
	Anxiety	151.421	16	< .001	.086	.116	64.6%
	Depression	113.058	16	< .001	.065	.09	68.6%
Energy drinks	General health T1	226.518	18	< .001	.132	.19	74.5%
	General health T2	189.28	18	< .001	.106	.15	72.5%
	Stress	114.547	18	< .001	.065	.089	64.2%
	Anxiety	148.71	18	< .001	.084	.113	64.8%
	Depression	102.134	18	< .001	.059	.081	68.6%
Energy drinks/ breakfast combinations	General health T1	243.535	20	< .001	.141	.204	74.9%
	General health T2	218.013	20	< .001	.121	.172	72.7%
	Stress	121.808	20	< .001	.069	.095	64.6%
	Anxiety	157.112	20	< .001	.089	.119	64.6%
	Depression	116.189	20	< .001	.067	.092	68.5%
Caffeinated Soft Drinks/Gum	General health T1	223.228	16	< .001	.14	.203	75.2%
	General health T2	195.593	16	< .001	.118	.169	73.1%
	Stress	100.997	16	< .001	.063	.086	64.6%
	Anxiety	124.745	16	< .001	.077	.104	64.6%
	Depression	104.486	16	< .001	.065	.091	68.8%

Table C.1. Model fit statistics and percentage of variance explained by each multivariate analysis presented in Chapter 7.

observed = .059, largest Nagelkerke R^2 value observed = .204), although they were able to predict between 63.2% and 75.2% of cases correctly. For models examining school performance outcomes, the percentage of variance explained was typically higher (smallest Cox and Snell R^2 value observed = .086, largest Nagelkerke R^2 value observed = .4). These models predicted between 62.8% and 86.7% of cases correctly.

Predictor variable	**Outcome**	**Omnibus tests of model coefficients**			**Model summary**		
		$\chi 2$	df	*p*	Cox & Snell R^2	Nagelkerke R^2	Correctly predicted
Total weekly caffeine	School attendance	183.169	18	< .001	.105	.14	63.4%
	English attainment	396.868	19	< .001	.218	.29	69.9%
	Maths attainment	388.228	19	< .001	.213	.285	71.5%
	Behavioural sanctions	189.676	19	< .001	.109	.196	86.5%
Individual sources of caffeine	School attendance	191.719	21	< .001	.11	.147	64%
	English attainment	412.636	22	< .001	.225	.3	70.5%
	Maths attainment	416.23	22	< .001	.226	.303	71.7%
	Behavioural sanctions	198.198	22	< .001	.114	.204	86.4%
Breakfast	School attendance	187.735	15	< .001	.108	.144	62.8%
	English attainment	394.503	16	< .001	.217	.29	70.5%
	Maths attainment	384.545	16	< .001	.212	.284	71.7%
	Behavioural sanctions	177.809	16	< .001	.103	.185	86.6%
Energy drinks	School attendance	200.456	17	< .001	.115	.154	63.8%
	English attainment	405.238	18	< .001	.223	.297	70.4%
	Maths attainment	399.4	18	< .001	.219	.293	72%
	Behavioural sanctions	191.956	18	< .001	.111	.198	86.6%
Energy drinks/ breakfast combinations	School attendance	202.478	19	< .001	.117	.156	63.7%
	English attainment	406.191	20	< .001	.224	.298	70.9%
	Maths attainment	396.02	20	< .001	.218	.292	71.9%
	Behavioural sanctions	188.137	20	< .001	.109	.195	86.7%
Caffeinated Soft Drinks/Gum	School attendance	171.351	15	< .001	.107	.143	63.5%
	English attainment	352.824	16	< .001	.211	.281	70%
	Maths attainment	348.577	16	< .001	.208	.278	70.3%
	Behavioural sanctions	167.857	16	< .001	.105	.19	86.5%

Table C.2. Model fit statistics and percentage of variance explained by each multivariate analysis from T1 presented in Chapter 8.

Predictor variable	Outcome	Omnibus tests of model coefficients			Model summary		
		χ2	df	*p*	Cox & Snell R^2	Nagelkerke R^2	Correctly predicted
Total weekly caffeine	School attendance	274.787	18	< .001	.15	.201	66.1%
	English attainment	268.103	19	< .001	.148	.197	67.6%
	Maths attainment	244.669	19	< .001	.137	.182	67.3%
	Behavioural sanctions	151.494	19	< .001	.086	.137	81%
Individual sources of caffeine	School attendance	285.598	21	< .001	.156	.208	65.8%
	English attainment	293.288	22	< .001	.161	.214	67.2%
	Maths attainment	264.961	22	< .001	.147	.196	67.2%
	Behavioural sanctions	160.391	22	< .001	.091	.145	80.4%
Breakfast	School attendance	286.994	15	< .001	.157	.209	65.7%
	English attainment	278.783	16	< .001	.153	.205	67.1%
	Maths attainment	237.118	16	< .001	.133	.177	67.1%
	Behavioural sanctions	161.198	16	< .001	.092	.146	81%
Energy drinks	School attendance	270.09	17	< .001	.147	.196	65.7%
	English attainment	283.618	18	< .001	.154	.206	67.3%
	Maths attainment	249.717	18	< .001	.138	.184	66.5%
	Behavioural sanctions	175.432	18	< .001	.098	.156	80.6%
Energy drinks/ breakfast combinations	School attendance	287.22	19	< .001	.155	.208	65.5%
	English attainment	298.123	20	< .001	.162	.216	67.7%
	Maths attainment	252.493	20	< .001	.139	.186	66.7%
	Behavioural sanctions	179.477	20	< .001	.101	.16	80.9%
Caffeinated Soft Drinks/Gum	School attendance	273.477	15	< .001	.161	.215	66.6%
	English attainment	271.782	16	< .001	.161	.215	67.1%
	Maths attainment	247.45	16	< .001	.149	.198	67.4%
	Behavioural sanctions	169.967	16	< .001	.104	.166	81.3%

Table C.3. Model fit statistics and percentage of variance explained by each multivariate analysis from T2 presented in Chapter 8.

Predictor variable	Outcome	Omnibus tests of model coefficients			Model summary		
		χ2	df	*p*	Cox & Snell R^2	Nagelkerke R^2	Correctly predicted
Total weekly caffeine	School attendance	298.16	18	< .001	.167	.223	65.6%
	English attainment	272.646	19	< .001	.155	.207	66.5%
	Maths attainment	248.848	19	< .001	.143	.191	65.3%
	Behavioural sanctions	163.239	19	< .001	.095	.144	76.9%
Individual sources of caffeine	School attendance	311.881	21	< .001	.174	.233	65.3%
	English attainment	285.998	22	< .001	.162	.216	66.4%
	Maths attainment	259.699	22	< .001	.149	.199	65.9%
	Behavioural sanctions	168.808	22	< .001	.099	.149	76.8%
Breakfast	School attendance	310.438	15	< .001	.174	.233	66.4%
	English attainment	265.741	16	< .001	.152	.203	65.6%
	Maths attainment	244.292	16	< .001	.141	.189	65%
	Behavioural sanctions	153.626	16	< .001	.09	.137	77.2%
Energy drinks	School attendance	309.765	17	< .001	.174	.232	66.6%
	English attainment	272.898	18	< .001	.156	.208	65.8%
	Maths attainment	253	18	< .001	.146	.195	64.8%
	Behavioural sanctions	162.535	18	< .001	.095	.144	77.2%
Energy drinks/ breakfast combinations	School attendance	326.707	19	< .001	.183	.244	67.3%
	English attainment	273.817	20	< .001	.157	.209	66.4%
	Maths attainment	250.93	20	< .001	.146	.194	65%
	Behavioural sanctions	162.021	20	< .001	.096	.144	76.9%
Caffeinated Soft Drinks/Gum	School attendance	279.152	15	< .001	.17	.226	66.1%
	English attainment	235.66	16	< .001	.146	.195	66.9%
	Maths attainment	220.704	16	< .001	.138	.185	64.1%
	Behavioural sanctions	149.737	16	< .001	.095	.144	77.1%

Table C.4. Model fit statistics and percentage of variance explained by each cross-lag multivariate analysis presented in Chapter 9.

Predictor variable	Outcome	Omnibus tests of model coefficients			Model summary		
		χ2	df	*p*	Cox & Snell R^2	Nagelkerke R^2	Correctly predicted
Total weekly caffeine (increase vs. no increase)	School attendance	277.279	14	< .001	.194	.268	71.4%
	English attainment	312.962	15	< .001	.22	.303	77.6%
	Maths attainment	433.376	15	< .001	.29	.387	76.7%
	Behavioural sanctions	354.918	15	< .001	.241	.388	82.8%
Individual sources of caffeine (increase vs. no increase)	School attendance	276.955	17	< .001	.193	.268	72%
	English attainment	320.687	18	< .001	.225	.309	77.3%
	Maths attainment	436.144	18	< .001	.291	.389	76.5%
	Behavioural sanctions	358.778	18	< .001	.244	.391	83%
Breakfast (decrease vs. no decrease)	School attendance	283.156	15	< .001	.19	.264	71.1%
	English attainment	320.59	16	< .001	.217	.299	77.8%
	Maths attainment	439.275	16	< .001	.284	.379	76.2%
	Behavioural sanctions	382.487	16	< .001	.249	.395	82.3%
Energy drinks (increase vs. no increase)	School attendance	299.454	17	< .001	.201	.278	72.4%
	English attainment	320.037	18	< .001	.217	.299	77.8%
	Maths attainment	446.446	18	< .001	.289	.385	76.2%
	Behavioural sanctions	385.73	18	< .001	.251	.399	82.1%
Caffeinated Soft Drinks/Gum (increase vs. no increase)	School attendance	261.822	15	< .001	.197	.273	71.6%
	English attainment	292.963	16	< .001	.222	.305	77.5%
	Maths attainment	415.236	16	< .001	.298	.397	76.7%
	Behavioural sanctions	337.258	16	< .001	.246	.4	83.7%

Table C.5. Model fit statistics and percentage of variance explained by each change-score multivariate analysis presented in Chapter 9.

Appendix D: Interactions Between Dietary and Demographic/Lifestyle Variables in Relation to Mental Health and School Performance Outcomes in the Cornish Academies Project

In order to investigate whether cross-sectional associations between dietary variables and mental health and school performance outcomes presented in Chapters 7 and 8 may have been moderated by other factors, interaction analyses were conducted. Four variables were chosen that were considered the most likely to interact with diet: 1) sex, 2) presence/absence of a SEN status, 3) eligibility/ineligibly to receive FSM, and 4) number of sleep hours. The method used for examining these interactions was essentially the same as when the main effects were investigated at the multivariate level (i.e. the same covariates were entered into binary logistic regression analyses), except that the interaction term of interest was also included in the model. In each case the following groups were set as the reference category: total weekly caffeine (0mg/w), breakfast frequency (every day), energy drink frequency (less than once a week), Caffeinated Soft Drinks/Gum (lower than average consumption), sex (male), SEN status (presence of a SEN status), FSM (eligible to receive FSM), sleep (lower than average sleep hours).

In the case of sleep, in order to make interpreting/reporting the data easier, a categorical high/low (median split) variable was used to create the interaction term rather than the original continuous single-item measure. This was the case for all analyses in which an interaction between a dietary variable and sleep was investigated. In addition, analyses that investigated interactions between the Caffeinated Soft Drinks/Gum DABS factor score and demographic/lifestyle variables also utilised dichotomous (high/low, median split) variables for the interaction term.

Due to the large number of interactions investigated, a conservative approach to their interpretation was taken. Therefore, overall effects not considered statistically significant by conventional standards (i.e. $p < .05$) were not investigated further. In order to interpret the nature of the significant interactions, univariate level ANOVAs were examined so that the mean scores could be compared across groups.

D.1 Mental Health

D.1.1 Interactions Between Total Weekly Caffeine Consumption and Demographic/Lifestyle Variables in Relation to Mental Health Outcomes

Wald and *p* values relating to the overall significance of interactions between caffeine group and sex, SEN status, FSM, and sleep are presented in Table D.1. Only two significant interactions were observed. The first was between caffeine group and sex on the outcome of general health at T1. This reflected increased risk of females reporting poor general health, and reduced risk of males reporting poor general health occurring in the 500.1-750mg/w caffeine group; females also appeared to be at greater risk compared to males if they were in the >1000mg/w group (see Figure D.1). The second significant effect was an interaction between caffeine and sleep on the outcome of depression. This broadly reflected a higher chance of those in the 0mg/w, 0.1-250mg/w, and 750.1-1000mg/w caffeine consumption groups reporting high depression scores if they also achieved a below average number of sleep hours (see Figure D.2). The benefits of high sleep also appeared to be negated in those who consumed very high amounts of caffeine (i.e. the >1000mg/w group).

	Interaction term	**Wald**	***p***
General health T1	Caffeine*Sex	18.067	.003
	Caffeine*SEN	1.934	.858
	Caffeine*FSM	7.02	.219
	Caffeine*Sleep	4.65	.46
General health T2	Caffeine*Sex	2.811	.729
	Caffeine*SEN	8.07	.152
	Caffeine*FSM	2.27	.811
	Caffeine*Sleep	2.964	.706
Stress	Caffeine*Sex	2.241	.815
	Caffeine*SEN	2.331	.802
	Caffeine*FSM	10.02	.075
	Caffeine*Sleep	9.214	.101
Anxiety	Caffeine*Sex	10.516	.062
	Caffeine*SEN	2.195	.822
	Caffeine*FSM	4.432	.489
	Caffeine*Sleep	5.013	.414
Depression	Caffeine*Sex	8.118	.15
	Caffeine*SEN	4.636	.462
	Caffeine*FSM	4.271	.511
	Caffeine*Sleep	11.278	.046

Table D.1. Interactions between caffeine and sex, SEN status, FSM, and sleep in relation to mental health outcomes.

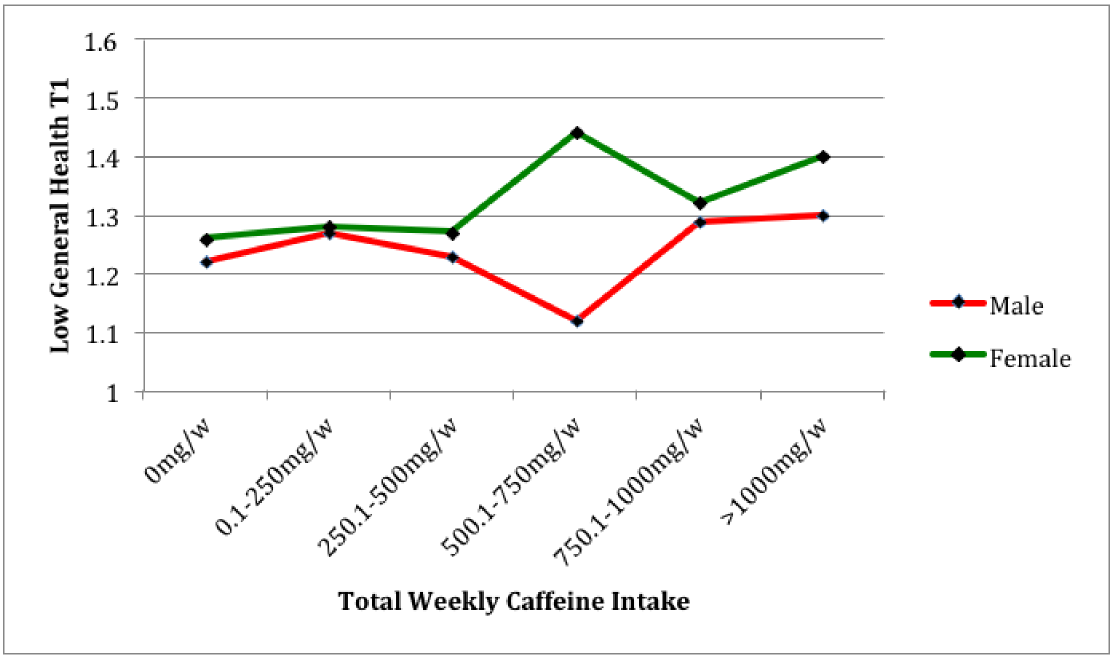

Figure D.1. Interaction between caffeine and sex on general health at T1.

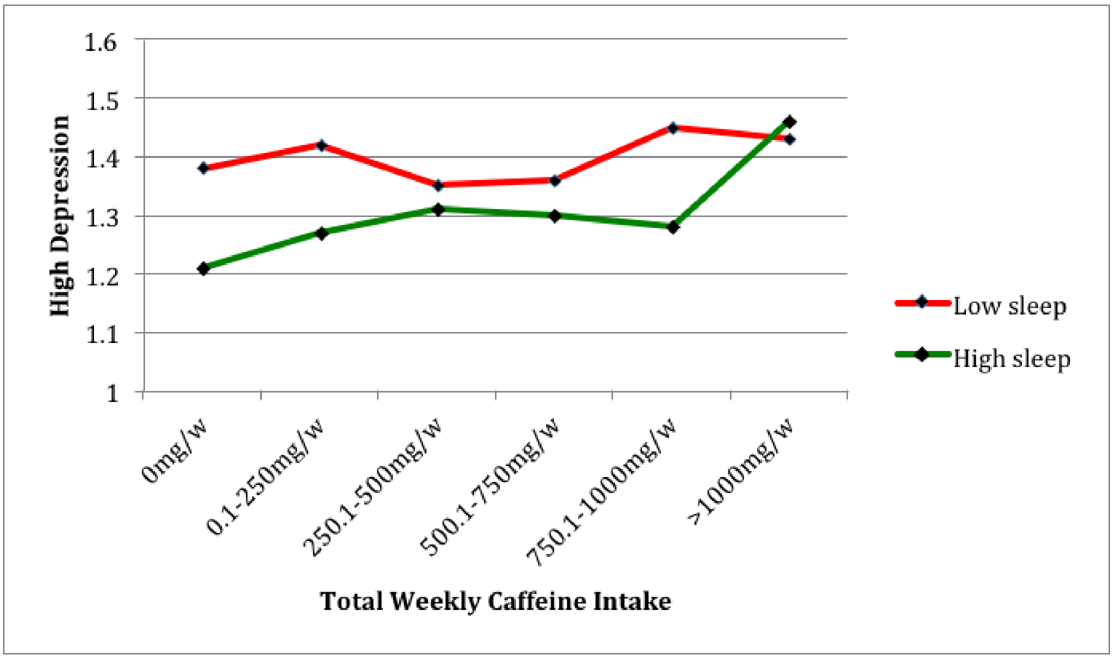

Figure D.2. Interaction between caffeine and sleep on depression.

D.1.2 Interactions Between Breakfast and Energy Drink Consumption and Demographic/Lifestyle Variables in Relation to Mental Health Outcomes

ORs, 95% CIs, and *p* values for the interaction analyses involving breakfast and energy drinks on mental health outcomes are shown in Table D.2. Only two significant interactions were observed regarding breakfast consumption. The first was an interaction with sleep on the outcome of general health at T2. This reflected the detrimental effect of not having breakfast every day being stronger in the low sleep group compared to the high sleep group (see Figure D.3). This could be due to children who achieve poor sleep being less likely to eat breakfast in the morning because of waking up late/being tired. As breakfast omission was considered simply as not eating breakfast every day, this effect might therefore be explained by overall breakfast frequency being lower in those with low sleep hours compared to those with high sleep hours. Chi-square analysis confirmed this to be the case at both time-points: T1, $\chi2$ (4, 1940) = 114.512, $p < .001$; T2, $\chi2$ (4, 2197) = 140.584, $p < .001$, with the effects appearing to be linear in nature: T1, $\chi2$ (1, 1940) = 103.851, $p < .001$; T2, $\chi2$ (1, 2197) = 134.357, $p < .001$. The second significant interaction observed in the current analysis was between breakfast consumption and sex on the outcome of stress. This reflected the negative effect of breakfast omission being stronger in females than in males (see Figure D.4).

	Breakfast				**Energy drinks**			
	Interaction term	OR	95% CI	*p*	Interaction term	OR	95% CI	*p*
General health T1	Breakfast*Sex	1.229	.753, 2.007	.409	Energy drinks*Sex	1.55	.911, 2.638	.106
	Breakfast*SEN	.755	.404, 1.411	.378	Energy drinks*SEN	1.081	.555, 2.103	.819
	Breakfast*FSM	1.434	.713, 2.887	.312	Energy drinks*FSM	1.172	.55, 2.495	.681
	Breakfast*Sleep	.765	.512, 1.141	.189	Energy drinks*Sleep	1.005	.606, 1.666	.986
General health T2	Breakfast*Sex	1.028	.646, 1.637	.906	Energy drinks*Sex	1.35	.801, 2.276	.26
	Breakfast*SEN	1.204	.715, 2.028	.485	Energy drinks*SEN	1.568	.898, 2.739	.113
	Breakfast*FSM	1.301	.642, 2.635	.465	Energy drinks*FSM	.806	.399, 1.63	.548
	Breakfast*Sleep	.595	.404, .877	.009	Energy drinks*Sleep	1.278	.759, 2.152	.357
Stress	Breakfast*Sex	1.6	1.056, 2.426	.027	Energy drinks*Sex	1.585	.92, 2.731	.097
	Breakfast*SEN	.782	.482, 1.271	.321	Energy drinks*SEN	.919	.535, 1.579	.759
	Breakfast*FSM	1.045	.529, 2.063	.9	Energy drinks*FSM	.856	.424, 1.728	.663
	Breakfast*Sleep	.866	.6, 1.248	.44	Energy drinks*Sleep	2.099	1.27, 3.47	.004
Anxiety	Breakfast*Sex	1.051	.695, 1.587	.815	Energy drinks*Sex	1.342	.813, 2.216	.25
	Breakfast*SEN	1.191	.74, 1.916	.471	Energy drinks*SEN	.946	.556, 1.61	.838
	Breakfast*FSM	1.124	.56, 2.256	.742	Energy drinks*FSM	.6	.297, 1.208	.152
	Breakfast*Sleep	.881	.617, 1.259	.488	Energy drinks*Sleep	1.303	.79, 2.151	.3
Depression	Breakfast*Sex	1.166	.76, 1.79	.483	Energy drinks*Sex	1.961	1.179, 3.261	.009
	Breakfast*SEN	1.424	.877, 2.311	.153	Energy drinks*SEN	1.761	1.026, 3.023	.04
	Breakfast*FSM	1.714	.866, 3.391	.122	Energy drinks*FSM	.576	.287, 1.153	.119
	Breakfast*Sleep	.909	.633, 1.307	.607	Energy drinks*Sleep	2.112	1.281, 3.481	.003

Table D.2. Interactions between breakfast and energy drink consumption and sex, SEN status, FSM, and sleep in relation to mental health outcomes.

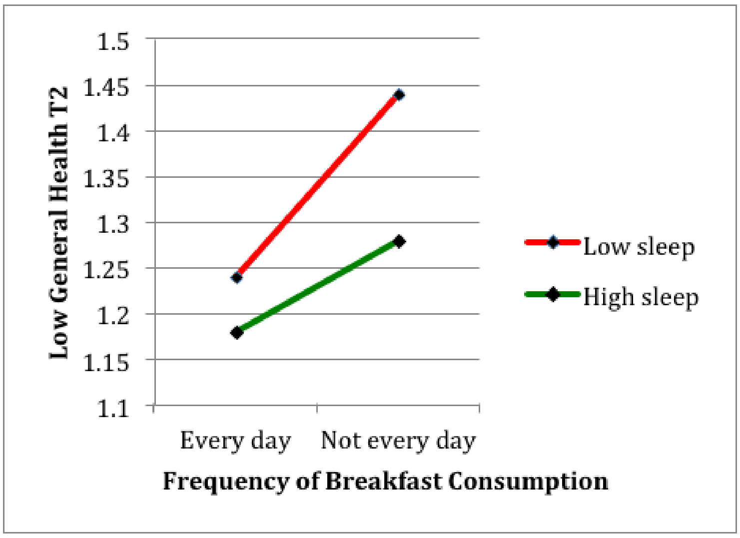

Figure D.3. Interaction between breakfast and sleep on general health at T2.

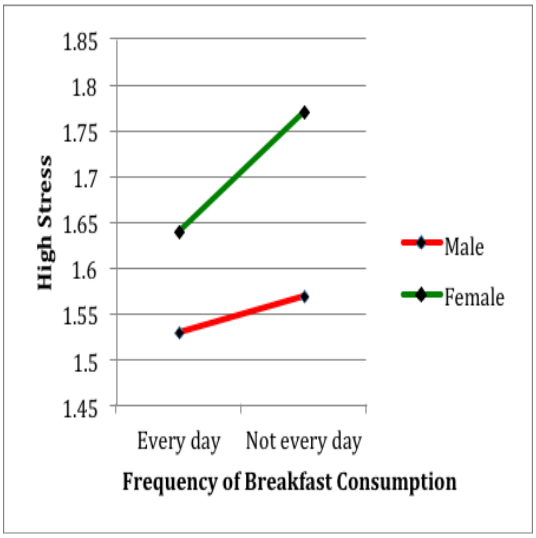

Figure D.4. Interaction between breakfast and sex on stress.

Significant interactions were observed between energy drink consumption and sleep upon the outcomes of stress and depression (see Figures D.5 and D.6, respectively). Essentially these effects reflected reduced risk of high stress and depression occurring in those who achieved high sleep hours and also consumed energy drinks infrequently. Although the addition of energy drinks actually appeared to be associated with slightly lower risk of stress and depression in those who reported low sleep hours, the addition of frequent energy drink consumption to those who achieved high sleep hours strongly increased their risk of undesirable outcomes. This therefore suggests that frequent consumption of energy drinks may negate the positive effect of good sleep.

Interactions were also observed between energy drink consumption and both sex and SEN status on the outcome of depression (see Figures D.7 and D.8, respectively). The first of these effects reflected frequent energy drink consumption being associated with increased levels of depression in females, whereas no such effect was observed in males. The second of these interaction effects was particularly interesting, as it showed that frequent energy drink use was associated with reduced depression in those with a SEN status, but with increased depression in those without a SEN status. A potential explanation for this effect would be that those who are already depressed might use energy drinks as a 'pick me up', whereas children with certain other mental health problems (e.g. ADHD) might actually gain therapeutic benefits from using central nervous system stimulants, such as caffeine. However, it should be made clear that this is purely speculation, and should not be interpreted as advice.

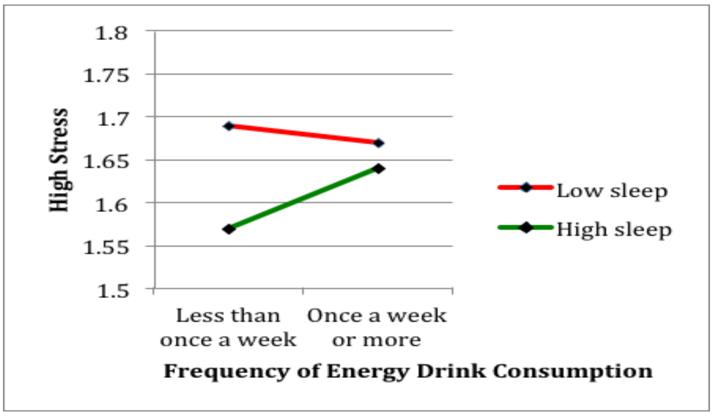

Figure D.5. Interaction between energy drinks and sleep on stress.

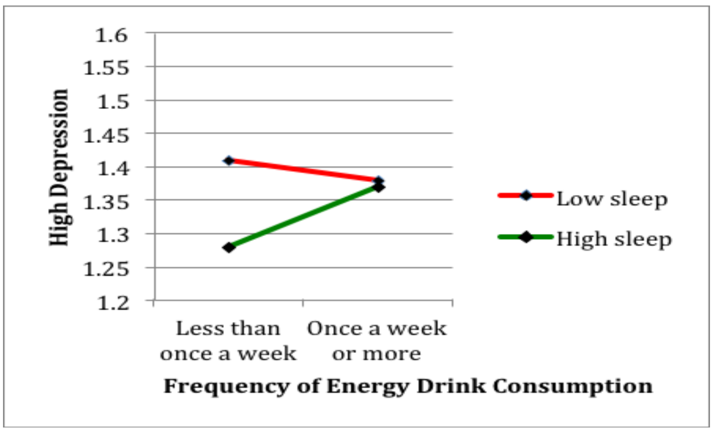

Figure D.6. Interaction between energy drinks and sleep on depression.

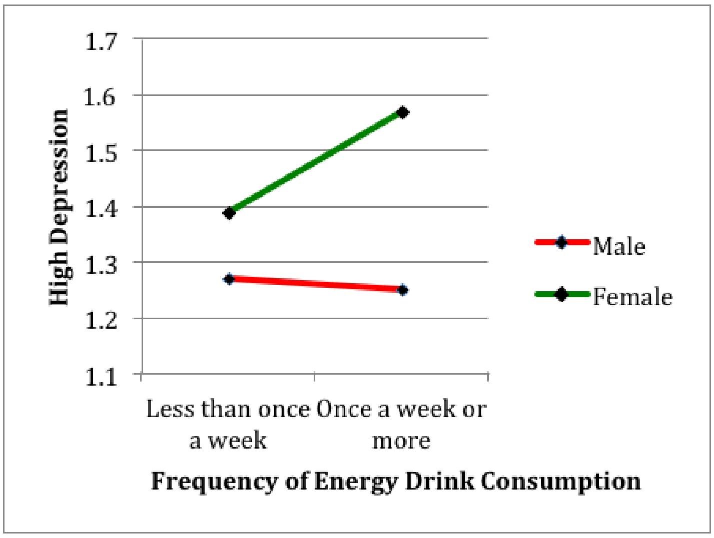

Figure D.7. Interaction between energy drinks and sex on depression.

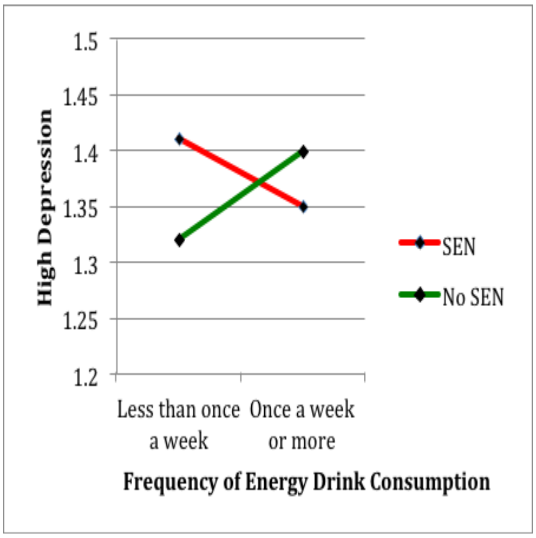

Figure D.8. Interaction between energy drinks and SEN status on depression.

D.1.3 Interactions Between Caffeinated Soft Drinks/Gum Consumption and Demographic/Lifestyle Variables in Relation to Mental Health Outcomes

ORs, 95% CIs, and *p* values relating to the interactions between Caffeinated Soft Drinks/Gum and sex, SEN status, FSM, and sleep in relation to mental health outcomes are shown in Table D.3. A significant interaction was observed between Caffeinated Soft Drinks/Gum consumption and sex in relation to general health at T1 (see Figure D.9). Although there was little difference between low and high consumption in males, females who were high consumers were at greater risk of reporting poor general health than were females who were low consumers. A significant interaction was also observed between Caffeinated Soft Drinks/Gum consumption and sleep on depression (see Figure D.10). Although depression scores for those who achieved low sleep hours did not differ considerably between the low and high Caffeinated Soft Drinks/Gum conditions, high consumers in the high sleep group were at increased risk compared to low consumers. As with previously discussed findings, this therefore suggests that high consumption of caffeinated products (in this case through the Caffeinated Soft Drinks/Gum factor) may reduce the beneficial effect of achieving high sleep hours.

Both of the interaction effects observed above appear to mirror those reported in previous sections (i.e. caffeine/sex on general health at T1, caffeine/sleep on depression, energy drinks/sleep on depression). Broadly the findings suggest that undesirable mental health effects associated with the dietary patterns examined here are likely to be stronger in females compared to males, and that high caffeine/energy drink use may reduce the benefits associated with high sleep hours.

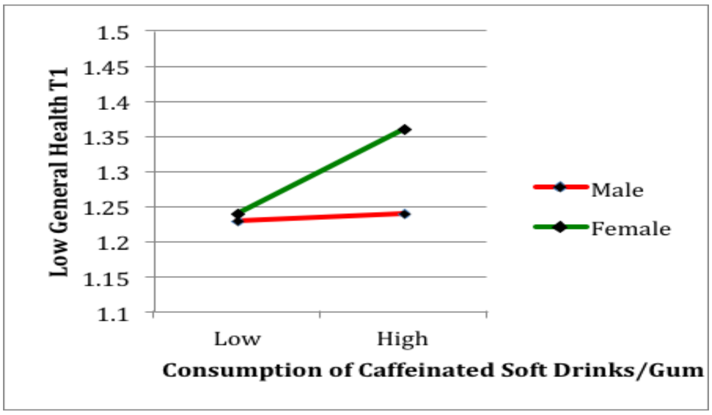

Figure D.9. Interaction between Caffeinated Soft Drinks/Gum and sex on general health at T1.

	Interaction term	OR	95% CI	*p*
General health T1	Caffeinated Soft Drinks/Gum*Sex	1.548	1.031, 2.324	.035
	Caffeinated Soft Drinks/Gum*SEN	.95	.646, 1.396	.793
	Caffeinated Soft Drinks/Gum*FSM	.854	.586, 1.246	.413
	Caffeinated Soft Drinks/Gum*Sleep	.954	.652, 1.395	.807
General health T2	Caffeinated Soft Drinks/Gum*Sex	1.298	.891, 1.888	.174
	Caffeinated Soft Drinks/Gum*SEN	1.023	.716, 1.464	.899
	Caffeinated Soft Drinks/Gum*FSM	1.159	.816, 1.647	.41
	Caffeinated Soft Drinks/Gum*Sleep	1.113	.776, 1.596	.561
Stress	Caffeinated Soft Drinks/Gum*Sex	1.102	.769, 1.58	.596
	Caffeinated Soft Drinks/Gum*SEN	.977	.703, 1.358	.891
	Caffeinated Soft Drinks/Gum*FSM	.992	.715, 1.375	.961
	Caffeinated Soft Drinks/Gum*Sleep	1.305	.941, 1.809	.11
Anxiety	Caffeinated Soft Drinks/Gum*Sex	.905	.646, 1.268	.563
	Caffeinated Soft Drinks/Gum*SEN	1.213	.881, 1.672	.237
	Caffeinated Soft Drinks/Gum*FSM	1.267	.922, 1.74	.144
	Caffeinated Soft Drinks/Gum*Sleep	1.171	.846, 1.621	.34
Depression	Caffeinated Soft Drinks/Gum*Sex	1.165	.825, 1.645	.385
	Caffeinated Soft Drinks/Gum*SEN	1.082	.777, 1.507	.642
	Caffeinated Soft Drinks/Gum*FSM	.872	.628, 1.211	.414
	Caffeinated Soft Drinks/Gum*Sleep	1.457	1.044, 2.034	.027

Table D.3. Interactions between Caffeinated Soft Drinks/Gum and sex, SEN status, FSM, and sleep in relation to mental health outcomes.

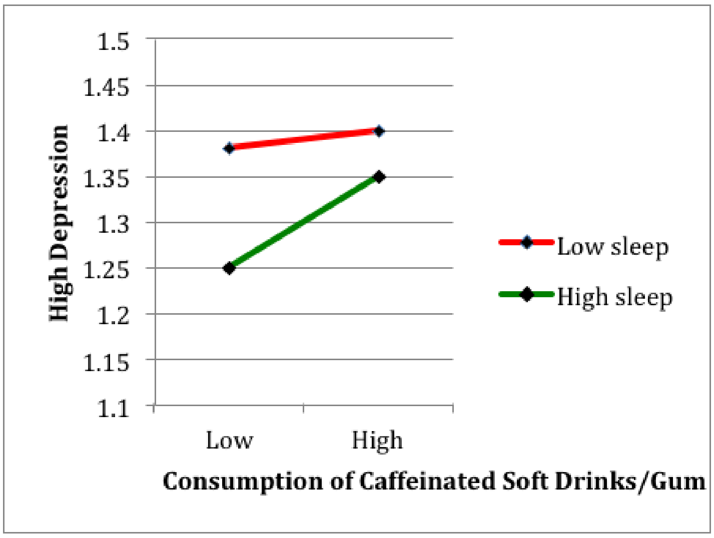

Figure D.10. Interaction between Caffeinated Soft Drinks/Gum and sleep on depression.

D.2 School Performance

D.2.1 Interactions Between Total Weekly Caffeine Consumption and Demographic/Lifestyle Variables in Relation to School Performance Outcomes

Whereas the last section investigated interactions between diet and demography/lifestyle on mental health outcomes, the current section presents analyses that relate to school performance. For Wald statistics and *p* values relating to the overall significance of interactions between caffeine and sex, SEN status, FSM, and sleep, see Table D.4.

A significant interaction between caffeine group and sex was observed in relation to behavioural sanctions at T2 (see Figure D.11). This interaction reflected males being more likely to be in the bad behaviour group for every caffeine condition other than 0mg/w and 750.1-1000mg/w. This was obviously different from the interaction reported in relation to general health at T1, in which females appeared to be at greater risk if they were members of the 500.1-750mg/w or >1000mg/w conditions.

	Interaction term	**T1**		**T2**	
		Wald	*p*	Wald	*p*
School attendance	Caffeine*Sex	4.045	.543	10.288	.067
	Caffeine*SEN	5.346	.375	6.18	.289
	Caffeine*FSM	3.197	.67	5.802	.326
	Caffeine*Sleep	1.827	.873	2.397	.792
English attainment	Caffeine*Sex	3.83	.574	4.671	.457
	Caffeine*SEN	6.021	.304	3.695	.594
	Caffeine*FSM	2.972	.704	8.553	.128
	Caffeine*Sleep	4.042	.543	5.501	.358
Maths attainment	Caffeine*Sex	6.705	.243	1.44	.92
	Caffeine*SEN	7.363	.195	11.017	.051
	Caffeine*FSM	2.798	.731	9.722	.083
	Caffeine*Sleep	7.08	.215	4.679	.456
Behavioural sanctions	Caffeine*Sex	3.378	.642	15.59	.008
	Caffeine*SEN	5.404	.369	4.209	.52
	Caffeine*FSM	10.945	.052	11.105	.049
	Caffeine*Sleep	3.492	.625	8.637	.124

Table D.4. Interactions between caffeine and sex, SEN, FSM, and sleep in relation to school performance outcomes.

Caffeine and FSM also interacted in relation to the outcome of behavioural sanctions at T2. This essentially reflected the upward trend associated with increased caffeine consumption being more pronounced in those eligible to receive FSM (see Figure D.12). This was particularly apparent for children with FSM in the 500.1-750mg/w, 750.1-1000mg/w, and >1000mg/w groups, who were at increased risk of bad behaviour relative to children in these groups who were not eligible for FSM.

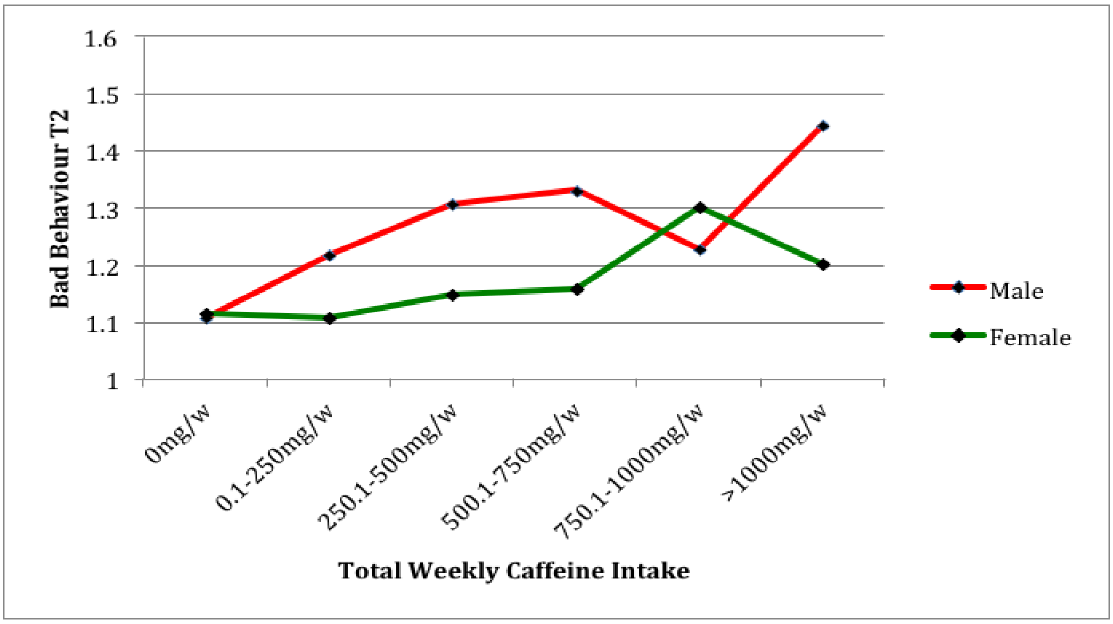

Figure D.11. Interaction between caffeine and sex on behavioural sanctions at T2.

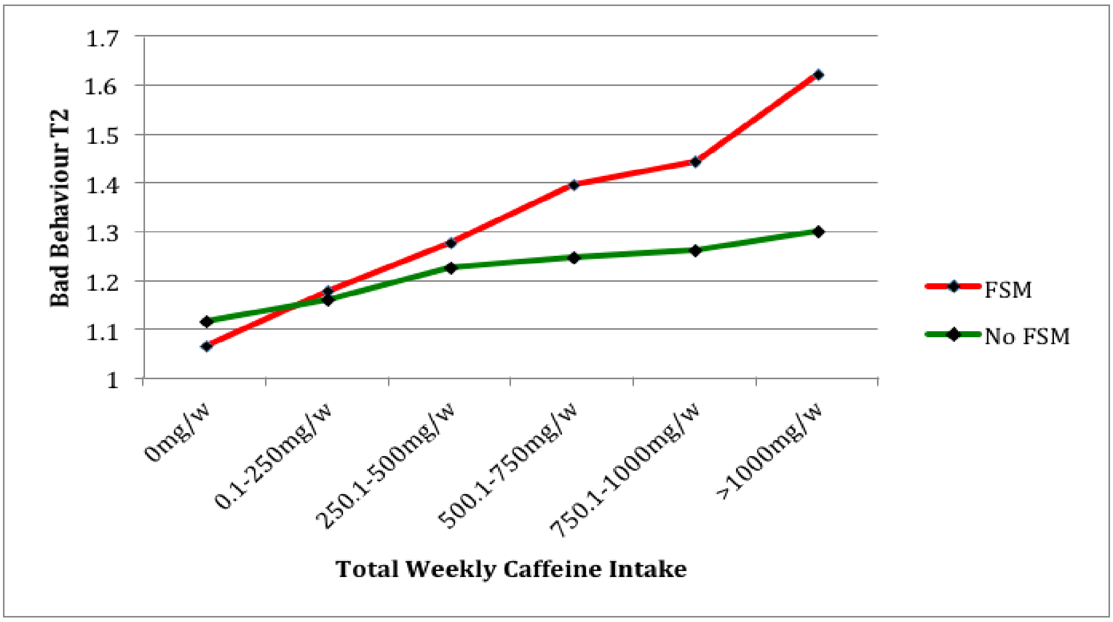

Figure D.12. Interaction between caffeine and FSM on behavioural sanctions at T2.

D.2.2 Interactions Between Breakfast and Energy Drink Consumption and Demographic/Lifestyle Variables in Relation to School Performance Outcomes

For all Wald statistics and *p* values relating to the overall significance of interactions involving breakfast and energy drinks, see Table D.5. Five significant findings were made regarding breakfast consumption, and four of these were interactions with sex. Those effects relating to attendance at T1, and English and maths attainment at T2 each reflected a greater decrease in performance associated

		Breakfast				**Energy drinks**			
		Interaction term	OR	95% CI	*p*	Interaction term	OR	95% CI	*p*
School attendance	T1	Breakfast*Sex	1.588	1.046, 2.411	.03	Energy drinks*Sex	.953	.595, 1.525	.84
		Breakfast*SEN	1.049	.61, 1.804	.862	Energy drinks*SEN	1.198	.663, 2.166	.55
		Breakfast*FSM	1.316	.678, 2.554	.417	Energy drinks*FSM	.872	.418, 1.82	.716
		Breakfast*Sleep	1.002	.702, 1.432	.99	Energy drinks*Sleep	1.396	.892, 2.186	.144
	T2	Breakfast*Sex	1.062	.694, 1.625	.781	Energy drinks*Sex	.857	.514, 1.429	.554
		Breakfast*SEN	1.19	.731, 1.939	.484	Energy drinks*SEN	1.863	1.086, 3.197	.024
		Breakfast*FSM	1.064	.536, 2.112	.86	Energy drinks*FSM	1.023	.507, 2.063	.949
		Breakfast*Sleep	1.039	.72, 1.498	.84	Energy drinks*Sleep	1.303	.789, 2.153	.301
English attainment	T1	Breakfast*Sex	1.142	.728, 1.79	.563	Energy drinks*Sex	.934	.563, 1.549	.792
		Breakfast*SEN	1.026	.501, 2.102	.944	Energy drinks*SEN	.686	.294, 1.599	.383
		Breakfast*FSM	.888	.436, 1.812	.745	Energy drinks*FSM	.688	.312, 1.517	.354
		Breakfast*Sleep	1.456	.99, 2.142	.056	Energy drinks*Sleep	1.214	.747, 1.975	.434
	T2	Breakfast*Sex	1.592	1.038, 2.441	.033	Energy drinks*Sex	1.412	.849, 2.35	.184
		Breakfast*SEN	1.632	.979, 2.723	.061	Energy drinks*SEN	1.366	.77, 2.422	.287
		Breakfast*FSM	.498	.246, 1.008	.053	Energy drinks*FSM	.339	.158, .728	.006
		Breakfast*Sleep	1.18	.815, 1.709	.379	Energy drinks*Sleep	1.428	.846, 2.408	.182
Maths attainment	T1	Breakfast*Sex	.955	.608, 1.501	.842	Energy drinks*Sex	.773	.466, 1.285	.321
		Breakfast*SEN	1.219	.617, 2.411	.569	Energy drinks*SEN	.481	.209, 1.109	.086
		Breakfast*FSM	.667	.33, 1.348	.259	Energy drinks*FSM	.681	.309, 1.498	.339
		Breakfast*Sleep	1.297	.883, 1.904	.185	Energy drinks*Sleep	1.309	.806, 2.127	.277
	T2	Breakfast*Sex	1.527	1.002, 2.327	.049	Energy drinks*Sex	1.189	.711, 1.989	.51
		Breakfast*SEN	1.164	.698, 1.942	.561	Energy drinks*SEN	1.576	.89, 2.79	.119
		Breakfast*FSM	1.007	.504, 2.013	.985	Energy drinks*FSM	.45	.208, .973	.042
		Breakfast*Sleep	.933	.647, 1.346	.71	Energy drinks*Sleep	.708	.424, 1.183	.188
Behavioural sanctions	T1	Breakfast*Sex	1.597	.841, 3.033	.153	Energy drinks*Sex	2.184	1.141, 4.181	.018
		Breakfast*SEN	.731	.379, 1.41	.35	Energy drinks*SEN	1.99	.999, 3.964	.05
		Breakfast*FSM	1.375	.639, 2.959	.415	Energy drinks*FSM	.627	.279, 1.408	.258
		Breakfast*Sleep	1.017	.612, 1.69	.948	Energy drinks*Sleep	.822	.46, 1.47	.509
	T2	Breakfast*Sex	1.789	1.019, 3.142	.043	Energy drinks*Sex	1.162	.66, 2.046	.603
		Breakfast*SEN	1.044	.604, 1.804	.877	Energy drinks*SEN	1.728	.983, 3.038	.057
		Breakfast*FSM	.456	.205, 1.012	.054	Energy drinks*FSM	.535	.249, 1.15	.109
		Breakfast*Sleep	.56	.356, .881	.012	Energy drinks*Sleep	.969	.567, 1.654	.907

Table D.5. Interactions between breakfast and energy drink consumption and sex, SEN status, FSM, and sleep in relation to school performance outcomes.

with breakfast omission compared to its consumption occurring in females relative to males (see Figures D.13, D.14, and D.15, respectively). These findings were therefore similar to that observed in relation to stress in the previous section, and suggest that females may be more susceptible to risks associated with breakfast omission than are males. However, on closer inspection, no interaction was actually observed in relation to behavioural sanctions at T2 (see Figure D.16). As this latter analysis did not control for covariates, it is likely that such effects as this rely on additional factors that are only accounted for at the multivariate level.

Breakfast and sleep were found to interact in relation to behavioural sanctions at T2 (see Figure D.17). Although there was not much difference within the high sleep group, those in the low sleep group who also did not eat breakfast every day were at increased risk of bad behaviour compared to those who ate breakfast every day. This is similar to the effect on general health at T2 reported in the previous section, in which the negative association with breakfast omission appeared to be greater in the low sleep group. The effect may therefore be explainable by breakfast consumption being negatively associated with sleep hours (i.e. those in the 'not every day' group who are low sleepers are likely to consume breakfast less frequently than are those in the 'not every day' group who are high sleepers).

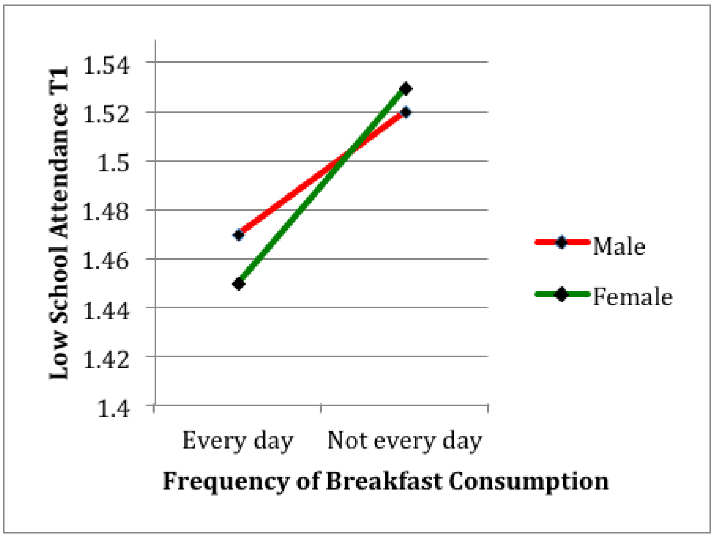

Figure D.13. Interaction between breakfast and sex on school attendance at T1.

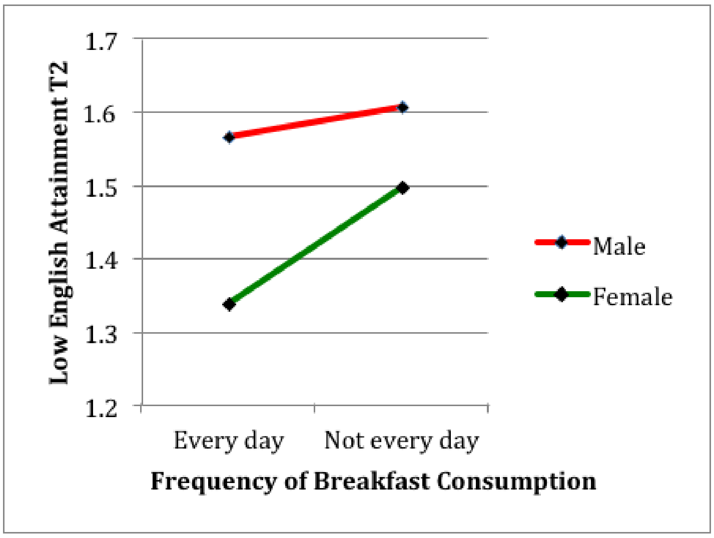

Figure D.14. Interaction between breakfast and sex on English attainment at T2.

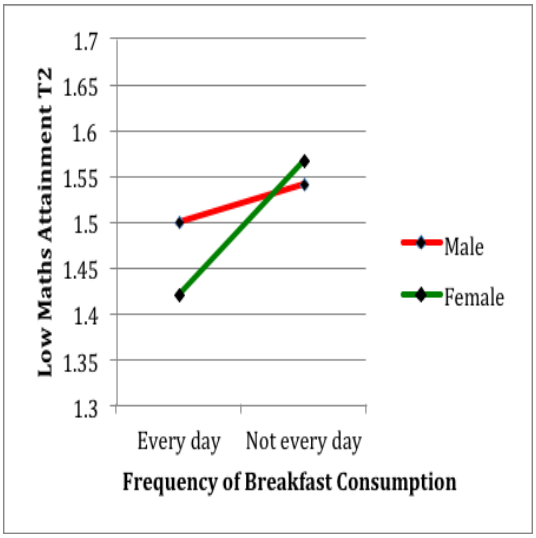

Figure D.15. Interaction between breakfast and sex on maths attainment at T2.

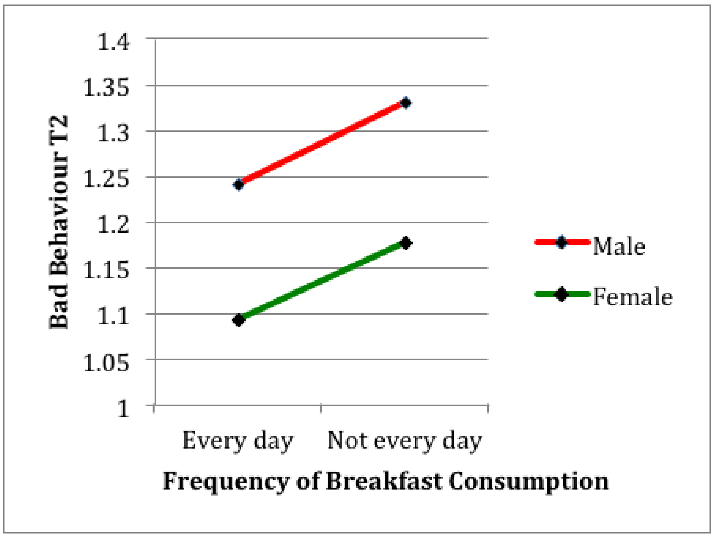

Figure D.16. Interaction between breakfast and sex on behavioural sanctions at T2.

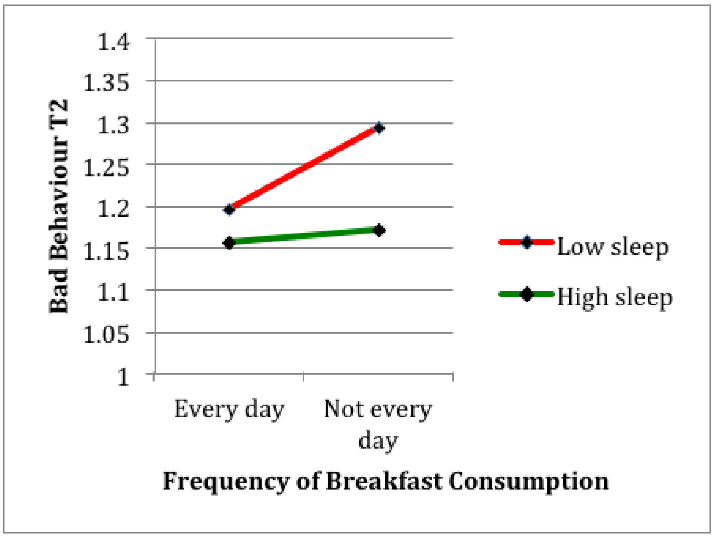

Figure D.17. Interaction between breakfast and sleep on behavioural sanctions at T2.

Energy drinks and SEN status interacted in relation to school attendance at T2 (see Figure D.18). This reflected a larger detrimental effect of frequent energy drink use occurring in those without a SEN status compared to those with one. This could be considered similar to the interaction observed on depression, in which risk was increased in frequent energy drink consumers who did not have a SEN status.

Energy drinks also interacted with FSM on English and maths attainment at T2 (see Figures D.19 and D.20, respectively). In both cases this reflected a stronger detrimental effect of frequent energy drink consumption occurring in those eligible for FSM compared to those who were not. These effects are therefore similar to the interaction observed between caffeine and FSM on behavioural sanctions at T2, in which the association between the two variables appeared to be stronger in those eligible for FSM compared to those who were not. It is also interesting to note the contrast in findings in this section compared to the last, as no significant interactions involving FSM were observed in relation to mental health outcomes.

Energy drink consumption also interacted with sex in relation to behavioural sanctions at T1 (see Figure D.21). Although a closer inspection did not reveal an obvious interaction effect, there was a trend for the frequent consumption of energy drinks to be associated with a stronger negative effect in females compared to males, which is consistent with the finding that frequent energy drink consumption appeared to be associated with increased risk of depression in females but not in males.

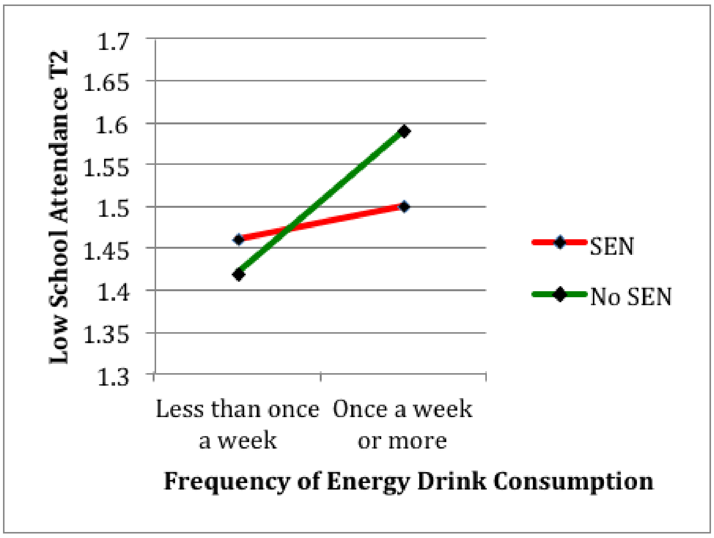

Figure D.18. Interaction between energy drinks and SEN status on school attendance at T2.

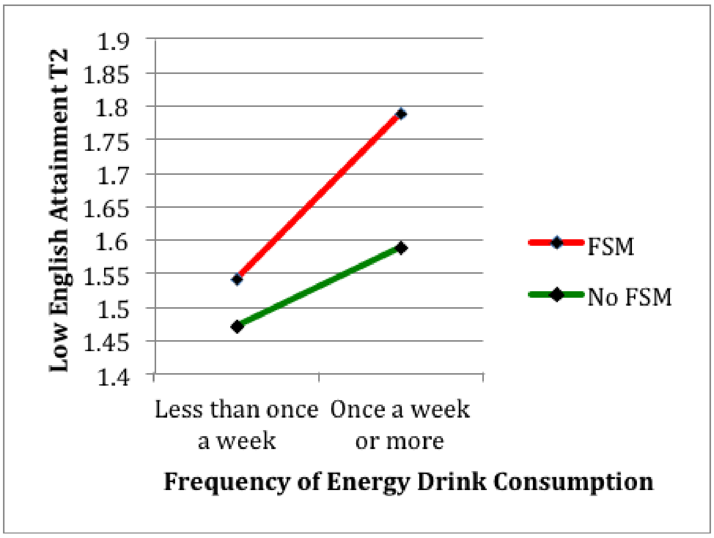

Figure D.19. Interaction between energy drinks and FSM on English attainment at T2.

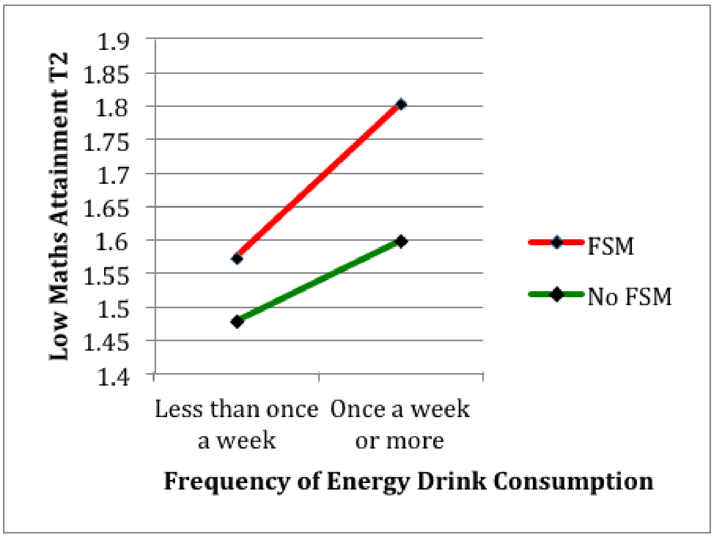

Figure D.20. Interaction between energy drinks and FSM on maths attainment at T2.

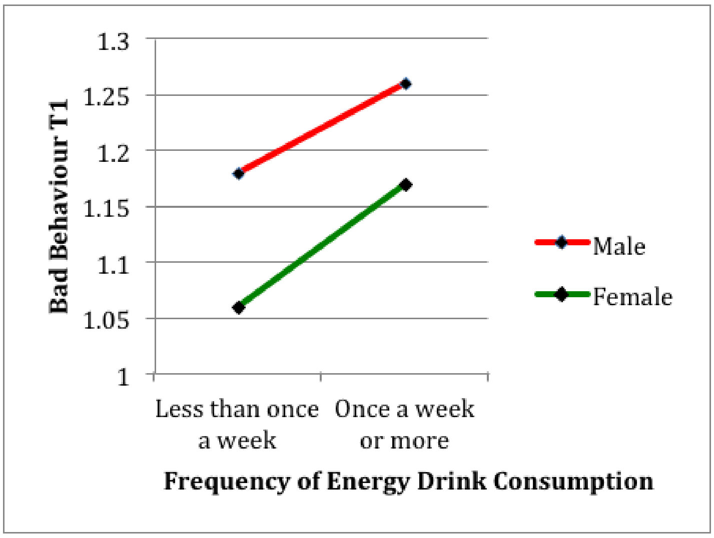

Figure D.21. Interaction between energy drinks and sex on behavioural sanctions at T1.

D.2.3 Interactions Between Caffeinated Soft Drinks/Gum Consumption and Demographic/Lifestyle Variables in Relation to School Performance Outcomes

For ORs, 95% CIs, and *p* values in relation to interactions between Caffeinated Soft Drinks/Gum consumption and sex, SEN status, FSM, and sleep in relation to school performance outcomes, see Table D.6. Only one significant interaction was observed. This was between Caffeinated Soft Drinks/Gum consumption and sleep on the outcome of English attainment at T1. However, on closer inspection, there appeared to be no predictive value for these variables beyond the main effects themselves (see Figure D.22).

Although little evidence for interactions involving the Caffeinated Soft Drinks/Gum factor was provided, this section has uncovered a number of interactions between diet and demography/lifestyle and school performance. However, most effects were not statistically significant, and those that were tended to differ across outcomes and time-points. Due to the general inconsistency of these findings, both in relation to mental health and to school performance, no further consideration of interaction effects between diet and demography/lifestyle is made in this thesis.

	Interaction term	T1			T2		
		OR	95% CI	*p*	OR	95% CI	*p*
School attendance	Caffeinated Soft Drinks/Gum*Sex	1.276	.896, 1.818	.176	.914	.639, 1.307	.621
	Caffeinated Soft Drinks/Gum*SEN	1.307	.939, 1.819	.112	1.148	.824, 1.599	.415
	Caffeinated Soft Drinks/Gum*FSM	1.203	.869, 1.666	.266	1.033	.741, 1.44	.847
	Caffeinated Soft Drinks/Gum*Sleep	1.184	.861, 1.628	.297	1.117	.801, 1.559	.514
English attainment	Caffeinated Soft Drinks/Gum*Sex	1.186	.812, 1.732	.378	.944	.658, 1.353	.752
	Caffeinated Soft Drinks/Gum*SEN	1.283	.9, 1.83	.168	1.085	.774, 1.522	.635
	Caffeinated Soft Drinks/Gum*FSM	1.314	.926, 1.863	.126	.872	.624, 1.217	.42
	Caffeinated Soft Drinks/Gum*Sleep	1.453	1.028, 2.053	.034	1.269	.908, 1.773	.163
Maths attainment	Caffeinated Soft Drinks/Gum*Sex	1.032	.707, 1.506	.87	.903	.632, 1.289	.573
	Caffeinated Soft Drinks/Gum*SEN	1.09	.763, 1.559	.635	1.114	.796, 1.559	.529
	Caffeinated Soft Drinks/Gum*FSM	1.117	.788, 1.583	.534	.905	.649, 1.262	.556
	Caffeinated Soft Drinks/Gum*Sleep	1.29	.916, 1.818	.145	1.016	.728, 1.419	.925
Behavioural sanctions	Caffeinated Soft Drinks/Gum*Sex	1.765	.95, 3.277	.072	1.167	.713, 1.909	.54
	Caffeinated Soft Drinks/Gum*SEN	1.216	.742, 1.993	.438	1.279	.84, 1.947	.251
	Caffeinated Soft Drinks/Gum*FSM	1.148	.714, 1.845	.57	1.152	.771, 1.721	.49
	Caffeinated Soft Drinks/Gum*Sleep	.783	.498, 1.23	.289	.981	.653, 1.475	.927

Table D.6. Interactions between Caffeinated Soft Drinks/Gum and sex, SEN status, FSM, and sleep in relation to school performance outcomes.

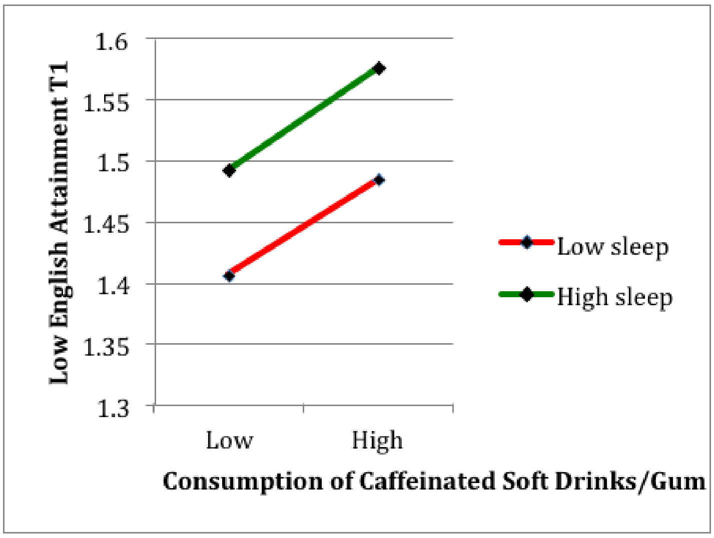

Figure D.22. Interaction between Caffeinated Soft Drinks/Gum consumption and sleep on English attainment at T1.