

# You are what your friends eat: systematic review of social network analyses of young people's eating behaviours and bodyweight

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## ABSTRACT

**Background** This review synthesises evidence regarding associations between young people's social networks and their eating behaviours/bodyweight, and also explores how these vary according to the setting and sample characteristics.

**Methods** A systematic review of cross-sectional and longitudinal observational studies examining the association between measures of young people's social networks based on sociometric data and eating behaviours (including calorific intake) and/or bodyweight.

**Results** There is consistent evidence that school friends are significantly similar in terms of their body mass index, and friends with the highest body mass index appear to be most similar. Overweight youth are also less likely to be popular and more likely to be socially isolated at school. Frequency of fast food consumption has also been found to cluster within groups of boys, as have body image concerns, dieting and eating disorders among girls.

**Conclusion** School friendships may be critical in shaping young people's eating behaviours and bodyweight and/or vice versa, and suggests the potential of social-network-based health promotion interventions in schools. Further longitudinal research is needed to examine the processes via which this clustering occurs, how it varies according to school context, and the effects of non-school networks.

## BACKGROUND

In high-income countries, obesity among children and young people has increased rapidly since the latter part of the 20th century.<sup>1</sup> For example, a third of children and young people in the USA are considered to be overweight or obese, and prevalence is now also as high as 35% in parts of Europe, with rates of increase accelerating worldwide.<sup>2</sup> In addition to the long-term health risks associated with obesity in adulthood, obesity is associated with type 2 diabetes among children and adolescents, and overweight adolescents have higher rates of depressive symptoms and lower self-esteem.<sup>3</sup> Conversely, trends in young people's dieting/weight-control behaviours and eating disorders are also of public health concern: 2–3% of adolescent females are thought to have a clinical eating disorder.<sup>4</sup> These young people are at risk of long-term physical harms and early mortality due to vitamin deficiencies and rapid weight loss.<sup>5</sup> Recognition of these trends and harms has led to an increasing emphasis on prevention and early intervention, and a need to understand better the

determinants of such problems.<sup>6–8</sup> Social network analysis is one approach, examining the influence of social relationships on these outcomes.

Sociometric studies examine social relationships in terms of *nodes* (individuals) and *ties* (relationships), drawing on reciprocal reports from each individual in a putative tie. Network analysis based on these sociometric data allows examination of how the relationships of an individual and the characteristics of the broader social network are associated with, and can influence, outcomes. Such analyses can overcome problems with earlier studies of peer effects on health-related behaviours, as those examined immediate friendships only, rather than the wider peer group,<sup>9</sup> and also they generally relied on data from the reports of a single informant on the actions of others, and this tends to overestimate the reciprocity of ties and the sharing of behaviours and characteristics of friends.<sup>10</sup>

Recent longitudinal studies of adults' social networks suggest that obesity and eating disorders diffuse through social ties and may be 'socially contagious'.<sup>11–12</sup> Although these studies focus on adults and not young people, theoretical models to understand body-image concern and eating disorders have included peers as an important sociocultural determinant,<sup>13</sup> and empirical studies report that young people perceive their close friends and peers to influence their eating behaviours.<sup>14–17</sup>

This suggests that social networks may influence young people's eating behaviours and adolescent bodyweight, as they do in adults. However, the evidence regarding associations and causal influences between young people's social networks and eating behaviours, calorific intake and/or bodyweight has not been synthesised. Determining whether social networks causally influence these outcomes requires more than evidence of association.<sup>11</sup> As well as peer influence, associations may reflect reverse causality, whereby young people select friends as based on shared behaviours and/or bodyweight (homophily),<sup>18</sup> or confounding due to structural equivalence, whereby friends share characteristics, such as family income and neighbourhood context, other than their peer group, and these shape their eating behaviours and weight.<sup>19</sup>

This systematic review aimed to: (1) examine whether there are associations between measures of individual social position (for example, popularity) or a measure of the overall structure of social networks (for example, density) and young people's eating behaviours, calorific intake and/or bodyweight; and (2) explore how these associations vary

according to the setting and participants' sociodemographic characteristics. To do this we examined cross-sectional and longitudinal studies based on analyses of sociometric data. Although longitudinal data are needed to examine the direction of potential network effects and processes over time, cross-sectional studies can provide further evidence regarding the nature and extent of associations, informing further research and new interventions.<sup>20</sup>

## METHODS

### Search strategy

Major bibliographic databases (Social Science Citation Index, PubMed) and specialist registers (ADOLESC, ERIC) were searched in March 2009 using appropriate free-text and thesaurus terms relating to the population (for example, 'adolescent' or 'youth'), social networks (for example, 'network' or 'peer group') and health-related outcomes (for example, 'diet' or 'obesity'). A full list of terms is available on request. Keywords, titles and abstracts were then screened according to the inclusion criteria specified below. The bibliographies of included studies were also searched and key investigators were contacted to identify 'grey literature', PhD theses and forthcoming publications.

### Inclusion criteria

There were no restrictions according to language or publication date. Cross-sectional and longitudinal observational studies examining the association between measures of young people's social networks based on reciprocal sociometric data and eating behaviours or bodyweight were identified, including studies of dyadic relationships nested within larger sociometric datasets. Those studies that described non-reciprocal egocentric reports of relations were not included. Studies were therefore eligible for inclusion if they: (A) collected 'reciprocal' data from a defined group of young people in the age range 11–18 years in order to be able to describe the pattern and/or nature of friendship connections (ties) between individual young people (nodes); (B) provided summaries of social-network characteristics at the level of the individual (for example, popularity) or network (for example, density); (C) reported on measures of eating-related behaviours, caloric intake or bodyweight at the individual or network level; and (D) reported one or more measures of association between (B) and (C).

### Data extraction and synthesis

A standardised framework was used by two independent reviewers to extract data from studies (available on request). Neither outcomes nor summaries of social-network characteristics were sufficiently homogenous to undertake statistical meta-analysis and therefore findings are synthesised narratively.

## RESULTS

After screening 2242 titles and abstracts, we identified 10 studies (published between 1995 and 2010) that met our inclusion criteria. All of these focused on school social networks and five used data collected in the US National Longitudinal Study of Adolescent Health (Add Health) surveys (but undertook different analyses of these data).<sup>21–25</sup> A further two studies were based on other US studies<sup>26–27</sup> and three used social network data collected in Australian high schools.<sup>28–30</sup>

Sample sizes ranged from 385 to 17 557 school students (see table 1 for further details of study design, sample size and characteristics, methods for collecting and analysing social

network data, and key findings reported by authors). Three studies reported on longitudinal data,<sup>22–24</sup> while seven drew on cross-sectional data. One study reported only on associations between individual-level measures of young people's school social networks—such as the number of nominations received/given (in-degree/out-degree), reciprocity and centrality—and bodyweight.<sup>21</sup> Eight used sociometric data to examine network-level associations with eating behaviours/bodyweight.<sup>23–30</sup> Two of these also reported analyses of individual-level measures of young people's school social networks.<sup>24–27</sup> One study also reported associations among dyads constructed within the Add Health dataset.<sup>22</sup>

The studies reported on a range of outcome measures. One examined high-calorie food consumption.<sup>30</sup> Eight studies examined body mass index (BMI), used to define 'healthy', overweight, obese and underweight individuals.<sup>21–25 27–29</sup> Two examined dieting, extreme weight-loss behaviours, binge eating and body-image concern, as well as BMI score.<sup>28–29</sup> One focused on bulimic symptoms.<sup>26</sup>

### School social networks and high-calorie food consumption

One cross-sectional study focused on secondary school students' high-calorie food consumption and found that male friends were significantly alike in their consumption of fast food, but no similarities were identified between girls' friends and fast food consumption, or other measures of high-calorie food consumption (for example, high-calorie drink consumption).<sup>30</sup>

### School social networks, BMI and obesity

All eight studies that used BMI scores to calculate bodyweight and/or identify overweight and underweight individuals found evidence that school friends tend to be similar in terms of their BMI.<sup>21–25 27–29</sup> Five of these studies were based on analyses of Add Health surveys, which include questions about friendship networks and height/weight.<sup>21–25</sup>

Trogdon and colleagues' cross-sectional analyses of the Add Health data found that BMI of friends is positively associated with a student's own BMI. When the mean BMI of an adolescent friend is one unit higher (approximately 6 lb (2.72 kg) for a 16-year-old of average height), the adolescent's own weight is higher by 0.3 BMI units (approximately 2 lb (0.91 kg) for a 16-year-old of average height).<sup>24</sup> These associations were strongest among those young people at the higher end of the BMI spectrum (that is, overweight). Similarly, Valente and colleagues analysed cross-sectional data collected in four schools in the Los Angeles area and found that overweight youth were twice as likely to have overweight friends.<sup>27</sup>

Drawing on longitudinal data from two waves of the Add Health surveys, Halliday and Kwak also found that the average BMI of friends was positively associated with a student's own BMI at follow-up, and that those students who have friends who are overweight are also more likely to subsequently become overweight themselves.<sup>25</sup> This suggests the importance of social influence. Fowler and Christakis similarly found that risk of becoming obese increased when friends were obese, even after controlling for overall school trends.<sup>25</sup> Further support for the idea of *social influence* comes from Fowler and Christakis finding that non-reciprocal 'named friends' were *not* influenced by 'namers' over time.<sup>25</sup>

Conversely, Cohen-Cole and Fletcher suggest that observed similarities in the BMI of friends over time in the Add Health study are explained by *homophily*.<sup>22</sup> They constructed friendship dyads based on the first friend named by respondents in the Add Health survey and found that, after controlling for potential

**Table 1** Summary of included studies (n=10)

Author(s) (study name)	Country	Study design	Sample size and characteristics	Data collection methods	Method(s) for collecting and summarising social network data	Method(s) for analysing social network data	Eating behaviour and/or bodyweight measures	Key findings
Cohen-Cole and Fletcher (2008) <sup>22</sup> (National Longitudinal Study of Adolescent Health (Add Health))	USA	Longitudinal	Schools: N/S; students: n=1988	School-based and in-home surveys	Respondents asked to list up to 10 of their closest friends (five males, five females) Dyads constructed based on 'first friend named' by each subject	Logistic and OLS regression	Obesity	Odds that an ego becomes obese if his or her 'best friend' is obese: unadjusted=0.8, after adjusting for school-specific trends=0.51, after adjusting for school-specific trends and individual fixed effects=NSE
de la Haye et al (2009) <sup>30</sup>	Australia	Cross-sectional	Schools: n=2; students: n=385 (age 13–15 years; 202 males, 183 females)	School-based survey	Respondents listed the first and last names of all their 'close friends' in their school grade (defined as friends they 'hang around with' most)	Exponential random graph modelling, stratified by gender	High-calorie food consumption (fast food, savoury snack foods, sweet snack foods, high-calorie drinks)	Girls: no significant within-group similarity Boys: (1) fast food consumption: significant within-group similarity in 2/3 networks (MPEADE -0.08 to -0.12); (2) sweet snack food consumption: significant within-group differences in 1/3 networks (MPEADE 0.16); (3) savoury snack food consumption: no significant differences; (4) high-calorie drink consumption: no significant differences Ego becomes obese if his or her 'best friend' is obese after adjusting for school-specific trends (coefficient 0.033, SE 0.014, p=0.020) Evidence of 'directional effects' (that is, influence): 'named friends' not influenced by 'namers' (p=0.90) Correlations between own BMI and average peer BMI
Fowler and Christakis (2008) <sup>23</sup> (Add Health)	USA	Longitudinal	Schools: N/S; students: n=1988	School-based and in-home surveys	Respondents asked to list up to 10 of their closest friends (5 male, 5 female)	Logistic regression	Obesity	Ego becomes obese if his or her 'best friend' is obese after adjusting for school-specific trends (coefficient 0.033, SE 0.014, p=0.020) Evidence of 'directional effects' (that is, influence): 'named friends' not influenced by 'namers' (p=0.90) Correlations between own BMI and average peer BMI
Halliday and Kwak (2009) <sup>25</sup> (Add Health)	USA	Longitudinal	Schools: n=16; students: wave 1, n=4617; wave 2, n=2970 (mean age 15 years; 48% male, 52% female; ethnicity: 55% Caucasian, 19% African-American, 12% Asian; SES: single-parent household ~30%)	School-based and in-home surveys	Respondents asked to list up to 10 of their closest friends (5 male, 5 female)	Logistic regression (school fixed effects)	BMI Overweight: BMI at or above 85th percentile Underweight: BMI below the 10th percentile	BMI: girls: 10 point increase in friend BMI associated with 1.9 increase in own BMI; boys: 10 point increase in friend BMI associated with 1.8 increase in own BMI Overweight: girls: 10% increase in friends' propensity to be overweight is associated with 1.1% increase in own propensity to be overweight; boys: 10% increase in friends' propensity to be overweight is associated with 0.8% increase in own propensity to be overweight Underweight: no correlation Determinants of changes in own BMI: adolescent who nominate overweight friends at wave 1 most likely to gain weight by wave 2 BMI: significant within-group similarity (effect size 1.69, p=0.000) Dieting: significant within-group similarity (effect size 0.26, p=0.001) Extreme weight loss behaviours: significant within-group similarity (effect size 0.27, p=0.020) Binge eating: significant within-group similarity (effect size 0.24, p=0.026) Body image concern: no significant differences
Hutchinson and Rapee (2007) <sup>29</sup>	Australia	Cross-sectional	Schools: n=10; students: n=1094 (mean age 12.3 years; 100% female; SES: 84% born in Australia, 83% English first language, 82% two-parent family)	School-based survey	Respondents asked to identify friends who they spend most time with at school from the Grade 7 roster Friendship cliques (N=173) identified using UCINET software	MANCOVA within friendship cliques	BMI Dieting Extreme weight-loss behaviours Binge eating Body image concern	BMI: adolescent who nominate overweight friends at wave 1 most likely to gain weight by wave 2 BMI: significant within-group similarity (effect size 1.69, p=0.000) Dieting: significant within-group similarity (effect size 0.26, p=0.001) Extreme weight loss behaviours: significant within-group similarity (effect size 0.27, p=0.020) Binge eating: significant within-group similarity (effect size 0.24, p=0.026) Body image concern: no significant differences

Continued

Table 1 Continued

Author(s) (study name)	Country	Study design	Sample size and characteristics	Data collection methods	Method(s) for collecting and summarising social network data	Method(s) for analysing social network data	Eating behaviour and/or bodyweight measures	Key findings
Paxton <i>et al</i> (1999) <sup>26</sup>	Australia	Cross-sectional	Schools: n=6; students: n=523 (age 15–16 years, 100% female)	School-based survey	Respondents asked to identify girls who they spend most time with at school from the Grade 10 roster Friendship cliques (n=79) identified using UCINET software	MANCOVA within and between friendship cliques Hierarchical regression models of friendship variables	BMI Body image concerns Dieting Extreme weight loss Binge-eating	Intraclique versus interclique variability: (1) BMI: significantly higher between-group than within-group variance (2) Body image concerns: significantly higher between-group than within-group variance (p=0.002) (3) Dieting: significantly higher between-group than within-group variance (p=0.024) (4) Extreme weight loss: significantly higher between-group than within-group variance (p=0.001) (5) Binge-eating: no significant differences Friendship variables predicted: 14% variance in body image concerns, 14% variance in dietary restraint, 12% variance in extreme weight-loss behaviours, 12% variance in binge-eating disorders Bulimic symptoms were predicted by: bulimic symptoms in the friendship network (OR 1.29, p<0.0001); rate of anorexia or bulimia among friends (OR 0.12, 0.0001) Within-network similarities varied by grade: positive association at 9th grade; negative association at 12th grade
Pike (1995) <sup>26</sup>	USA	Cross-sectional	Schools: n=3; students: n=410 (mean age 16 years, range 14–19 years; 100% female)	School-based survey.	Respondents asked to identify up to 6 of their closest female friends	Girls were considered part of an individual's friendship network if they reciprocated the nomination of friendship Hierarchical regression modelling, stratified by grade Multivariate regression analysis	Bulimic symptoms	In-degree (mean no. of nominations): girls: 3.41 overweight versus 5.01 normal-weight (p<0.001); boys: 3.38 overweight versus 4.55 normal weight (p<0.001) Popularity ( $\leq 5$ nominations): girls: 27% overweight versus 47% normal weight (p<0.001); boys: 28% overweight versus 40% normal weight (p<0.001) Reciprocity (best male friend nominates as best friend): girls: 12% overweight versus 29% normal weight (p<0.002); boys: 31% overweight versus 34% normal weight (p=0.3) Reciprocity (best female friend nominates as best friend): girls: 34% overweight versus 46% normal weight (p=0.002); boys: 18% Centrality (mean Bonacich score): girls: 0.53 overweight versus 0.78 normal weight (p<0.001); boys: 0.54 overweight versus 0.69 normal weight (p<0.001) Social isolation (no nominations): overweight OR 1.71 (CI 1.39 to 2.20)
Strauss and Pollack (2003) <sup>21</sup> (Add Health)	USA	Cross-sectional	Students: n=17 557 (7th to 12th Grade; BME: 18% African-American, 12% Hispanic 12%; SES: 29% single-parent household)	School-based and in-home surveys	Respondents asked to list up to 10 of their closest friends (5 male, 5 female) Friendship networks were generated using Pajek and SAS/IML software		Overweight (BMI above 95th percentile)	

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Table 1 Continued

Author(s) (study name)	Country	Study design	Sample size and characteristics	Data collection methods	Method(s) for collecting and summarising social network data	Method(s) for analysing social network data	Eating behaviour and/or bodyweight measures	Key findings
Trogdon et al (2008) <sup>24</sup> (Add Health)	USA	Cross-sectional	Schools: n=16; students: n=3702 (mean age 16.1 years)	School-based and in-home surveys	Respondents asked to list up to 10 of their closest friends (5 male, 5 female)	Multivariate regression analysis	BMI Overweight (BMI at or above 85th percentile)	Friendship nominations: overweight adolescents less likely to be nominated as a friend Influence of friends' weight: mean weight among friends positively associated with adolescent weight (OLS 0.30, p<0.001) Influence of grade-level peers' weight: mean weight among grade-level peers positively associated with adolescent weight (OLS 0.23, p<0.005) Girls: (1) friends' average BMI: positive association with being overweight; (2) number of friends named: positive association with being overweight (OR 1.57, CI 1.01 to 2.46); (3) frequency named as a friend: negative association with being overweight for girls (OR 0.89, CI 0.75 to 1.07) Boys: (1) friends' average BMI: positive association with being overweight; (2) number of friends named: no association with being overweight; (3) frequency named as a friend: no association with being overweight
Valente et al (2009) <sup>27</sup>	USA	Cross-sectional	Schools: n=4; students: n=617 (age 11–15 years; 36% male, 64% female; ethnicity: 36% Asian, 30% Hispanic, 12% Caucasian, 12%, 12% mixed, 6% other, 3% African-American)	School-based survey	Respondents asked to nominate friends in their class	Random-effect logistic regression modelling, with individuals nested by school-class	Overweight (BMI above 95th percentile)	

BME, black and minority ethnicity; BMI, body mass index; MANCOVA, multivariate analyses of covariance; MPEADE, model parameter estimates for absolute difference effects; N/S, not stated; NSE, no significant effect; OLS, ordinary least squares; Pajek, large network analysis program (<http://pajek.imfm.si/doku.php>); SAS/IML, interactive matrix programming with integration to R (SAS Institute, Cary, North Carolina, USA); SES, socioeconomic status; UCINET, social network analysis program (Analytic Technologies, Lexington, Kentucky, USA).

confounding due to shared school environment, the odds that an ego becomes obese increase by 51% if his or her 'alter' (friend) is also obese.<sup>22</sup> After controlling for contextual factors and individual-level 'fixed effects' the relationship between friendship dyads and BMI disappeared; the authors suggest that this indicates that young people *select* friends similar to themselves.

Trogdon and colleagues found that overweight adolescents were less likely to be nominated as a friend,<sup>24</sup> as did Strauss and Pollack who studied the social position of overweight students and reported that for all network measures overweight adolescents were more likely to receive no or few friendship nominations and report fewer reciprocal friendships.<sup>21</sup> After adjusting for sociodemographic factors, participation in physical activity and clustering by school, the average 'social penalty' was -1.25 friendship nominations for girls and -1.03 for boys (p<0.001). While Valente and colleagues found that overweight girls were less likely to be named as a friend, there was no such association among boys.<sup>27</sup>

At the network level, the two Australian cross-sectional studies suggest that female high-schools students' friendship groups resemble each other with respect to BMI scores, and that differences in BMI are significantly greater *between* rather than within friendship groups.<sup>28 29</sup>

### School social networks, body image concerns and eating disorders

There is evidence that among girls behaviours such as dieting and extreme weight loss are clustered in certain groups within schools. In a cross-sectional US study, Pike found that bulimic symptoms were strongly predicted by having female high-school friends who also reported bulimic symptoms,<sup>26</sup> while Hutchinson and Rapee also found significant within-group similarity regarding students' dieting, extreme weight loss behaviours and binge eating among girls at Australian high schools, even after controlling for BMI, self-esteem and 'negative' emotions. Around 25% of the variance in these behaviours could be explained by group membership.<sup>29</sup> Friendship groups that reported high levels of dieting and extreme weight loss behaviours were also associated with high mean group reports of: friends' concern with thinness and dieting, peer pressure to lose weight and to be thin, and peer teasing.<sup>29</sup>

In contrast, another cross-sectional study of female high school students in Australia by Paxton and colleagues found that friendship groups among girls in Australian high schools shared similar levels of body image concern, dietary restraint and use of extreme weight loss behaviours after adjusting for individual physical and psychological factors.<sup>28</sup> However, within this sample, binge eating was not associated with social network once individual-level sociodemographic and physical factors were included in multivariate analysis. Further analyses suggested that perceptions of friends' views and actions with respect to body image concern and dieting, and the extent to which a student reported comparing her body with others, were influential in these behaviours clustering.<sup>28</sup>

### How do these associations vary according to the setting and sociodemographic characteristics?

The study by de le Haye and colleagues found associations between boys' friendship groups and fast-food consumption within two out of three school networks.<sup>30</sup> Within one network, the consumption of fast food was positively associated with popularity (receiving nominations), suggesting that the underlying social processes may vary across different school cultures and contexts. Although fast-food consumption appeared to

cluster among groups of male school-friends, the propensity to be overweight when friends were overweight and the risk of social isolation due to being overweight appeared to be greatest among females.<sup>21 22 27</sup> There is also some evidence that the importance of friendships on having eating disorders might be greatest in early adolescence, for example, among 12–14 year olds, and this diminishes later in the high school careers of females.<sup>26</sup>

## DISCUSSION

The evidence reviewed suggests that, in high-income countries, school friendships may be critical in shaping young people's eating behaviours and bodyweight and/or vice versa. There is consistent evidence that school friends are significantly similar in terms of their BMI, and adolescents with the highest BMI appear to be most similar. Overweight youth are also less likely to be popular students and are at risk of being socially isolated at school. Frequency of fast-food consumption has also been found to cluster within groups of boys, as have body image concerns, dieting and eating disorders among girls.

Although there is consistent evidence about associations, the studies reviewed do not provide definitive evidence about the relative importance of peer influence, peer selection and structural equivalence/confounding. It is plausible that all three occur, and this partly explains the patterns reported. There is some evidence that peer influence may underlie diffusion of obesity<sup>23 25</sup> and eating disorders,<sup>28 29</sup> and that homophily may explain observed similarities in the BMI of friends over time.<sup>22</sup> Although structural equivalence may partly explain within-group similarities, these may decline once potential confounders, such as school environment, are adjusted for. However, none of the studies found that such external, shared characteristics fully explained significant relationships between students' social networks, on the one hand, and their eating behaviours or bodyweight, on the other.

## Limitations

Only a limited number of studies were identified ( $n=10$ ), all of which drew on data from the USA or Australia, so these findings may not be generalisable elsewhere. Furthermore, most of the studies were cross-sectional and cannot determine causal direction. The three longitudinal studies drew different conclusions because of their different methodological approaches.<sup>22 23</sup> Furthermore, the findings of Cohen-Cole and Fletcher are limited because they only used friendship dyads (rather than all observed friendships), which are static over time, and this leaves students' 'random' ex-friends in the model and thus reduces the chance of finding any effects due to friendship.<sup>22</sup>

Although all the included studies aimed to control for confounding by age, gender, ethnicity and/or socioeconomic status, there may have been residual confounding from factors such as parenting styles or baseline non-health risk behaviours. However, *overadjustment* is also a potential limitation, and some studies may therefore have *underestimated* the true association between students' social networks and eating behaviours/bodyweight. For example, Hutchinson and Rapee report that around 25% of the variance in the eating behaviours they studied could be explained by group membership after controlling for individuals' BMI, self-esteem and 'negative' emotions,<sup>29</sup> although factors such as self-esteem may lie on the causal pathway. More generally, the statistical methods applied in the field of social network analysis are constantly evolving, and results may differ according to the whether logistic regression models or exponential random graph models are applied.<sup>27 30</sup>

All the analyses examined young people's social networks *in school*, ignoring out-of-school friendships, which may be influential.<sup>31</sup> While schools provide a unique institutional context in which to collect and construct 'complete' (rather than 'egocentric') network data,<sup>32</sup> young people have other peer groups and different friends outside school so the identified networks are incomplete.<sup>31</sup> For example, other friends who live in the same neighbourhood but go to a different school, or have left school, could be influential in determining eating behaviours. A further limitation with the studies identified is that they do not examine how the macrosocial network structure of a school or community can influence aggregate health outcomes over and above the effects of friendship networks. For example, do schools with *denser networks* and/or larger components facilitate the *diffusion* of obesity or 'crash' dieting?

Finally, a limitation of all systematic reviews is their reliance on authors' descriptions of the methods and exposures under study, and how the findings are presented in published reports and papers. For example, authors do not always define concepts such as obesity in exactly the same way or report how they measured this. Furthermore, measures of effect sizes were reported inconsistently across studies, and in some cases the effect sizes were not reported. It is also important to note that in some cases multiple tests of significance within papers may have resulted in some apparent associations having arisen due to chance.

## Implications for policy and practice

Youth is a period of dramatic physical, cognitive, social and emotional development, and offers health promoters a special opportunity to encourage healthy lifestyles. Although peer education has been widely used to address adolescent substance use and sexual health,<sup>33 34</sup> school-based peer education addressing young people's eating behaviours and bodyweight has received relatively little attention. Interventions addressing parental influences, food prices and marketing, and school nutrition policies continue to receive greatest attention and investment.<sup>8</sup> The evidence synthesised here suggests the potential of social-network-based health promotion interventions in schools. One such intervention is the AHEAD project, an intervention that aims to promote healthy eating via the ASSIST model of peer education and positive influence,<sup>34</sup> currently being piloted by researchers at Bristol University.

There may also be scope for developing peer-group-based counselling and motivational interviewing interventions targeting those groups of young women most at risk of eating disorders in a supportive, non-stigmatising group setting. It would also be appropriate to pilot interventions aiming to support overweight students in making new friendships in school in order to avoid isolation or confinement to *obesogenic cliques*.

Furthermore, if school friendships *are* influential in determining young people's eating behaviours and bodyweight, then interventions such as those above could have a social 'multiplier' effect<sup>35</sup> whereby their initial impact spreads more widely via social diffusion. This would, in turn, imply that those school-based interventions that have previously been found to be effective, such as whole-school healthy eating programmes,<sup>36</sup> may have a greater 'reach', wider benefits and be more cost-effective than previously thought.

## Implications for research

Well-conducted longitudinal studies are necessary to determine the relative importance of selection, influence and structural

equivalence. Such studies need to occur in a wider range of contexts, and in countries other than the USA and Australia, and should also aim to capture non-school friends via community and online surveys. Future studies should also examine the effects of macrosocial as well as microsocial networks, and the processes through which any effects occur (for example, through the establishment of BMI norms and a reference for body image).

Additionally, little attention has been paid to how and why social-network influences can vary according to contextual and sociodemographic characteristics, and this should be a priority for future analyses of social network studies of young people's eating and weight. For example, does the relative importance of selection versus influence vary according to school context, and if so how? Qualitative studies are also needed to understand the meaning and importance of network structures within school hierarchies,<sup>37</sup> and explore how school-environmental factors vary, such as the canteen peer-group environment.<sup>38</sup> Finally, despite increasing concerns,<sup>39</sup> the current evidence ignores peer group influences on eating disorders among boys, who could also be subject of future social network studies on the issue.

## CONCLUSION

Social network analysis is a rapidly emerging area within the research on adolescent eating behaviours and bodyweight, with 7 out of the 10 studies in this review published since 2007. In the field of public health, network analysis can be applied to understand how social relationships determine health-related

knowledge, attitudes and behaviours and to inform new health promotion interventions.<sup>20</sup> There is consistent evidence that school friends are significantly similar in terms of their eating behaviours and bodyweight, particularly the most overweight young people. Further longitudinal research is needed to examine the processes via which this clustering occurs, and how it varies according to school context. There is also scope for health promoters to pilot and evaluate social-network-based health promotion interventions in schools to promote healthy eating and reduce body image concerns.

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## REFERENCES

1. **Strauss RS**, Pollack HA. Epidemic increase in childhood overweight, 1986–1998. *JAMA* 2001;**286**:2845–8.
2. **Lobstein T**, Jackson-Leach R. *International Comparisons of Obesity Trends, Determinants and Responses: Evidence Review*. London: UK Government Office for Science, 2007. <http://www.foresight.gov.uk>.
3. **Strauss CC**, Smith K, Frame C, et al. Personal and interpersonal characteristics associated with childhood obesity. *J Pediatr Psychol* 1985;**10**:337–43.
4. **Favaro A**, Ferrera S, Santonastaso P. The spectrum of eating disorders in young women: a prevalence study in the general population sample. *Psychosom Med* 2003;**65**:701–8.
5. **Steinhausen H**. An analysis of the outcome of anorexia nervosa and bulimia nervosa. *Eur Psychiat* 1997;**12**:145s.
6. **Pearson J**, Goldklang D, Streigel-Moore RH. Prevention of eating disorders: challenges and opportunities. *Int J Eat Disord* 2002;**31**:233–9.
7. **Jacobi C**, Hayward C, De Zwaan M, et al. Coming to terms with the risk factors for eating disorders: application of risk terminology and suggestions for a general taxonomy. *Psychol Bull* 2004;**130**:190–5.
8. **Koplan JP**, Liverman CT, Kraak VI. *Preventing Childhood Obesity: Health in the Balance*. Washington, DC: National Academies Press, 2005.
9. **West P**, Michell L. Smoking and peer influence. In: Goreczny AJ, Hersen M, Boston MA, eds. *Handbook of Pediatric and Adolescent Health Psychology*. Needham Heights, MA: Allyn & Bacon, 1999:179–202.
10. **Alexander C**, Piazza M, Mekos D, et al. Peers, schools and adolescent smoking. *J Adolesc Health* 2001;**29**:22–30.
11. **Christakis NA**, Fowler JH. The spread of obesity in a large social network over 32 years. *New Engl J Med* 2007;**357**:370–9.
12. **Crandall CS**. The social contagion of binge eating. *J Pers Soc Psychol* 1988;**55**:558–98.
13. **Stice E**, Agras W. Predicting onset and cessation of bulimic behaviours during adolescence: a longitudinal grouping analysis. *Behav Ther* 1998;**29**:257–76.
14. **Wertheim EH**, Paxton SJ, Schutz HK, et al. Why do adolescent girls watch their weight? An interview study examining sociocultural pressures to be thin. *J Psychosom Res* 1997;**42**:345–55.
15. **Lieberman M**, Gauvin L, Bukowski WM, et al. Interpersonal influence and disordered eating behaviors in adolescent girls: the role of peer modeling, social reinforcement, and body-related teasing. *Eat Behav* 2001;**2**:215–36.
16. **Ludvigsen A**, Sharma N. *Burger Boy and Sporty Girl: Children and Young People's Attitudes Towards Food in School*. Barking: Barnardo's, 2004.
17. **Milner M**. *Freaks, Geeks and Cool Kids: American Teenagers, Schools and the Culture of Consumption*. New York: Routledge, 2004.
18. **McPherson M**, Smith-Lovin L, Cook JM. Birds of a feather: homophily in social networks. *Annu Rev Sociol* 2001;**27**:415–44.
19. **Abel G**, Plumridge L, Graham P. Peers, networks or relationships: strategies for understanding social dynamics as determinants of smoking behaviour. *Drugs Educ Prev Pol* 2001;**9**:325–38.
20. **Valente T**. Opinion leader interventions in social networks. *BMJ* 2006;**333**:1082–3.
21. **Strauss RS**, Pollack HA. Social marginalisation of overweight children. *Arch Pediatr Adolesc Med* 2003;**157**:746–52.
22. **Cohen-Cole E**, Fletcher JM. Is obesity contagious? Social network vs. environmental factors in the obesity epidemic. *J Health Econ* 2008;**27**:1382–7.
23. **Fowler JH**, Christakis NA. Estimating peer effects in social networks: a response to Cohen-Cole and Fletcher, and Trogon, Nonemaker, and Pais. *J Health Econ* 2008;**27**:1386–91.
24. **Trogon JG**, Nonemaker J, Pais J. Peer effects in adolescent overweight. *J Health Econ* 2008;**27**:1388–99.
25. **Halliday TJ**, Kwak S. Weight gain in adolescents and their peers. *Econ Hum Biol* 2009;**7**:181–90.
26. **Pike KM**. Bulimic symptomatology in high school girls. Towards a model of cumulative risk. *Psychol Women Q* 1995;**19**:373–96.
27. **Valente T**, Fujimoto K, Chou C, et al. Adolescent affiliations and adiposity: a social network analysis of friendships and obesity. *J Adolesc Health* 2009;**45**:202–4.

### What is already known on this subject

- ▶ Recent evidence suggests that obesity and eating disorders can spread via social networks.
- ▶ Various theories and empirical studies suggest young people's friends may influence their eating behaviours, bodyweight and body image concerns.
- ▶ No systematic review has synthesised the evidence about the association of young people's social networks and eating behaviours or bodyweight, and whether associations reflect influence, selection or confounding.

### What does this study add

- ▶ There is consistent evidence that school friends are significantly similar in terms of eating behaviours and body mass index, with the strongest associations for body mass index found among the most overweight. Eating disorders have also been found to cluster within groups of female friends. Overweight youth are less likely to be popular and more likely to be socially isolated at school.
- ▶ This evidence suggests the potential of social-network-based health promotion interventions in schools to complement existing school-based initiatives addressing young people's diet.
- ▶ The relative importance of influence, selection and confounding is uncertain because of the inconsistency of findings from the small number of longitudinal studies.

28. **Paxton SJ**, Schutz HK, Wertheim EH, *et al.* Friendship clique and peer influences on body image concerns, dietary restraint, extreme weight-loss behaviors, and binge eating in adolescent girls. *J Abnorm Psychol* 1999;**108**:255–66.
29. **Hutchinson DM**, Rapee RM. Do friends share similar body image and eating problems? The role of social networks and peer influences in early adolescence. *Behav Res Ther* 2007;**45**:1557–77.
30. **de la Haye K**, Robins G, Mohr P, *et al.* Obesity-related behaviours in adolescent friendship networks. *Soc Networks* 2010;**32**:161–7.
31. **Kirke DM**. Collecting peer data and delineating peer networks in a complete network. *Soc Networks* 1996;**18**:333–46.
32. **Scott J**. *Social Network Analysis: A Handbook*. London: Sage, 2001.
33. **Stephenson J**, Strange V, Forrest S, *et al.* Pupil-led sex education in England (RIPPLE study): cluster-randomised intervention trial. *Lancet* 2004;**364**:338–46.
34. **Campbell R**, Starkey F, Holliday J, *et al.* An informal school-based peer-led intervention for smoking prevention in adolescence (ASSIST): a cluster randomised trial. *Lancet* 2008;**371**:1595–602.
35. **Christakis NA**. Social networks and collateral health effects—have been ignored in medical care and clinical trials, but need to be studied. *BMJ* 2004;**329**:184–5.
36. **Shepherd J**, Harden A, Rees R, *et al.* *Young People and Healthy Eating: A Systematic Review of Research on Barriers and Facilitators*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London, 2001.
37. **Michell L**, Amos A. Girls, pecking order and smoking. *Soc Sci Med* 1997;**44**:1861–9.
38. **Neumark-Sztainer D**, Story M, Perry C, *et al.* Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. *J Am Diet Assoc* 1999;**99**:929–37.
39. **Dominé F**, Berchtold A, Akre C, *et al.* Disordered eating behaviors: what about boys? *J Adolesc Health* 2009;**44**:111–17.

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