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Eating, Drinking and Wellbeing

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Abstract

The aim of the present chapter is to present a conceptual framework for examining associations between eating, drinking and wellbeing. The approach is exemplified by considering two topics which have received considerable attention, namely the effects of consumption of breakfast and ingestion of caffeine. It is argued that other aspects of diet can be considered in a similar way once the volume of research reaches appropriate levels. The first feature of the current approach to wellbeing is that it is multi-factorial. Research on diet and health has confirmed the view that there is more to health than the absence of disease. Being able to function efficiently, both mentally and physically, is an important part of wellbeing. Similarly, the absence of negative affective states (negative mood, stress, anxiety and depression) and the presence of positive emotions (positive affect, happiness, and life satisfaction) have long been recognised as key features of wellbeing. Previous research has investigated the relationship between diet and well-being, with some topics such as the effect of a healthy diet (e.g. consumption of breakfast, fruit and vegetables and oily fish) or a bad diet (e.g. junk food) being widely studied. Other aspects of eating and drinking require further attention (e.g. eating super-foods such as broccoli; effects of BMI; emotional eating; and consumption of foods which change the gut microbiome – pre-biotics and probiotics). There are three major problems with most of the previous research. First, the different dietary topics are often studied in isolation, which clearly misrepresents the real-life situation. Secondly, wellbeing is influenced by other established predictors (psychosocial factors such as stress, social support, personality and coping styles; health-related behaviours such as exercise, and sleep) and these are rarely controlled for. Thirdly, most of the research involves cross-sectional studies. What is now needed are multi-variate, longitudinal studies of eating, drinking and wellbeing. Such research will elucidate underlying biological mechanisms and develop practical approaches of preventing and managing negative effects and maximising positive ones.

Introduction

This chapter will discuss different conceptual frameworks for investigating associations between eating, drinking and well-being. Key issues will be covered by focusing on specific topics where there has been extensive research. This approach is sensible as other aspects of nutrition and well-being have received less coverage and more research is required to extend our knowledge to food and drink more generally. The main areas focused on are the consumption of breakfast and ingestion of caffeine. Not only has there been extensive research on these topics but they are also areas where the issue of their impact on well-being has been addressed. The aim is not to provide extensive literature reviews but to demonstrate key features of different approaches to the study of diet and well-being. The above section shows that a focused approach to eating, drinking and well-being is desirable at this stage. In part this reflects uncertainty about definitions and approaches to the study of well-being. Two different conceptualisations are covered here, one reflecting a holistic view of well-being, and the other a more specific conceptualisation of the well-being process.

A Holistic Approach to Well-being

Background research

This approach, first described in detail by Smith (2005a), developed from the realisation that there is more to being healthy than being free from disease. Research on nutrition has often investigated associations with different types of disease, but there have also been studies relating diet to both physical and mental functions. The term “well-being” is sometimes replaced by “quality of life” or by the concepts of being able to function well and having a positive mood state. In the area of nutrition the term “functional food” refers not only to the beneficial effects related to chronic disease but to the potential for improved well-being. The relationship between diet and both negative and positive mental health has also been examined, often indicating subtle changes in mood rather than the presence of clinical conditions. These approaches apply across the life-span with different functions receiving attention at certain ages (e.g. education outcomes in childhood/adolescence; performance at work in adults; and cognitive decline in the elderly).

Smith (2005a) described how the above approach could be used in empirical research, and the possible benefits of high fibre diets were the initial subject matter. The basis of this approach came from previous research on the effects of food and drink on cognitive function and mood. Initial interest in this area came from research on the effects of lunch on sustained attention and subjective alertness. Laboratory studies showed that one is less able to concentrate after consumption of lunch and that alertness is reduced at that time. However, ingestion of caffeine removed the post-lunch dip, and further research has shown that a general benefit of ingesting caffeinated drinks is to reduce the impairments observed in other low alertness states (e.g. working at night). These results have been confirmed in research from several other laboratories (see Smith, 2002, for reviews of these early studies).

Consumption of breakfast has been associated with better memory for lists of words and a more positive mood (see Smith, 2011a for a review). This effect has been explained in terms of glucose having a positive effect when the brain is deprived of glucose by the night-time

fast. Glucose may have other functional benefits, and it has been shown to improve simulated driving performance. Again, other laboratories have also demonstrated similar beneficial effects of breakfast consumption and glucose.

Other studies have examined the effects of regular patterns of consumption. A number of our studies show that consumption of breakfast is associated with subjective reports of better health. Similarly, the severity and frequency of minor illnesses may be lower in those who regularly consume breakfast. Most of these studies have involved small sample sizes, but they are supported by results from research with large, representative community samples. This epidemiological research showed that breakfast consumption was related in a linear dose-response pattern to subjective health. While such research suggests associations between diet and well-being, it is difficult to imply causality from these cross-sectional studies. However, initial studies such as these have led to subsequent intervention studies which alter digestion which then leads to changes well-being. This approach has led to intervention studies manipulating the fibre content of breakfast cereal. Short intervention studies revealed that consumption of high fibre breakfast cereal led to increased energy levels. Subsequent research has shown that supplementing breakfast cereal with inulin, a fibre that occurs naturally in vegetables such as onions, leeks and chicory, can improve memory in the short-term (Smith, 2019) and increase alertness, possibly due to prebiotic changes to gut flora, after two weeks of ingestion.

Breakfast, Health and Cognitive Function

Breakfast and Nutritional Requirements

Breakfast provides vitamins and minerals necessary to meet nutritional requirements (Rampersaud et al., 2005). Ready-to-eat-breakfast-cereal can improve the diet by providing fortified micronutrients and by reducing fat levels. Indeed, it has been shown that breakfast consumers have better quality diets, with more fibre and nutrients and fewer calories than those who skip breakfast. Rampersaud et al., (2005) showed that children who eat breakfast have higher daily intakes of calcium, fibre, vitamin C, vitamin A, riboflavin, iron and zinc compared to non-consumers. It is recommended that we consume whole grains, fruits and vegetables and low milk products. Many popular breakfast foods increase intake of such food groups. Breakfast often contributes up to 30% of whole-grain intake, which reduces the risk of coronary heart disease and diabetes.

Breakfast and weight management

It has been shown that the risk of obesity is four times greater in breakfast skippers compared to those who eat breakfast (Ma et al., 2003). Research has also shown that breakfast consumers have lower BMIs and are less likely to gain weight. Similar results have been found for children and adolescents. Breakfast may also help weight management by influencing satiety.

Breakfast and Physical Health

Breakfast consumers have lower levels of cholesterol. Metabolic syndrome is linked with being obese and having an increased risk of coronary artery disease and diabetes. Diets rich

in whole grains and dairy products (found in many breakfasts) lead to a reduced risk of metabolic syndrome (Baxter, Coyne and McClintock, 2006). Dietary fibre found in breakfast cereals also improves digestion, and whole-grain wheat may have a prebiotic effect. Breakfast consumption may also influence the immune system, and research has found higher numbers of NK cells and a lower number of T cells in those did not consume breakfast.

Breakfast and Cognitive Function

Extensive laboratory research, largely using young adults as volunteers, has shown that consumption of breakfast is associated with improved episodic memory (see Smith, 2018, for a review). Studies of children have been reviewed by Hoyland, Dye and Lawton (2009) and, they conclude that breakfast improves cognition, especially memory. This effect is most easily demonstrated in groups with poor nutrition. Research using a sample of high school students showed that breakfast improved visuo-spatial memory in males. School breakfast programmes can have positive effects which may be due to increased school attendance.

Breakfast and Mood

Consumption of breakfast is associated with an acute increase in positive mood (see Smith, 2011, for a review). Such effects have been observed with different types of breakfast, a range of breakfast cereals, and cereal bars. They have been found in studies of children and adolescents.

Huang et al. (2010) analysed data from a national representative sample (N=15,340) to examine associations between breakfast and health-related quality of life in. Breakfast skippers had significantly lower well-being scores on the SF-36, reflecting reduced vitality, reduced mental health, poorer general health, and more problems with social functioning and emotional roles.

Other research has found that those who consumed a cereal breakfast each day had lower levels of perceived stress, were less emotionally distressed and depressed than those who ate breakfast less frequently (see Smith, 2011a, for a review). Regular breakfast consumers had a healthier diet, drank less alcohol and were less likely to be smokers than breakfast skippers. However, the relationship between cereal breakfast consumption and health did not reflect differences in these other health-related behaviours. Smith (2010) replicated these benefits of regular breakfast consumption with a sample of children. These findings were also confirmed in an intervention study with breakfast cereal consumption being associated with greater alertness, fewer minor symptoms and bowel problems, lower depression, emotional distress and fatigue, and fewer cognitive problems. Other research shows that the effects of breakfast on wellbeing appear to be most pronounced with breakfast cereal in combination with dairy products.

Effects of breakfast on real-life cognitive function and safety

The major benefits of breakfast consumption are to be seen in the areas of weight management, nutritional intake and health. Studies of children demonstrate that breakfast consumption may improve school attendance and cognition which, can then lead to greater academic achievement. Less is known about the real-life behavioural implications of

consuming breakfast for adults. Chaplin and Smith (2011) examined effects of breakfast consumption on the health and safety of a sample of 870 nurses. The results showed that cognitive errors, accidents, injuries were more frequent in those who skipped breakfast. In addition, stress at work was greater in those who rarely ate breakfast. Further research investigating real-life activities outside of the workplace is now required. This future research should involve interventions rather than cross-sectional analyses.

The next section presents a profile of the effects of caffeine that lead to the holistic profile of its effects on well-being.

Caffeine, Health and Cognitive Function

Acute effects of caffeine on cognitive function and mood

Ingestion of doses of caffeine between 100 and 300 mg can increase alertness and attention. Research has identified effects that occur in low alertness situations where caffeine improves performance on tasks requiring sustained attention. Other effects can be seen even in alert individuals and show that caffeine improves the encoding of new stimuli. Episodic memory tasks are usually unaffected by caffeine whereas working and semantic memory show a benefit. These memory effects are usually smaller than those seen in attention tasks (see Smith, 2002, and 2011b for reviews of caffeine and cognitive function).

In terms of mood changes, the main effect of caffeine is to increase alertness, especially when volunteers are fatigued. Some research has also shown that caffeine makes the person feel happier and more sociable. Caffeine can increase anxiety if given in doses over 300mg (Lieberman, 1992) or to sensitive individuals. The effects described above are robust and found when caffeine is given to withdrawn consumers, those who have recently consumed caffeine, or to non-consumers. Many studies have involved giving a single large dose of caffeine which does not reflect how we consume it, but research has found that the behavioural changes seen after a single dose of 200 mg caffeine were also observed after four separate doses of 65 mg spread over the day (which gave an identical final caffeine level to the large single dose).

Caffeine and sleep

Large amounts of caffeine consumed in the evening can stop people going to sleep and reduce their sleep duration). Most caffeine drinkers stop their consumption earlier in the day to prevent this. Indeed, it is often difficult to find evidence supporting the view that high consumption per se will affect sleep. For example, Sanchez-Ortuno et al. (2005) conducted a survey of French workers and found that drinking up to 7 cups of coffee a day was not associated with a decreased duration of sleep.

Other research has used caffeine to reduce the negative effects of sleep loss. The American Academy of Sleep Medicine (Bonnet et al., 2005) has concluded that caffeine can increase wakefulness, as measured by sleep latency tests. Caffeine also removes or reduces the performance decrements seen in sleep-deprived individuals doing attention and working

memory tasks. Caffeine also increases the subjective alertness of sleep-deprived individuals. Recommended doses of caffeine for sleep-deprived individuals are usually 200-300 mg because side-effects can occur with higher doses (e.g. 600 mg).

Caffeine and physical performance

Research on this topic has been reviewed by the International Society of Sports Nutrition (Goldstein et al., 2010). They concluded that caffeine can improve performance of trained athletes when the dose is between 3-6 mg/kg. Caffeine is ergogenic for endurance exercise, such as time-trial performance, soccer and rugby. Effects of caffeine on strength-power performance are less clear.

Beneficial effects of habitual consumption of caffeine on performance

There has been less research on the regular consumption of caffeine consumption than on its acute effects. Strongest evidence for beneficial effects of regular caffeine consumption on cognition comes from a study which examined the association between habitual caffeine consumption and performance in a representative sample of over 9,000 adults. Caffeine consumption showed a dose-response relationship to with performance, and the benefits were greatest in those who had consumed the most over a long period of time. Caffeine has also been shown to improve simulations of real-life activities (e.g. driving - Horne & Reyner, 1996; simulated assembly line work, Muehlbach and Walsh, 1995; simulated complex work, Streufert et al., 1997).

Caffeine and real-life performance and safety

Smith (2005b) examined the association between regular caffeine consumption and safety and performance in the work-place. The first study revealed that consumption of more caffeine was associated with greater alertness over the day and reduced slowing of reaction time. A second study found associations between higher caffeine consumption and fewer accidents and errors at work. Overall, the results from this study suggest that caffeine may have benefits for safety and performance efficiency at work. A similar study examined safety and cognitive function in non-working samples (Smith, 2009). Overall, the results showed that in a non-working population, greater caffeine consumption was associated with better cognitive functioning. This benefit of caffeine was not associated with negative health costs.

Tse et al. (2009) studied the effects of caffeine on co-operative social behaviour. Caffeine reduced negative affect and increased social support. Research has suggested that high consumption of energy drinks is associated with anti-social or risky behaviour (Miller, 2008; O'Brien et al., 2008). These cross-sectional studies could reflect reverse causality, with those who frequently take risks choosing to drink energy beverages.

Caffeine and driving

Results from studies using driving simulators have shown that caffeine generally reduced the impaired driving performance seen in fatigued drivers. Philip et al. (2006) examined the effects of sleepiness and caffeine on real-life driving. Sleepiness increased lane crossing, an

effect reduced by 200 mg of caffeine. These results suggest that the effects of caffeine observed with artificial tasks may apply to real-life behaviour.

Driving performance can be impaired by factors such as alcohol. Liquori and Robinson (2001) found that caffeine may improve reaction time and increase subjective alertness after alcohol but does not completely counteract the alcohol-induced impairment of driving.

Smith (cited by Smith, 2009) examined road traffic accidents in a community sample (N=6648). 2.2% of caffeine consumers were involved in a road accident whereas 3.6 % of non-consumers of caffeine reported an accident. Logistic regression analyses, adjusting for confounders, showed that consumption of caffeine nearly halved the risk of being involved in a road traffic accident (OR=0.58 CI 0.35, 0.98). This result confirms the positive benefits of caffeine for road safety and accident prevention.

Caffeine and prevention of cognitive decline in the elderly

Animal research shows that caffeine consumption may prevent memory decline (Cunha & Agostinho, 2010). Epidemiological studies have also examined whether there is an association between habitual level of caffeine consumption and dementia. A systematic review and meta-analysis (Santos et al., 2010) showed a trend towards a protective effect of caffeine for cognitive function in the elderly.

Mental Health

The literature shows that in samples with low levels of trait anxiety, caffeine only increases anxiety after large amounts that would rarely be ingested. Other research has examined effects of caffeine consumption in those with high levels of anxiety. Caffeinism refers to symptoms associated with very high caffeine intake (often over 1000mg a day) that are very similar to severe chronic anxiety (Greden, 1974). However, caffeinism appears to be a specific condition, and there is little evidence for correlations between caffeine intake and anxiety in psychiatric outpatients (Eaton and Mcleod, 1984). Research has also investigated whether caffeine exacerbates the anxiety produced by other stressors. Shanahan and Hughes (1986) found that caffeine increased anxiety induced by a stressful task, but other research (e.g. Smith et al., 1997b) has not shown interactive effects between caffeine and stressors such as noise.

Caffeine intake has been associated with lower depression scores and even a reduced risk of suicide (see Lara 2010 for a review). This effect of caffeine on depression may have other beneficial effects on health. Depression often leads to immune-suppression which can lead to an increased susceptibility to infectious disease, and Smith (cited by Smith, 2009) found that caffeine consumption was also associated in a dose-response fashion with fewer upper respiratory tract symptoms.

Caffeine and children and adolescents

Caffeine is now added, sometimes in large amounts, to soft drinks that are consumed by children and adolescent. Older research on the behavioural effects of caffeine on children confirm many of the findings seen in adults (see Temple, 2009, for a review). Effects of caffeine in studies of children are often smaller than those in studies of adults, which may reflect the smaller doses consumed by the children. It is widely agreed that caffeine intake by pregnant women should be kept below 200 mg, although there is no evidence showing that caffeine consumption during pregnancy or childhood influences the development of the brain.

Health effects of caffeine consumption

A cost-benefit analysis of the effects of caffeine usually involves comparing beneficial behavioural outcomes and costs with any possible negative long term health effects. It has been suggested that caffeine is associated with many chronic health problems but most of the effects are not significant when confounders are controlled (Nawrot et al., 2003). In contrast, there are now suggestions that caffeine consumption may lead to health benefits. For example, Daly (2007) has shown that research on caffeine has been important in defining the role of phosphodiesterases, adenosine receptors, and calcium release channels in biological processes. Caffeine and related analogues are potential therapeutic agents for intervention in asthma, diabetes, cancer, Alzheimer's and Parkinson's disease.

Conclusions about caffeine and well-being

Research on the positive behavioural effects of caffeine has established a robust profile of the changes in performance and mood that occur acutely after ingestion. Regular caffeine consumption has also been shown to improve well-being and may contribute to better health and safety. A cost-benefit analysis even suggests that earlier views of negative health effects of caffeine are incorrect and that regular consumption may improve both acute and long term health.

The next section examines well-being in a slightly different way and considers the microstructure of the well-being process linking predictors, appraisals and positive or negative outcomes.

The Well-being Process

Recent approaches to the wellbeing of working adults have measured it with the Smith Wellbeing Questionnaire (SWELL – Smith & Smith 2017) or the Wellbeing Process Questionnaire (WPQ - Williams, Pendlebury & Smith 2017; Williams & Smith 2016, 2018; Williams, Thomas & Smith 2017). These surveys have also been used in studies of the well-being of students (Williams, Pendlebury, Thomas & Smith, 2017).

The wellbeing process model was based on the Demands-Resources-Individual Effects (DRIVE) model (Mark & Smith 2008), which was originally used in research on occupational stress. The model requires measurement of negative characteristics such as stressors, resources to cope with challenges, such as support and control, and individual differences such as personality

and coping style. The model allowed for the addition of new variables, with positive outcomes, such as happiness, positive affect and life satisfaction being included in later research. Such positive outcomes are often called "wellbeing". However, the wellbeing process includes both negative and positive characteristics (e.g. demands, support and control), appraisals (life satisfaction and perceived stress), individual differences (e.g. negative coping and positive personality) and outcomes (e.g. happiness and anxiety/depression). Recent research has led to new variables being added to the model (e.g. burnout and work-life balance; resilience, and training attitudes; ethnicity; and psychological contract fulfilment).

An important feature of these surveys is that they use short scales which are highly correlated with the longer established questionnaires. These short scales have been shown to have good validity and reliability. They have been widely used in cross-sectional studies and also been used in longitudinal studies which can give a better idea of the direction of causality. In the context of this chapter, it is now important to examine whether aspects of eating and drinking, such as consumption of breakfast and ingestion of caffeine, are associated with positive and negative wellbeing outcomes, and whether any effects remain significant when established predictors of wellbeing are covaried.

The next section describes results from a study of students (N=268) who completed the WPQ and also provided information on the frequency of breakfast consumption and caffeine use (the Diet and Behaviour Survey – Richards, Malthouse & Smith, 2015). The univariate correlations showed that caffeine consumption was correlated with negative outcomes (r= 0.22), as was skipping breakfast (r=0.23). Skipping breakfast was also negatively associated with positive outcomes (r = -0.23). However, caffeine consumption was also associated with established predictors of negative wellbeing (negative coping: r = 0.22; positive personality: r = -0.14). Similarly, skipping breakfast was associated with established predictors of the positive and negative outcomes (negative coping: r = 0.19; social support: r = -0.13; positive personality: r = -0.23). Regressions including caffeine, skipping breakfast and the established predictors of positive and negative outcomes showed that there were no significant effects of caffeine or skipping breakfast when personality, coping, exposure to stressors and social support were adjusted. Further research is now required to replicate and extend these preliminary findings. One approach that is certainly required is to take a multi-variate approach to eating and drinking behaviour. Often nutrients or meals and drinks are studied in isolation which is not representative of real-life. Indeed, many aspects of diet are highly correlated and without a multi-variate approach it is possible to come to erroneous conclusions based on univariate analyses. The importance of considering correlated psychological characteristics has been demonstrated above. Smith and Richards (2018) demonstrated the importance of adjusting for correlated aspects of diet. Their research examined the association between consumption of energy drinks and academic performance of adolescents. The initial univariate analyses suggested that those who frequently consumed energy drinks were more likely to have poorer attainment. However, consumption of energy drinks was part of a junk food diet, and when this was statistically controlled, the association between energy drinks and attainment was no longer significant.

The way forward

There has been considerable research on diet and behaviour (see Gomez-Pinilla, 2008; Kristjannson et al., 2010; Northstone et al., 2012) but there are a number of reasons why it has been difficult to interpret the findings and apply them to real-life settings. First, most studies take a univariate approach and consider a dietary variable in isolation. If the study is investigating acute effects then one also needs to address whether these will occur with repeated ingestion and with consumption of other food and drink. Cross-sectional studies are causally ambiguous; for example, does breakfast influence mental health or does mental health influence the likelihood of consuming breakfast? Instead, longitudinal studies, preferably with an intervention, are needed to determine causal relationships. Epidemiological research on diet and behaviour often fails to control for important personal and lifestyle characteristics. For example, Smith (1999) suggested that consumption of breakfast may be a good indicator of a generally healthy lifestyle rather than just having specific effects.

Research has identified several different dietary effects that require further analysis and investigation. Beneficial effects of breakfast (Kleinman et al., 2002; Lesani et al., 2016; Lien , 2007; Littlecott et al., 2016), fruit and vegetables (Blanchflower et al., 2013; Lin & Morrison, 2002; Mujic & Oswald, 2016; Smith & Rogers, 2014), the Mediterranean diet (McMillan et al., 2011), a vegetarian diet (NHS, 2015), grazing (Hewlett et al., 2009), super-foods (e.g. broccoli; NHS, 2015) and pre- and probiotics (Spector, 2015) have been identified. Negative effects have been related to junk food (Niemeier et al., 2006; Zahara et al., 2014), energy drinks (Richards et al., 2015), high levels of caffeine (Smith, 2002), emotional eating (Goer et al., 2008; Han & Pistole, 2014; Michels et al.; 2012), dietary restraint (Brunstrom et al., 2005) and a high BMI (Booth et al., 2014). Secondary analyses of existing databases can determine whether these effects are still significant when psychosocial and lifestyle variables are taken into account. However, we have no existing data which allows us to determine whether effects remain when other dietary effects are controlled. It is now easy to do this using a well-established methodology which can be applied to primary, secondary and university education, those of working age, and the elderly.

The present approach is similar to that taken in a recent study by Tan et al. (2018). They argue that little is known about multiple health behaviours across age groups and the underlying mechanisms are unclear. The model they used was a Compensatory Carry-Over Action model which postulates that different aspects of diet are interrelated and are driven by shared underlying mechanisms such as quality of sleep. Their study was cross-sectional and only involved adults of different ages. Use of longitudinal studies with children can lead to clearer identification of causal mechanisms and cognitive fatigue, rather than sleep, maybe the underlying mechanism. There are other plausible CNS mechanisms that underlie such dietary effects (Yeomans, 2017). Yeomans reviewed animal and human research and concluded that repeated consumption of high fat or high fat/high sugar diets leads to specific impairments in the functioning of the hippocampus, which causes reduced cognitive performance.

Conclusion

In summary, future research must investigate whether the impacts of diet on behaviour are still significant when confounding factors (psychosocial factors, lifestyle and other dietary effects) are controlled. Longitudinal studies must also be carried out to provide a better indication of causality. In addition, educational interventions, such as those using film media, need to be evaluated, and this has the potential to be used for dissemination and to increase the impact of future results. Research should address all ages, and it is important to use a method which can be applied across the lifespan and is applicable to vulnerable sub-groups (e.g. those with special educational needs and those with other existing disease).

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