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Overweight status and psychological well-being in adolescent boys and girls: a multilevel analysis*

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Background: Psychological distress and high body mass index (BMI) are linked in adults, especially in females. Effects of social position and behaviour, and whether obesogenic environments affect adolescents and adults equally are unresolved. The aim was to examine associations between psychological distress and being overweight in adolescents, by sex, accounting for social, lifestyle and contextual factors. Correlation of area-level variation in overweight status in adolescents and adults was investigated. **Methods:** Height, weight, General Health Questionnaire 12 (GHQ12) of psychological distress, physical activity, smoking, alcohol consumption, area deprivation and social class were available on 635 male and 618 female adolescents (13–15 years) from two cross-sectional population health surveys conducted in Scotland in 1998–99/2003–04. Multilevel logistic regression modelled overweight (including obese) status accounting for intraclass correlation of adolescents in households within postcode sector areas in health board regions. Univariable analysis examined effects of high (4 or more) GHQ12 score; multivariable analysis further allowed for covariates. Adult data were used to assess the importance of correlation between adolescent and adult area-level variation. **Results:** Univariably, there was significantly increased risk of being overweight associated with high GHQ12 score for girls but not boys; adolescent and adult area-level variation correlation did not impact. Results remained significant for girls in multivariable analyses (OR = 2.44, 95% confidence interval (CI): 1.33–4.50) and non-significant for boys (OR = 1.31, 95% CI: 0.56–3.05). **Conclusions:** Findings indicate being overweight is associated with psychological distress in adolescent girls, but not boys. Effects are not mediated by social, lifestyle or contextual factors.

Keywords: adolescents, body mass index, mental health, multilevel modelling

Introduction

In recent years, obesity and overweight has become a major public-health concern, particularly among children and adolescents. Prevalence is increasing, with figures for overweight in children in the United Kingdom tripling from 5 to 6% in boys and 9–10% in girls to 22% and 28% in 1999, respectively in 20 years[1]; rates are higher in Scotland than for the United Kingdom as a whole.[2] Obesity levels have risen concurrently with increases in psychological morbidity among adolescents, with rises in, for instance, emotional problems from 8 to 13% in boys and girls in 1986 to 13 and 20% in 1999, respectively.[3] It is important to understand the connection between elevated body mass index (BMI) and psychological distress in adolescence since this is a potentially crucial stage relating to the development of both.[4] A recent review on children and adolescents suggests that among community samples few obese children are depressed or have low self-esteem although there is evidence that girls and adolescents as well as those seeking treatment may be at higher risk.[5] Conclusions from another review indicate the existence of links between obesity and aspects of psychological distress such as low self-esteem, depression and anxiety in children and adolescents.[6] Recent work based on a study of adolescents in Scotland found small differences in psychological distress between obese and non-obese individuals, particularly among girls.[7]

Since there have been findings of positive associations between adolescent depression and later obesity among females, but negative associations in males, any analysis of correlation between weight and psychological distress should take into account the possible moderating effect of gender.[8,9] Little is known about how factors such as family social position and individuals' lifestyles may operate in relation to psychological distress and bodyweight. Possible differences in psychological distress or weight status existing across social class groups,[10] and by physical activity,[11] smoking,[12] alcohol consumption,[13] as well as age[14] may be driving or mediating associations between being overweight and psychological distress. For instance, if physical inactivity, a component of high bodyweight, also plays a role in psychological distress, then any observed association between being overweight and psychological distress could, at least partly, be due to physical inactivity. Overlooking social circumstances and lifestyles could potential result in findings of a relationship between being overweight and psychological distress which is not necessarily real; such potential confounding should be addressed.

Contextual factors can be involved in weight status in childhood and adolescence,[15] with areas of residence[16–18] considered potential obesogenic environments[16,19]—those encouraging overconsumption of energy-dense foods, and physical inactivity, leading to obesity.[16] Suggested factors through which areas of residence can be obesogenic are

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socioeconomic status and associated amenities such as fast-food outlets.[20] Such potential geographical clustering should thus be taken into account,[19,21] by being incorporated as a level in a hierarchical model,[22] avoiding error which would otherwise result from incorrect assumptions of independence of observations within areas; previous investigations in children have not taken context into account.[6]

Although eating habits and physical activity patterns of children are intrinsically linked with those of parents[23,24] as is weight status,[25] little is known about whether obesogenic environments affect children in the same way as they do adults. Considering areal variations in overweight status in adults and associations with such variations in adolescents may inform and reinforce analyses by 'borrowing strength'—using the information available from the overweight status on adults, and the possible correlation of area effects on adult overweight with area effects for adolescent overweight, to improve the estimated area effects on adolescent overweight. This can be addressed by accounting for the correlation between area-level variation of overweight in adolescents and that in adults. The importance of environment in terms of adult weight—whether obesogenic neighbourhood environments operate in the same way on children as they do on adults—has not previously been investigated.

Data on 13–15 year olds—the age group considered to be pre-adulthood teens—from the Scottish Health Surveys (SHS) 1998 and 2003 provide the chance to investigate the association of being overweight with psychological distress among adolescents in Scotland, by sex, accounting for social, lifestyle and contextual factors, whilst affording the opportunity to assess the importance of the correlation of unexplained area-level factors in overweight status in adolescents with such factors in adults.

Methods

Data used were from the second and third waves of the SHS, 1 year cross-sectional nationally representative samples of the population living in private households in Scotland, conducted 1998–99[24] and 2003–04[26] respectively. The 1998 survey was the first SHS to include data on adolescents and children as well as adults. In each, around one-third (312) of the postcode sectors of Scotland were sampled from all 15 health board in Scotland, as was the case at the times of surveys. Postcode sectors are small areas with total population averaging 5000, although there is considerable variety in size. The overall response rates were 77 and 67% of all eligible households, with 9903 and 5090 households participating, respectively. Within each household, up to two children aged 2–15 years as well as one adult (1998) aged 16–74 years, or all adults (2003), were selected randomly to be included in the survey. The analysis presented here was based on the sub-sample of adolescent children that is those aged 13–15 years.

Psychological distress

Data available include responses to items of the General Health Questionnaire 12 (GHQ12), a widely used standard composite measure of psychological distress[27] applicable to adolescents[28] as well as adults. GHQ12 consists of 12 questions on recent concentration abilities, sleeping patterns, self-esteem, stress, despair, depression and confidence. Respondents were asked to categorize their experiences relative to their normal functioning. Due to the sensitivity of the questions they were asked in the self-completion booklet. GHQ12 is usually dichotomized at either 3 or 4; we chose a threshold of 4, with a score of 4 or more being indicative of psychological distress.[29]

Overweight status

Height and weight were measured by interviewers, and used to derive BMI in $kg\,m^{-2}$. BMI was used to group individuals as normal, overweight or obese, using the thresholds based on the international cut off points which correspond to trajectories passing through 25 and $30\,kg\,m^{-2}$ at 18 years of age.[30,31] Since the proportions of high scoring GHQ12 were not significantly different for overweight and obese individuals [11.5% (29/252) and 5.9% (3/51), respectively; ($P = 0.320$)], these groups were combined into a single overweight/obese group. The term overweight is used to refer to individuals who are overweight or obese. Adolescents with BMI below $15\,kg\,m^{-2}$—$15\,kg\,m^{-2}$ being the 2nd percentile value for 14 year olds (mid-age range), corresponding to BMI of $17\,kg\,m^{-2}$ at age 18 years (non-validated)[30] and thus threshold for serious underweight[32]—were excluded from the analyses (six boys and two girls, only 1 of whom had a GHQ12 score of more than 3).

Covariates

As well as age, and sex, other covariates available were physical activity, cigarette smoking, alcohol consumption, household social class and area deprivation. Respondents were asked about a range of physical activities, including walking, housework, gardening, sports or exercise activities carried out in the week prior to interview. Total duration of relevant activities was classified as more than 60 min, 30–59 min or <30 min on at least 5 days in the week. Information on cigarette smoking and alcohol consumption was obtained in the self-completion booklet. Adolescents were asked if they smoked cigarettes, and if so, how many in a week and grouped according to whether they did not smoke, smoked less than once a week or smoked at least once a week. Adolescents were asked which alcoholic drinks, if any, they had consumed in the last 7 days; intake was categorized as none or some. Social class was based on that of the chief income earner of the household and categorized according to the Registrar General's classification scheme.[33] Area deprivation was measured by the Carstairs index of material deprivation, developed for the Scottish health experience. It combines data derived from the 1991 United Kingdom census on male unemployment, household overcrowding, non-car ownership and low social class at the postcode sector level, with high numbers corresponding to deprived areas.[34,35]

Statistical methods

Pearson χ^2 tests were used to compare differences in the distributions of age, sex, GHQ12 and the other covariates by overweight status as well as availability of BMI data. The data were hierarchically structured, with individuals living in postcode sector areas which belong to the various health board regions in Scotland. Health boards were grouped into seven regions based on the survey sampling design.[26] Multilevel logistic regression models, stratified by sex, were fitted to account for the data hierarchy (adolescents within postcode area within health board region) and differential effects for boys and girls. The intraclass correlation coefficient—the proportion of the total variance attributable to differences in overweight between areas—was estimated for dichotomous outcomes assuming a threshold model to ascertain the percentage of the total variation in being overweight attributable to the postcode area.[22] First, univariable logistic regression was applied to model the unadjusted relationship between the outcome—overweight status—and

the explanatory variable—GHQ status. Since these data are cross-sectional, the alternative option of having GHQ status as the outcome variable and overweight status as the explanatory is equally valid, thus association was ascertained both ways. If the environment in which an adolescent lives is obesogenic—that is, if the environment contributes to the likelihood of an individual being overweight or obese—then it is reasonable to suppose that there may be similar effects upon adults living in the same areas. We assessed this possibility by jointly modelling the BMI data of adults and adolescents, in effect allowing for a correlation between the likelihood of adults and that of adolescents living in the same area being overweight, and using the adult data to supplement the estimation of area effects for adolescents (and hence the variation between areas) in the univariable multilevel models. Multivariable analysis incorporated adjustment by the covariates: age, sex, physical activity, cigarette smoking, alcohol consumption, household social class and area deprivation. The appropriateness of combining data from two separate surveys was assessed by the significance of GHQ12-survey interaction terms to ensure the relationship between overweight status and GHQ12 score did not differ by survey. Sensitivity analyses were conducted to ensure results were robust regardless of choice of 3 or 4 for the GHQ12 threshold, or continuous score. Finally, associations in the overweight, excluding obese individuals, were assessed in isolation.

Results

In total, 750 boys and 736 girls aged 13–15 years were interviewed in SHS 1998 and 2003. Of these, BMI of at least 15 kg m^{-2} was available for 662 (88%) boys and 657 (89%) girls. There were no significant differences in the distributions of age ($P = 0.681$), sex ($P = 0.542$), GHQ12 ($P = 0.905$), physical activity ($P = 0.603$), smoking ($P = 0.886$), drinking ($P = 0.629$), or social class of chief income earner ($P = 0.915$) for those with valid compared with those with unknown or invalid BMI, although there was a difference for Carstairs index of deprivation ($P = 0.005$).

Full GHQ12 and covariate data were available for 635 (96%) boys and 618 (94%) girls with known BMI (table 1). Of those, 146 [23% (21% in 1998 and 25% in 2003)] boys and 157 [25% (24% in 1998 and 27% in 2003)] girls were overweight, with mean BMIs of 21.0 [standard error (SE) = 3.7] and 21.7 (SE = 3.3), respectively. The percentage of overweight boys with a high-GHQ score was not significantly different from that of normal weight boys (7% versus 5%, $P = 0.518$), whereas in girls the percentages were significantly different (17% versus 8%, $P = 0.010$). Patterns of age, physical activity, cigarette smoking, alcohol consumption, social class and area deprivation did not differ by overweight status in boys. Among girls only area deprivation was significantly associated, with those from the most deprived areas being more likely to be overweight.

There was some postcode sector area-level variation: 0.014 (SE = 0.207) in boys and 0.297 (SE = 0.244) in girls, suggesting that 0.4 and 8.3% (calculated from the intraclass correlation coefficient) of the total variation in being overweight among boys and girls, respectively, is attributable to the area (or factors associated with the area). However, there was no health board regional variation beyond that which would be expected from a Binomial model, thus data were modelled as individuals within postcode sector areas.

Table 1 The distributions of GHQ12, age, physical activity, smoking, drinking, social class of chief income earner, and Carstairs index of deprivation by overweight status and sex

Characteristic	Boys ($n = 635$)			Girls ($n = 618$)		
	Normal weight *n* (%)	Overweight/obese *n* (%)	*P*-value[a]	Normal weight *n* (%)	Overweight/obese *n* (%)	*P*-value[a]
GHQ12						
Low: <4	466 (95)	137 (94)		427 (93)	134 (85)	
High: ≥4	23 (5)	9 (6.2)	0.302	34 (7)	23 (15)	0.010
Age						
13	170 (35)	49 (34)		157 (34)	61 (39)	
14	152 (31)	49 (34)		149 (32)	49 (31)	
15	167 (34)	48 (33)	0.852	155 (34)	47 (30)	0.523
Physical activity on at least 5 days per week						
≥60 min	325 (66)	84 (58)		170 (37)	59 (38)	
30–59 min	80 (16)	27 (18)		112 (24)	31 (20)	
<30min	84 (17)	35 (24)	0.107	179 (39)	67 (43)	0.473
Cigarette smoking per week						
None	445 (91)	140 (96)		421 (91)	144 (92)	
Less than once	9 (2)	1 (1)		12 (3)	3 (2)	
More than or equal to once	35 (7)	5 (3)	0.155	28 (6)	10 (6)	0.883
Alcohol consumption in previous week						
None	432 (88)	123 (84)		412 (89)	141 (90)	
Any	57 (12)	23 (16)	0.202	49 (11)	16 (10)	0.877
Social class[b]						
I or II	183 (37)	44 (30)		167 (36)	53 (34)	
III	185 (38)	70 (48)		179 (39)	58 (37)	
IV or V	121 (25)	32 (22)	0.086	115 (25)	46 (29)	0.560
Carstairs index quintile						
Least deprived	112 (23)	40 (27)		99 (21)	22 (14)	
2	110 (22)	25 (17)		102 (22)	28 (18)	
3	101 (21)	38 (26)		105 (23)	35 (22)	
4	80 (16)	23 (16)		87 (19)	35 (22)	
Most deprived	86 (18)	20 (14)	0.287	68 (15)	37 (24)	0.034
Total	489 (77)	146 (23)		461 (75)	157 (25)	

a: based on χ^2 tests
b: social class of chief income earner

Table 2 Multivariable multilevel logistic regression of risk of being overweight/obese by GHQ12, age, physical activity, smoking, drinking, Carstairs index of deprivation and social class of chief income earner

Characteristic	Boys		Girls	
	OR[a]	95% CI[b]	OR[a]	95% CI[b]
GHQ12				
Low: <4	1	–	1	–
High: ≥4	1.31	0.56–3.05	2.45	1.33–4.50
Age				
13	1	–	1	–
14	1.08	0.67–1.74	0.79	0.49–1.28
15	0.94	0.58–1.53	0.76	0.46–1.23
Physical activity on at least 5 days per week				
≥60 min	1	–	1	–
30–59 min	1.26	0.75–2.11	0.77	0.45–1.32
<30 min	1.59	0.98–2.58	1.14	0.73–1.77
Cigarette smoking per week				
None	1	–	1	–
Less than once	0.22	0.02–1.97	0.81	0.20–3.19
More than or equal to once	0.34	0.12–0.96	0.94	0.40–2.21
Alcohol consumption in previous week				
None	1	–	1	–
Any	1.92	1.06–3.48	0.99	0.50–1.95
Social class[c]				
I or II	1	–	1	–
III	1.73	1.09–2.75	0.88	0.55–1.42
IV or V	1.35	0.77–2.37	1.10	0.65–1.85
Carstairs index quintile				
Least deprived	1	–	1	–
2	0.63	0.35–1.16	1.32	0.66–2.66
3	1.00	0.57–1.76	1.53	0.78–3.01
4	0.71	0.38–1.35	2.09	1.05–4.13
Most deprived	0.58	0.30–1.11	2.76	1.36–5.59

a: Odds ratio
b: 95% confidence interval
c: Social class of chief income earner

Univariably, for boys, there was an increased risk of being overweight associated with having high-GHQ12 score [odds ratio (OR) = 1.33] but this did not achieve statistical significance at the 5% level [95% confidence interval (CI): 0.60–2.95]. For girls, there was a significantly increased risk (OR = 2.27; 95% CI: 1.26–4.08). Relationships between overweight status and GHQ12 score did not vary by survey year ($P = 0.175$ for girls and $P = 0.598$ for boys), validating the combining of data from the two surveys.

To address the possible environmental element of postcode area-specific adult population overweight prevalences, available data on 6477 men and 8041 women aged 16 years and over were used to assess the effect of accounting for correlation of area-level variation in overweight status of adolescents and postcode area-level variation in overweight status of adults. Adjustment for the correlation resulted in only minor alterations in OR estimates and 95% CI compared with the basic univariable multilevel model (to OR = 1.29; 95% CI: 0.58–2.84 for boys and OR = 2.24; 95% CI: 1.24–4.02 for girls). The small difference is likely to be due to the small area-level variation in adult BMI of 0.058 (SE = 0.014). Subsequent analysis was thus performed on data on adolescents only.

In multivariable analysis association between high-GHQ12 score and being overweight in girls remained significant (OR = 2.45; 95% CI: 1.33–4.50) with the relationship in boys being non-significant, as for the univariable results (OR = 1.31; 95% CI: 0.56–3.05) (table 2). Of the covariates, the risk of being overweight was significantly increased in boys who reported drinking any alcohol in the previous week relative to those who had not drunk any alcohol and among boys in social class III relative to social classes I and II. The odds of being overweight were significantly lower among boys who smoked at least once a week relative to those who did not smoke. Among girls, living in an area in the most deprived two quintiles was significantly associated with being overweight (table 2). Between-area variance coefficient estimates were 0.127 (SE = 0.228) for boys and 0.344 (SE = 0.254) for girls. Similar results were obtained with a GHQ12 threshold of 3: multivariable OR = 2.66 (95% CI: 1.57–4.52) for girls; and OR = 1.55 (95% CI: 0.83–2.89) for boys. Considering GHQ12 on a continuous scale produced equivalent results with a one point increase in the score being associated with a significant increase in being overweight in girls but not boys [multivariable OR = 1.18 (95% CI: 1.06–1.31) for girls; and OR = 1.03 (95% CI: 0.89–1.19) for boys]. Considering GHQ12 as the outcome and overweight status as the exposure yielded analogous results [multivariable OR = 2.20 (95% CI: 1.09–4.45) for girls; and OR = 1.33 (95% CI: 0.58–3.04) for boys]. Finally, in assessment excluding the obese, results for the overweight individuals only also concurred [multivariable OR = 2.70 (95% CI: 1.47–4.95) for girls; and OR = 1.12 (95% CI: 0.40–3.17) for boys]. The obese alone were too few in number (20 girls and 31 boys) to draw any reliable inference.

Discussion

Using survey data on over 1200 adolescents representative of the population, we found being overweight to be associated with psychological distress in girls aged 13–15 years in Scotland. The statistically significant relationship remained in girls when account was taken of the other factors of lifestyle and environment considered here. The relationship was not statistically significant for boys.

Some limitations of this work must be acknowledged. Since analyses are based on cross-sectional data, the direction of causation cannot be assessed.[7,36] Future research could involve prospective follow-up of larger numbers of adolescents within a longitudinal study; such a design offers the most effective means of establishing the dynamics of the relationship between problem weight and psychological distress. These analyses are confined to addressing psychological distress by the single measure, GHQ12, not particular psychiatric conditions, and as such do not explore the possible role of gender in condition-specific effects.[37] Further, the GHQ12 measures deviations from people's usual functioning in the previous few weeks and therefore cannot detect chronic conditions. A GHQ12 score of 4 or more is nevertheless indicative of the presence of a possible psychiatric disorder and is thus useful in this context. As an alternative to the threshold of 4, GHQ12 scores are sometimes dichotomized at 3.[38,39] To ensure our findings were robust, we performed sensitivity analyses with this scheme, as well as continuous GHQ12 scores; conclusions were not altered, lessening any concerns of chance findings. With only 15% of overweight/obese girls having a high GHQ12 score, the effect may be modest but is nonetheless significant. Because the occupation classifications are based on characteristics other than income, and the dominant occupation may not be the highest paid, a small degree of misclassification may result from using the chief income earner's social class as a proxy for the status of the household. However, it has the advantage of boosting the proportion of individuals who can be classified, especially young people.[40]

A major strength of this work is that in the SHS anthropometric measurements were taken by the interviewers as part of the study protocol and not self-reported, providing reliable data. Additionally, the GHQ12 items were

self-completed and thus more likely to be truly representative of psychological state compared with interview-based tools.

These findings add to the existing literature, and are in line with those from other child/adolescent studies.[4,8,9,41,42] Findings from the National Longitudinal Study of Adolescent Health in the United States indicate that those having depressed mood at baseline were twice as likely to be obese 1 year later.[4] Especially pronounced associations of obesity and depression in female adolescents and young adults have been identified.[42] There is some evidence of a lack of association between obesity and self-esteem in pre-adolescent girls[43,44] indicating that the connection is not established until adolescence. Results concur with recent work by Sweeting *et al.*,[7] also based on Scottish adolescents, which found several associations albeit small, with low mood, self-esteem and self-image; especially among females. It is of interest that deprivation was not associated with being overweight in boys; this fits with findings in adult men in Scotland, among whom socio-economic disadvantage is not associated with risk of being overweight, whereas for women it is associated with a higher risk.[45] The lack of association between physical activity and overweight status is unexpected and could be due to the categorization insufficiently distinguishing between extremes in activity levels. Apparent conflicting findings of significance in associations with overweight status among boys in the baseline tests for trend (table 1) and formal results (table 2) are due to difference in statistical methods (for alcohol consumption) and category specific results (for cigarette smoking and social class). Also worthy of comment are findings of considerably lower levels of psychological distress in the small number of children who met the criteria for obesity compared to the larger overweight group, although results did not reach statistical significance.

Although not statistically significant, there was an effect of postcode area of residence, and accounting for this between area variation meant the reliability of the analyses was improved by refinement of SE and corresponding CI. Despite advocacy by health-professionals of behavioural interventions taking a family-based approach,[46] which have been found to be the most effective treatments,[6] household was not found to be a significant factor here (data not shown). This is likely to be due to the average of just 1.04 adolescents per household, with little power to detect variation. This work represents the first attempt to address the importance of environment in terms of adult weight. Although there was reasonable correlation between adolescent and adult overweight at the area level, including adult data had only a minor impact on the OR and CI limit estimates for adolescents, possibly explained by small variation in adult overweight status at the area level or lack of power given the relatively small adolescent sub-sample.

Although pathways of association between psychological state and overweight could not be investigated here, the relationship is likely to be bidirectional. That being overweight leads to psychological problems is to be expected in the current social environment: overweight adolescents are at the mercy of conflicting influences of the accessibility of high-fat fast food combined with a societal emphasis on thinness and fitness.[47] The function of body image in the relationship between obesity and psychological distress[48] is conceivably more powerful among adolescent girls—they may experience heightened distress resulting from perceptions of being overweight as unacceptable to a greater degree than boys—which would explain gender differences found here. Alternatively, girls with mental health problems could be more likely than boys to turn to food as solace. It is unclear whether the distress is indeed weight related due to family and peer disapproval, to the stresses of trying to conform by dieting, or a combination of factors.[49] Converse explanations for the link include mood-related dysfunctional eating patterns and lack of enthusiasm for physical activity.[50]

In summary, we found associations between being overweight and psychological distress in female adolescents in Scotland which, when adjusted for lifestyle and environmental factors, remained statistically significant. In terms of policy implications, this provides a basis for consideration of the use of diagnosis and treatment of psychological distress to reduce overweight/obesity. Equally, in assessing overweight adolescents, health professionals should be mindful of psychological state.[51]

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Conflicts of interest: None declared.

Key points

- Being overweight was associated with psychological distress in adolescent girls in Scotland and remained so following adjustment by socio-economic and behavioural factors, confirming existing findings in other countries.
- Accounting for environment in terms of adult weight was found to have a negligible effect.
- While managing overweight adolescents, health professionals should be aware of increased risk of psychological distress, particularly with girls.

References

1 Rennie KL, Jebb SA. Prevalence of obesity in Great Britain. *Obes Rev* 2005;6:11–2.

2 Jebb SA, Rennie KL, Cole TJ. Prevalence of overweight and obesity among young people in Great Britain. *Public Health Nutr* 2004;7:461–5.

3 Collishaw S, Maughan B, Goodman R, Pickles A. Time trends in adolescent mental health. *J Child Psychol Psychiatry* 2004;45:1350–62.

4 Goodman E, Whitaker RC. A prospective study of the role of depression in the development and persistence of adolescent obesity. *Pediatrics* 2002;110:497–504.

5 Wardle J, Cooke L. The impact of obesity on psychological well-being. *Best Pract Res Clin Endocrinol Metab* 2005;19:421–40.

6 Zametkin AJ, Zoon CK, Klein HW, et al. Psychiatric aspects of child and adolescent obesity: a review of the past 10 years. *J Am Acad Child Adolesc Psychiatry* 2004;43:134–50.

7 Sweeting H, Wright C, Minnis H. Psychosocial correlates of adolescent obesity, 'slimming down' and 'becoming obese'. *J Adolesc Health* 2005;37:409.

8 Pine DS, Goldstein RB, Wolk S, Weissman MM. The association between childhood depression and adulthood body mass index. *Pediatrics* 2001;107:1049–56.

9 Pine DS, Cohen P, Brook J, Coplan JD. Psychiatric symptoms in adolescence as predictors of obesity in early adulthood: a longitudinal study. *Am J Public Health* 1997;87:1303–10.

10 Sobal J, Stunkard AJ. Socioeconomic status and obesity: a review of the literature. *Psychol Bull* 1989;105:260–75.

11 Parsons TJ, Manor O, Power C. Physical activity and change in body mass index from adolescence to mid-adulthood in the 1958 British cohort. *Int J Epidemiol* 2006;35:197–204.

12 Potter BK, Pederson LL, Chan SS, et al. Does a relationship exist between body weight, concerns about weight, and smoking among adolescents? An integration of the literature with an emphasis on gender. *Nicotine Tob Res* 2004;6:397–425.

13 Buemann B, Astrup A. How does the body deal with energy from alcohol? *Nutrition* 2001;17:638–41.

14 Dai S, Labarthe DR, Grunbaum JA, et al. Longitudinal analysis of changes in indices of obesity from age 8 years to age 18 years. Project HeartBeat! *Am J Epidemiol* 2002;156:720–9.

15 Maffeis C. Childhood obesity: the genetic-environmental interface. *Baillieres Best Pract Res Clin Endocrinol Metab* 1999;13:31–46.

16 Poston WS, 2nd, Foreyt JP. Obesity is an environmental issue. *Atherosclerosis* 1999;146:201–9.

17 Zeller M, Daniels S. The obesity epidemic: family matters. *J Pediatr* 2004;145:3–4.

18 Cummins S, Macintyre S. Food environments and obesity–neighbourhood or nation? *Int J Epidemiol* 2006;35:100–4.

19 Golan M, Crow S. Parents are key players in the prevention and treatment of weight-related problems. *Nutr Rev* 2004;62:39–50.

20 Macdonald L, Cummins S, Macintyre S. Neighbourhood fast food environment and area deprivation-substitution or concentration? *Appetite* 2007;49:251–4.

21 Ellaway A, Anderson A, Macintyre S. Does area of residence affect body size and shape? *Int J Obesity* 1997;21:304–8.

22 Snijders TAB, Bosker RJ. *Multilevel analysis: an introduction to basic and advanced multilevel modeling*. London: Sage Publishers, 1999.

23 Moore LL, Lombardi DA, White MJ, et al. Influence of parents' physical activity levels on activity levels of young children. *J Pediatr* 1991;118:215–9.

24 Shaw A, McMunn A, Field Je, editors. *The Scottish health survey 1998*. Vol. 1. Findings. Vol. 2 Technical report. Edinburgh: HMSO; 2000.

25 Maril S, Bondestam M, Bergstrom R, et al. Prevalence trends of obesity and overweight among 10-year-old children in western Sweden and relationship with parental body mass index. *Acta Paediatr* 2004;93:1588–95.

26 Craig R, Deverill C, Pickering K, Prescott A. Volume 4: Technical Report, Chapter 1: Methodology and Response. In: Bromley S, Sproston K, Shelton N, editors. *The Scottish health survey 2003*. Edinburgh: The Scottish Executive Department of Health, 2005.

27 Goldberg D, Williams PA. *Users Guide to the General Health Questionnaire*. Windsor: NFER-Nelson, 1988.

28 Doyle M. Health status. In: Sproston K, Primatesta P, editors. *Health Survey for England 2002 Volume 1: The health of children and young people*. London: The Stationery Office, 2003.

29 Goldberg DP, Oldehinkel T, Ormel J. Why GHQ threshold varies from one place to another. *Psychol Med* 1998;28:915–21.

30 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *Br Med J* 2000;320:1240–3.

31 Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Arch Dis Child* 1995;73:25–9.

32 Nicholls D, Viner R. Eating disorders and weight problems. *Br Med J* 2005;330:950–3.

33 Leete R, Fox J. Registrar General's social classes: origins and uses. *Population Trends* 1977;8:1–7.

34 Carstairs V, Morris R. *Deprivation and health in Scotland*. Aberdeen: Aberdeen University Press, 1991.

35 McLoone P, Boddy FA. Deprivation and Mortality in Scotland, 1981 and 1991. *Br Med J* 1994;309:1465–70.

36 French SA, Perry CL, Leon GR, Fulkerson JA. Self-esteem and change in body mass index over 3 years in a cohort of adolescents. *Obes Res* 1996;4:27–33.

37 Mustillo S, Worthman C, Erkanli A, et al. Obesity and psychiatric disorder: developmental trajectories. *Pediatrics* 2003;111:851–9.

38 Williams R, Eley S, Hunt K, Bhatt S. Has psychological distress among UK South Asians been under-estimated? A comparison of three measures in the west of Scotland population. *Ethn Health* 1997;2:21–9.

39 West P, Sweeting H. Fifteen, female and stressed: changing patterns of psychological distress over time. *J Child Psychol Psychiatry* 2003;44:399–411.

40 Craig P, Forbes J. Social position and health: are old and new occupational classifications interchangeable? *J Biosoc Sci* 2005;37:89–106.

41 Myers A, Rosen JC. Obesity stigmatization and coping: relation to mental health symptoms, body image, and self-esteem. *Int J Obes Relat Metab Disord* 1999;23:221–30.

42 Strauss RS. Childhood obesity and self-esteem. *Pediatrics* 2000;105:e15.

43 Phillips RG, Hill AJ. Fat, plain, but not friendless: self-esteem and peer acceptance of obese pre-adolescent girls. *Int J Obes Relat Metab Disord* 1998;22:287–93.

44 French SA, Story M, Perry CL. Self-esteem and obesity in children and adolescents: a literature review. *Obes Res* 1995;3:479–90.

45 Hirani V. Anthropometric measures, overweight, and obesity. In: Bromley, Sproston K, Shelton N, editors. *The Scottish Health Survey 2003 Vol 2: Adults*. Edinburgh: The Scottish Executive Department of Health, 2005.

46 Fowler-Brown A, Kahwati LC. Prevention and treatment of overweight in children and adolescents. *Am Fam Physician* 2004;69:2591–8.

47 Strauss RS. Childhood obesity. *Pediatr Clin North Am* 2002;49:175–201.

48 Friedman KE, Reichmann SK, Costanzo PR, Musante GJ. Body image partially mediates the relationship between obesity and psychological distress. *Obes Res* 2002;10:33–41.

49 Ross CE. Overweight and depression. *J Health Soc Behav* 1994;35:63–79.

50 Rosmond R, Bjorntorp P. The role of antidepressants in the treatment of abdominal obesity. *Med Hypotheses* 2000;54:990–4.

51 Stunkard AJ, Wadden TA. Psychological aspects of severe obesity. *Am J Clin Nutr* 1992;55(Suppl 2):524S–32S.

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