The changing social patterning of obesity: an analysis to inform practice and policy development

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List of abbreviations used in the text

BMI	Body mass index (weight(m)/height (cm)^2)
BMI-SDS	Body mass index standard deviation score
CI	Confidence interval
HSE	Health Survey for England
IOTF	International Obesity Task Force
kg	Kilogram
m	Metre
Man	Manual social class group
NMan	Non manual social class group
MCS	Millennium Cohort Study
n	Number
NatCen	National Centre for Social Research
NICE	National Institute for Health and Clinical Excellence
NSF	National Service Framework
NS-SEC	National Statistics Socio-economic classification
OB	Obese (in adults, BMI $\geq$ 30 kg/m^2)
OV	Overweight (in adults, BMI $\geq$ 25 kg/m^2)
OR	Odds ratio
PA	Physical activity
PSA	Public Service Agreement
SD	Standard deviation
SDS	Standard deviation score
SE	Standard Error
SEP	Socio-economic position
SHS	Scottish Health Survey
TDS	Townsend Deprivation Score
WHR	Waist-hip ratio (ratio of waist to hip circumference)

Preface: what this study adds to knowledge

Trends in overweight and obesity by age, sex and socio-economic position

The analyses confirm reported trends in obesity in the British population, including its strong social gradient. Previous studies have not documented trends over such an extended period. The prevalence of obesity and overweight continue to rise in adults and children. In the Health Survey for England, women have higher levels of obesity overall, but men are more likely to be overweight at all ages. Among children, girls were more likely to be overweight and obese at most ages. However, the increases in obesity and overweight have been proportionately greater since the early 1990s in men than women, indicating a convergence of these trends. Cross-sectionally, prevalence of obesity, overweight and high waist-hip ratio increases up to age 75 years, but thereafter declines somewhat. There is evidence a strong social gradient from an early age, which is wider in females than males, but we found little evidence that this is either widening or narrowing over time in recent years, except in children. Levels of obesity are worse in some regions of the UK than others, after controlling for social and demographic factors, including Scotland, the North East, Yorkshire and Humber, and the East and West Midlands.

Weight gain among parents and its influence on weight gain in children

The presence of intergenerational effects was striking in our cohort analyses, confirming the results of previous studies and indicating the importance of early interventions for obesity. We found that obesity was associated with social class in both early life and adulthood, although there was a tendency for social differences in obesity to be greater for class of origin than concurrent social class in the 1958 Birth Cohort. We found socioeconomic gradients in weight gain in the Millennium Cohort Study of young children and their parents, contributing to the social patterning of obesity in children and adults. Although parental weight gain was not found overall to be strongly associated with faster weight gain in children from 9 months to 3 years, it was found to have a greater influence on children within ‘never worked or long-term unemployed’ households, suggesting an ‘at risk’ group.

Indicators of the changing epidemiology of diet and physical activity

There were some inconsistencies in our findings relating to behavioural risk factors for obesity and overweight. Nevertheless, there were indications that diet and, to a lesser extent, physical activity is socio-economically patterned. In the 1958 Birth Cohort, social differences in dietary factors, and for men physical activity, tended to be greater for concurrent social class in adulthood than social class of parents. This suggests that the origins of social inequalities may be different for BMI, activity and dietary habits and that interventions aimed at modifying behaviour in mid-life may be only partly successful in reducing inequalities in obesity. However, efforts to change diet and physical activity behaviour will need to continue among adults, as well as focus on the very young.

Methodological considerations

Overall, inconsistencies in the data collected and available for analysis from the national health surveys hinder their usefulness as a tool for research and policy analysis at national levels. Better data are needed on energy intake from the whole diet and energy expenditure from all types of physical activity across age and social groupings to inform future policy and practice. Further research is needed to understand better the relationship between diet and physical activity, and socio-economic position.

Executive summary

Background

The prevalence of overweight and obesity continues to increase globally and in the UK. Long-term consequences include raised risk of developing hypertension and stroke, coronary heart disease, diabetes, osteoarthritis and certain cancers. Recently, a socioeconomic gradient in the prevalence of excess body weight has emerged in the UK, such that it has increasingly become a condition associated with lower socioeconomic position. Recent cross-sectional studies suggest that socioeconomic gradients have become established in childhood.

The emerging socioeconomic gradient of obesity in children is of particular concern both because overweight and obese children have increased risk of obesity in adult life and weight management interventions among children and young adults are of limited effectiveness. Evidence from a longstanding national dietary survey indicates that in the post-war years absolute energy intakes gradually decreased. This suggests that declining levels of energy expenditure from habitual physical activity (PA) may have played an important role in the emerging obesity epidemic. However, less is known about the social patterning of diet and PA, and their relative importance as antecedents of overweight and obesity among different population groups.

The UK has a range of datasets which permit cross-sectional, longitudinal and inter-generational analyses of socioeconomic trends in obesity, and in its suspected influences (diet, PA and parental body mass).

Aims

In this project, we set out to use a range of existing datasets to explore the emerging socio-economic patterning of obesity and its main risk factors in the UK. We aimed to investigate age, sex and socioeconomic trends in:

- overweight and obesity, using national cross-sectional and longitudinal data
- weight gain among parents and its influence on weight gain in children, using national cohort studies
- indicators of the changing epidemiology of diet and PA, using national cross-sectional and longitudinal data

Methods

Analyses were conducted using data from three separate studies drawing on data from two British cohort studies (one historical birth cohort, started in 1958, and one contemporary cohort, started in 2000) and from the annual cross-sectional national health surveys (Health Survey for England (HSE) and Scottish Health Survey (SHS)). Whilst we were able to use common definitions for measures of obesity and overweight and social class, there were limitations that prevented us from combining datasets. The analyses are thus presented separately.

Analyses of the 1958 Birth Cohort used data on approximately 17,000 males and females followed up prospectively (at ages 7, 11, 16, 23, 33, 42, 45 years). We examined socio-economic differences in overweight and obesity, using international cut-offs for body mass index (BMI), comparing manual and non-manual social groups, as defined by adult occupation and by social origins (occupation of father). Socio-economic differences in BMI were assessed at different ages from childhood to adulthood; differences in PA and diet were assessed using indicator variables, such as frequency of fruits and salad intake, at ages 33 and 42y. The BMI of about 3000 4-18 year-old offspring was examined in relation to BMI gain over different periods of the cohort members lives, comparing the association in social class groups. Multilevel models and logistic models were used to test the inter-generational associations. BMI was standardised in several analyses to allow comparison between ages and generations.

The Millennium Cohort Study (MCS) is a longitudinal study, which was set up to examine the social, economic and health-related circumstances of the new century's babies and their families. It includes a relatively high number of families from ethnic minority and disadvantaged areas. So far data have been collected when the cohort child was 9 months and 3 years old. Interviews were conducted with the main carer (usually the mother) and their partners at both contacts and information obtained on a large number of factors, including self-reported parental weights and heights, the child's last weight (~ 9 months), socioeconomic position, ethnicity and a range of other covariates. At 3 years the child's weight and height were measured. For 8561 children with complete measurements, we used regression analysis to assess social patterning in weight gain to 3 years and BMI at 3 years, in relation to maternal and partner weight gain.

Analyses of the HSE and SHS were undertaken using the statistical software STATA v9 and incorporated appropriate data weights to allow comparisons between years. Logistic regression was used to model the relationship between the three main binary outcomes (obesity, overweight and high waist-hip ratio (WHR)) and a number of explanatory variables (e.g. age, year, gender and the lifestyle factors). Given the difference in availability of data and the patterns seen in adults and children, separate models were fitted and reported for adults and children. For both adults and children, the results have been reported from separate models for males and females. Results are presented for the HSE in the main body of the report. Results for the SHS and regional comparisons are derived from a limited common dataset and are presented in Appendix 2.

Key findings

Age, sex and socioeconomic trends in overweight and obesity

Our findings support and extend those of the published research literature, which suggests that the obesity epidemic continues to grow unabated. Offspring in the 1958 birth cohort have on average greater BMIs than their parents at similar ages in childhood, and year on year increases in age-group specific prevalence of overweight obesity and high WHR were observed in the national health surveys. In the HSE, Woman have higher levels of obesity overall, but men are more likely to be overweight at all ages. Among children, girls were more likely to be overweight and obese at most ages. However, the increases in obesity and overweight have been proportionately greater since the early 1990s in men than women, indicating a convergence of these trends. Cross-sectionally, prevalence of obesity, overweight and high WHR increases up to age 75 years, but thereafter declines somewhat.

Although socio-economic differentials in body mass were not present in children in the 1958 Birth Cohort, there is evidence that they are emerging at age 3 years in the MCS, with marked differences between the 'never worked and long term unemployed' group and higher social groups. The socio-economic gap seems to be wider for females than males at all ages and across time in the national health surveys. However, although we have demonstrated marked socio-economic patterning of obesity and markers of behavioural risk in adults and children, males and females, our analyses have not shown that the gap between rich and poor has widened, or narrowed, since the early 1990s.

Weight gain among parents and its influence on weight gain in children

We found considerable evidence for longitudinal and intergenerational influences on obesity. In the MCS, greater gestational age at birth and higher birth weight were associated with greater weight gain up to 3 years of age. In the 1958 Birth Cohort, adiposity tracked from childhood into adulthood. Moreover, we found that parental BMI independently predicted offspring BMI and, if both parents were overweight or obese, then the chances of offspring being overweight or obese were even greater than if one parent had excess body weight. In the MCS, there was evidence that socioeconomic patterning of weight gain to 3 years was linked to parental weight gain. In families where the household socio-economic classification was 'never worked or long term unemployed', weight gain from 9 months to 3 years was predicted by maternal weight gain over the same period. Socioeconomic patterning of weight gain between 9 months and 3 years for the whole cohort was abolished once parental weight gain was taken into account. In the 1958 Birth Cohort, BMI in adulthood was better predicted by social class of origin than concurrent social class, although both had an independent effect.

The changing epidemiology of diet and physical activity

Markers of behavioural risk in the three studies were limited in their range and quality, providing only crude indicators of risk. We found some inconsistency in results of analyses of behaviours within the three analyses. Overall, whole milk consumption has decreased over time in the national health surveys. Over the same period consumption of lower fat (semi-skimmed and skimmed) milks increased. Milk consumption was patterned socio-economically, with the manual social class group more likely to drink whole milk. However, paradoxically, obesity and overweight were greater among those drinking lower fat milks than whole milk, which may be a consequence of people switching to lower fats milks in order to control weight or may be a result of response bias. Our inability to determine the direction of causality is an obvious limitation of cross-sectional analyses using the national health surveys.

Although fruit and vegetable consumption did not change over the short time frame for which data were available (2001 and 2004) in the national health surveys, it was consistently higher among older adult age groups and the higher social class group in adults. Greater fruit and vegetable consumption was associated with greater prevalence of overweight and lower prevalence of a high WHR in men, but a lower prevalence of obesity and lower prevalence of high WHR in women. Among boys, as in men, those eating more fruit and vegetables were more likely to be overweight, but there were no similar associations in girls.

Data on diet was similarly limited in the 1958 Birth Cohort. However, social class differences in diet tended to be greater for concurrent social class than social class of origin, suggesting a more important effect of present environment on behaviour.

Physical activity declined with age in all years of the national health surveys and was lower among women than men. However, trends over time were less clear and a social patterning was only observed in men, with manual social class men being more active. Nevertheless, lower levels of activity were associated with greater prevalence of obesity, overweight and high WHR, and this relationship was consistent over time. Among children there was some indication that levels of activity have declined over time, but activity was not associated with levels of overweight or obesity.

In contrast, data from the 1958 Birth Cohort showed an association between manual social class and lower levels of PA and, over time, social differentials in PA were better predicted by concurrent socio-economic position (SEP) than social class of origin, again suggesting a more important role for environmental factors in adulthood. The conflicting findings on PA and body mass in the cross-sectional and cohort studies may be due to the different methods used to assess PA, both of which were based on self-report.

Conclusions

Analyses of these three datasets have largely confirmed reported trends in obesity in the British population, including its strong social gradient. However, within this broad conclusion, there are a number of more detailed findings which have implications for future policy, practice and research.

Age, sex and socioeconomic trends in overweight and obesity

Obesity and overweight have increased over time since 1993 in the national health surveys. Levels of excess body weight are greater among women than among men, although there is some evidence that men are catching up. Levels of overweight and obesity increase with age from childhood up to age 75 years. This finding supports the conclusion that efforts to prevent or reduce obesity and overweight need to start early in life and continue at least until retirement age.

Socioeconomic inequalities in body mass are marked but data from the HSE suggests these do not appear to have widened over the last 15 years. There is a clear need to focus on this inequality and reduce the gap between rich and poor. Implementation of the recently published guidance from the National Institute for Health and Clinical Excellence (NICE) on prevention and management of obesity will need to take account of this social patterning and ensure that the interventions proposed do not inadvertently further widen inequalities in obesity and overweight.

Levels of obesity are worse in some regions of the UK than others, after controlling for social and demographic factors. These regions, which include Scotland, the North East, Yorkshire and Humber, and the East and West Midlands, will need to make greater efforts to reduce levels of obesity than those regions with relatively lower levels of obesity.

Weight gain among parents and its influence on weight gain in children

The presence of intergenerational effects in both cohort studies was striking and suggests an important priority for public health interventions. Intergenerational effects may presently be amplifying the growth of the obesity epidemic through the generation of a repeating cycle, with obese parents having obese children, who become obese parents, and so on. Breaking this cycle will require a range of interventions including attention to preventing excessive weight gain in early childhood, among young parents and during pregnancy.

BMI was associated with social class in both early life and adulthood in the 1958 Birth Cohort, although there was a tendency for social differences to be greater for class of origin than concurrent social class. In contrast social differences in dietary factors, and for men PA, tended to be greater for concurrent social class. This suggests that the origins of social inequalities may be different for BMI, activity and dietary habits and that interventions aimed at modifying behaviour in mid-life may be only partly successful in reducing inequalities in obesity. Given this, we would not necessarily expect social inequalities in activity and diet to mirror those for BMI over time. This may also provide another argument for initiating efforts to prevent obesity early, preferably in childhood. However, efforts to change diet and PA behaviour will need to continue among adults. Recent BMI gain in parents was associated with offspring BMI in childhood, which may be due to environmental or genetic influences. Therefore, it would be beneficial to help parents to adopt lifestyle changes that can provide role models for their children and shape the environment for their children.

The MCS found socioeconomic gradients in weight gain in a contemporary cohort of young children and their parents, contributing to the social patterning of obesity in children and adults. Although parental weight gain was not found to be strongly associated with faster weight gain in children from 9 months to 3 years, it was found to have a greater influence on children within 'never worked or long-term unemployed' households, suggesting an 'at risk' group. These households may benefit from targeted help with an emphasis on a family-based approach to weight management.

The changing epidemiology of diet and physical activity

Physical activity and diet are known to be important determinants of energy balance and thus body mass. Despite some inconsistent findings from these analyses, efforts to reduce energy intake and increase energy expenditure should continue to play an important role in reducing obesity and overweight and, for diet in particular, focus on lower social groups.

Implications for research

Overall, inconsistencies in the data collected and available for analysis from the national health surveys hinder their usefulness as a tool for research and policy analysis at national levels. An assessment of the data consistently needed to monitor trends relevant to Choosing Health, National Service Frameworks (NSFs), NICE Guidance and strategies to reduce health inequalities would be of value. Better data are needed on energy intake from the whole diet and energy expenditure from all types of PA across age and social groupings. Further research is needed to understand better the relation ship between diet and PA, and SEP.

Contribution to the Public Health Research Consortium's main research themes

This project focuses on the Consortium's main themes of health inequalities, and risk and health, as well the cross-cutting theme of obesity and its risk factors.

Background

Introduction

The prevalence of overweight and obesity[*] continues to increase globally and in the UK.[2] Long-term consequences include raised risk of developing hypertension and stroke, coronary heart disease, diabetes, osteoarthritis and certain cancers.[3] Recently, a socioeconomic gradient in the prevalence of excess body weight has emerged in the UK, such that it has increasingly become a condition associated with lower socioeconomic position.[4] For example, in the 1958 birth cohort no socioeconomic gradient in overweight or obesity was observed in childhood or young adulthood, but a gradient has emerged in mid-life.[5] Recent cross-sectional studies[6-8] suggest that socioeconomic gradients have become established in childhood. The emergence of these gradients may be linked, since parental fatness predicts childhood fatness.[9]

The emerging socioeconomic gradient of obesity in children is of particular concern both because overweight and obese children have increased risk of obesity in adult life[9] and weight management interventions among children and young adults are of limited effectiveness.[10 11] Evidence from a longstanding national dietary survey indicates that in the post-war years absolute energy intakes gradually decreased, although some of this may be attributable to measurement error.[12] This suggests that declining levels of energy expenditure from habitual PA may have played an important role in the emerging obesity epidemic.[13 14] However, less is known about the social patterning of diet and PA, and their relative importance as antecedents of overweight and obesity among different population groups.

In this project, we set out to use a range of existing datasets to explore the emerging socio-economic patterning of obesity and its main risk factors in the UK. Below, we briefly review the literature on obesity and SEP. We then briefly describe the present policy context in the UK. After a statement of the objectives of this research, we then present the findings of three sets of analyses using two longitudinal studies (the 1958 British Birth Cohort and the UK Millennium Cohort Study) and the largest annual cross-sectional study series available: the HSE and SHS.

Review of literature on trends in obesity and socio-economic position

A comprehensive literature search was conducted in October 2007 on the following databases: MEDLINE (1980-1995, 1996 to Sept 2006 week 4, Ovid), EMBASE (1980-2006, Ovid), Scopus (1980-Oct 2006) and Social Sciences Citation Index (1980-Oct 2006). Search words used in MEDLINE and EMBASE were: socioeconomic, socio-economic, socio-demographic or socio-demographic, social, education$ adj3 level, income, occupation, deprivation, inequality$ combined with obesity, overweight, bmi, body mass index, body weight, body fat, fatness, adiposity. The searches were adapted as required for Scopus and Social Sciences Citation Index. Government web sites were also searched for relevant information.

Socioeconomic position in childhood and obesity in adulthood

A systematic review of childhood predictors of adult obesity, conducted in 1999, reported a consistent inverse relationship (lower risk of fatness associated with higher social group) between socioeconomic position (SEP) in childhood and adult obesity in both men and women.[8] This conclusion was based on evidence from cohort studies. Of 12 studies included, none

[*] We have used international cut off points for Body Mass Index (BMI) for overweight and obesity as described by Cole et al.. (1. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal* 2000;320:1240-3.) For adults these cut off points are 25kg/m² and 30kg/m² respectively. Although the overweight variable also includes obese individuals, it is referred to as 'overweight' in the text of the remainder of the report. For children, the international cut off points vary with age and differ for boys and girls. Values of less than 11 for adults and less than 6 for children were not used in the analysis

reported a positive relationship between childhood SEP and adult obesity, only 1 study reported no relationship and the remainder reported a negative association.

This inverse relationship between childhood SEP and adult obesity is strongly supported by findings from more recently published cohort studies in the UK. In longitudinal analyses from the 1958 British birth cohort, social class in children (based on father's occupation) at 7 years of age significantly predicted adult obesity in women at age 33 years.[5] For men, social class at birth significantly predicted adult obesity. This result was not explained by parental BMI, the individual's current social position or educational level in adult life. In a 1946 UK birth cohort followed up to age 53 years, father's social class based on occupation when participants were aged 4 years was inversely associated with both central and total obesity in men and women aged 53 years.[15] Data from the same cohort with follow-up of participants at 43 years of age found that childhood manual social class (defined by father's occupation at age 4 years) compared to non-manual social class was associated with higher mean BMI across adult life and that the effect increased with age.[16 17] The effect was independent of educational attainment and adult social class. In a cohort of Scottish children born between 1950 and 1956, low SEP at birth (based on father's occupation) was associated with adult overweight.[18] The association was attenuated by adjustment for educational attainment but some association remained.

Studies on European populations have found similar conclusions to those conducted in the UK. Childhood SEP has been shown to have an inverse relationship with obesity in adulthood. In a 1966 birth cohort in Finland, SEP at 1 year of age (based on father's occupation) was inversely related to BMI in adulthood at age 31 years in both men and women. The relationship remained after adjustment for maternal BMI.[19] Another cohort in Finland of people born between 1934 and 1944 found an inverse association between social class in childhood (defined by father's occupation in childhood) and the incidence of obesity in adult life in both men and women.[20] European population surveys have shown similar conclusions.[21]

Possible mechanisms for the relationships between childhood factors and adult obesity have been described.[22] These are nutrition in infancy or childhood, psychological factors, cultural or social attitudes to dietary restraint and fatness.

Childhood socio-economic position and childhood obesity

Evidence from cohort studies for a relationship between SEP in childhood and obesity at a later stage in childhood is more equivocal. In a study of the development of obesity in adolescents resident in London in relation to SEP, those in the lower quintile of SEP had higher rates of overweight and obesity at baseline in 1999, and this pattern was maintained over the five years of follow-up.[23] Residential area was used as a measure of SEP. Over five years of follow-up from age 11 to 16, no further divergence of overweight and obesity was seen, suggesting that differences in overweight and obesity by SEP are established by the age of 11. However, differences were not graded across levels of SEP. In contrast, in a comparison of two birth cohorts conducted in Newcastle forty years apart, BMI was similar in both cohorts at 9 years of age and showed no gradient by deprivation in childhood for Body mass index standard deviation score (BMI-SDS) in either study, although a gradient was seen in adulthood.[24] Studies included in the 1999 systematic review of the relationship between childhood SEP and childhood obesity also had mixed conclusions.[8]

Again, evidence from cross-sectional studies of an inverse relationship between SEP and obesity in children is mixed. In the 1999 systematic review by Parsons, in which 7 cross-sectional studies were included, some studies found an inverse association between SEP and obesity in children and some found no association.[8]

Power,[5] in a cross-sectional analysis of the 1958 British birth cohort, found no social class trend in childhood obesity. Using data from the 1999 HSE, no differences in obesity and overweight in children and young adults were seen by social class.[25]

However, in an analysis of data from the 1997 national Diet and Nutrition Survey (NDNS) in young people aged 4 to 18, in which social class was determined by the occupation of the head of the household, there was an inverse relationship between obesity and social class. Prevalence of obesity was significantly higher in those in social classes IV and V than in classes I-III.[6] Boys and girls aged 4 to 10 from schools with a high proportion of low income families were 65% more likely to be overweight.[26] In pre-school children, obesity was highest in most deprived groups and lowest in least deprived groups.[27] There is some evidence that obesity is increasing more rapidly in children of lower SEP. Data from the National Study of Health and Growth in 1974, 1984 and 1994 and from the HSE, yearly from 1996 to 2003, suggests that obesity seems to be increasing more rapidly among children from manual classes and lower income households, with differences becoming increasingly marked since 2000.[28]

Results of national surveys do support a link between childhood SEP and obesity. A recent review of obesity in children under 11, collated from information collected by the HSE between 1995 and 2003 reported that the prevalence of overweight and obesity has increased in this population of children since 1995. The prevalence of overweight rose from 22.7 % in 1995 to 27.7 % in 2003 and the prevalence of obesity rose from 9.9% in 1995 to 13.7% in 2003.[29] In an analysis that compared children from households based on manual or non-manual occupations, significantly more children from manual households were obese than non-manual households in 1998, 2002 and 2003. There were also significant differences, with levels of obesity higher in those living in the most deprived areas (16.4%) compared to the least deprived areas (11.2%).[29] Childhood obesity was also higher in the two highest income quintiles compared to the two lowest income quintiles. In children classified by the National Statistics Socio-Economic Classification (NS-SEC), prevalence of childhood obesity was lowest (12.4%) among managerial or professional households and highest among those with routine or semi-routine occupations (17.1%).[29]

Evidence for an inverse relationship between childhood SEP and obesity in childhood from European studies seems to be clearer than in UK studies. In a cohort of Danish school children who were 8-10 years old at baseline and 14-16 years old at follow up 6 years later, there were no significant differences in tracking of BMI between those in white-collar or blue collar occupations.[30] A significant inverse social gradient was seen in the prevalence of overweight in the 14 to 16 year old adolescents but not in those aged 8-10 years. A retrospective cohort study of Belgian adolescents followed between the ages of 12 and 15 years also concluded that social inequalities in obesity develop during adolescence.[31] In boys at age 12 years the greatest prevalence was found in the middle social group and at age 15 the prevalence of obesity was progressively greater lower down the social scale, although differences between groups were not significant. In girls, a significant social inverse gradient was already present at age 12 and was accentuated by age 15.

Widening of inequalities in obesity have been reported in French children between 1989 and 1999.[32] The mean BMI in 1999 was higher for children with fathers who were in lower occupational grades or unemployed relative to 1989. For children in the highest social classes, there was no change in BMI.

Data from cross-sectional and population surveys also supports an inverse relationship between childhood SEP and obesity in children. In Germany, an inverse social gradient was found in a survey of 5-7 years old children.[33] A nationally representative sample of Spanish adolescents[34] aged between 13 and 18.5 years, found a significant relationship between overweight and SEP in males but not in females. In males, the prevalence of overweight increased as socioeconomic position decreased from the high to medium-low socioeconomic groups.

Socio-economic position in adulthood and obesity in adulthood

An inverse relationship between current SEP in adulthood and obesity has been noted in many UK cohort studies. In a cohort of London-based civil servants (Whitehall II), civil service employment grade in both men and women was strongly related to BMI gain from age 25 to follow up 25 years later.[35] Those in lower grades had larger gains in BMI over 25 years than those in higher grades. Higher father's social class by occupation in a 1970 British birth cohort predicted loss of BMI between the ages of 16 and 30 years.[36]

However, different cohort studies have reported contrasting effects for men and women and by the age at which obesity was measured. The 1946 UK birth cohort found that in women, but not in men, there were independent, inverse associations between adult social class at ages 26 years and 43 years with all obesity measures at age 53 years.[15] The results were adjusted for childhood circumstances. Social class was based on occupation according to the registrar general's classification. However, the 1958 British birth cohort,[5] which also used occupation as a marker for SEP, found no relationship between obesity and SEP in adult or adolescent women. In men social class at age 23 was a predictor of adult obesity.

There is some evidence that a gradient of higher rates of obesity in those of lower SEP may emerge in early adulthood. In cross-sectional analyses of the 1958 British birth cohort, by early adulthood a social gradient had emerged for both sexes, with increasing prevalence of fatness from classes I and II to classes IV and V.[5] The social gradient emerged earlier for women, by age 16 years, but after that a social gradient was seen for both sexes. In a Newcastle birth cohort, a deprivation gradient measured by father's occupation, also became apparent in adulthood but was not found in childhood.[24] A cohort study of men and women in Stockport concluded that socioeconomic differences in obesity are mainly attained prior to 35 years of age. BMI of non-obese participants increased over time independently of deprivation status (assessed by Townsend Deprivation Score (TDS) of area of residence), whereas in obese participants, a positive association with higher deprivation was found.

An inverse relationship has also been found in some UK cross-sectional studies. Surveys in Britain and from other industrialised countries have found an inverse social gradient in the prevalence of abdominal obesity among both men and women.[37] A recent survey which used council tax valuation bands, NS-SEC and the Townsend Deprivation index as markers of SEP found a clear association by all 3 methods of an inverse gradient between current SEP and obesity.[38] However, in an earlier study in Scottish men, aged 35 to 64, current social class measured by occupation was not significantly related to BMI.[39]

In an analysis of obesity among people aged 16 and over using data from the HSE by social class of the head of the household and gender,[40] the prevalence of obesity (BMI >30kg/m^2) in women and men was markedly lower among those in professional (women 15.1%; men 12.0%) and managerial occupations (women 19.9%; men 12.0 %) than those in unskilled manual occupations (women 31.4%; men 19.3%). Prevalence of obesity was higher for women than men in all occupational groups. In a more recent analysis in the same population, results were reported by sex and by NS-SEC. This classification is based on occupation but included some different categories from the 1998 analysis. Women in higher managerial and professional occupations had a much lower percentage of obesity (16%) than women in any other classification and there was a consistent gradient between social classification and obesity prevalence. In men, while those in higher managerial and professional occupations had lower prevalence of obesity than most other groups (16%), the gradient was not as marked as for women.

An earlier review conducted in 1987 examined the relationship of SEP to weight change over time using studies from developed countries.[41] Using the methodologically strongest studies, there were relatively consistent inverse associations between occupation and weight gain for men and women.

A relationship between SEP in adulthood and obesity in adulthood is as clearly defined in European studies as it is in UK studies. In Finnish men and women who were born in Helsinki between 1934 and 1944 and were still resident in Finland in the year 2000, there was an inverse relationship between educational attainment and the incidence of obesity in adult life.[20] Low educational level, but not occupational class in both men and women was associated with overweight at age 30 in a cohort followed up for 14 years from age 16 to 30.[42] BMI at age 31 years was inversely related to social class at 31 years (based on father's occupation) in adults from a 1966 Finland birth cohort in both men and women.[19] Data from population surveys and cross-sectional analyses also supports an inverse link between SEP in adulthood and obesity.[21 43] However, it has been reported that in younger Swedish adults, the socioeconomic gap narrowed, not widened, between 1980 and 1997.[44]

Social mobility

The 1999 systematic review[8] also noted that social mobility appeared to have an effect on obesity only in women, with the prevalence of overweight less in those moving upwards in the social scale. Three studies were included that looked at social mobility and adult obesity in men, and all found no relationship. From 2 studies in women, those moving up the social scale had a lower prevalence of obesity than those who were downwardly mobile. Additionally, in an analysis of data from a 1946 cohort study, in which SEP was classified by occupation, both men and women who were upwardly or downwardly mobile tended to have characteristics between the class they left and the class they joined.[15] However, obesity itself may reinforce social inequalities.[45]

Parental BMI status

There is some consistent evidence that indicates a positive relationship between parental overweight and overweight in children. In the UK, in reports from the Avon Longitudinal Study of Parents and Children (ALSPAC), parental obesity was a strong predictor of obesity in 7 year old children.[46] When only one parent was obese, the risk of obesity at age 7 was increased. When both parents were obese, the risk was even higher (adjusted odds ratio 10.44, 95% CI 5.11 to 21.32). Parental obesity has also been associated with early adiposity rebound in ALSPAC.[47] Early adiposity rebound has been associated with higher BMI in adolescence and young adulthood.

In Australian studies, BMI in 18 year olds was significantly predicted by their mother's and father's BMI, independent of other lifestyle variables.[48] Also in Australia, maternal obesity but not paternal obesity were significantly associated with BMI and waist circumference in young people aged 12 to 13 years.[49]

In a survey of obesity in children under 11 from the HSE,[29] there was a clear relationship between parental BMI and rates of childhood obesity. In households where both parents were classified as obese or overweight, 19.8% of children were obese, compared to 6.7% of children in households where neither parent was obese or overweight.

Relationships between diet and physical activity and socio-economic position

A report on the health of children and young people,[50] which was based on data from the NDNS surveys, found that a higher proportion of children and adolescents from lower SEP households than those from higher SEP households consumed burgers, kebabs, chips and sugar or sugar confectionery. Comparisons were made between the bottom and top quintiles of weekly household income. In contrast, children and adolescents from higher SEP households were more likely to have consumed raw and salad vegetables, apples and pears, citrus fruits, bananas and fruit juice.

Energy intake of girls aged 4 to 18 was similar between girls from wealthier households compared to girls from poorer households. However, boys living in households receiving benefits had significantly lower energy intakes (80% of estimated energy requirement) than did boys in households not receiving benefits (91% of estimated energy requirement).

The development of obesity in those of lower SEP may be may be related to social class differences in the estimation of energy contents of foods. High fat foods may be perceived to have lower energy contents by those in lower social classes than in higher social classes.[51]

There are mixed messages from research about relationships between PA and SEP in children. In a 5 year longitudinal study of children aged 11-12 years at baseline, there was no association between SEP and PA in boys. In girls, those from lower SEP were less active and the effect of SEP did not change throughout the 5 years.[52] In the same study, levels of sedentary behaviour were greater in students from lower SEP backgrounds and again this difference was maintained throughout the study. Measures of SEP, including high family income at birth, high maternal education at birth and female gender have been linked to a sedentary lifestyle at ages 10 to 12 years.[53]

In secondary school children, it has been reported that SEP does not influence the time spent in PA[54] and there were no significant differences in fat intake between the sexes or across SEP. Physical activity was assessed by questionnaire. In a study in which PA was assessed by accelerometry, generally considered to be an accurate measure of PA, there were also no significant differences in time spent in PA or sedentary behaviour between affluent and deprived groups.[55] However, measures of SEP, including high family income at birth, high maternal education at birth and female gender have been linked to a sedentary lifestyle at ages 10 to 12 years.[53]

In adults, few cohort studies demonstrating the relationships between diet, PA and SEP were found. In a 14 year longitudinal study of Swedish men and women followed between the ages of 16 and 30 years, lack of PA was one factor that contributed to an association between educational level and overweight at age 30 years. A significantly higher percentage of those with less than 11 years of education never participated in PA compared to those with more than 12 years of education.[42]

Geographical variations

In a comprehensive review of obesity in children and young people it has been reported that in industrialised countries obesity is more prevalent in children aged 6 to 18 years in lower income groups than in developing countries with the comparisons used being the USA and Brazil.[56 57] In adults, in the developed world, obesity is inversely related to SEP but in developing countries the opposite relationship applies, with those with higher socioeconomic position having higher rates of obesity.[58] In Europe, the highest prevalence levels for childhood obesity are observed in southern European countries and northern European countries tend to have lower prevalence.[56]

Ethnicity

From the HSE 2004,[29] Health of ethnic minorities report, 23% of men and 23% of women in the general population were obese (BMI>30). Men from other minority ethnic groups had markedly lower obesity prevalence rates than the general population with the exception of Black Caribbean (25%) and Irish (27%) men who had higher rates of obesity. Prevalence was highest among Black African (39%), Black Caribbean (32%) and Pakistani (28%) women and lowest among Chinese women (7.6%). However, compared to a 1999 analysis of HSE data,[40] prevalence of obesity had increased in all ethnic groups reported. Prevalence of obesity in Black Caribbean men increased from 18 % in 1999 to 25% in 2004, although prevalence in Black Caribbean women remained the same (32%). Prevalence in Irish men increased from 20% in 1999 to 27% in 2004. Although Chinese women had the lowest rates of obesity in 2004, prevalence had increased from 4% in 1999 to 7.6% in 2004. 23% of men and women in the general population were obese in 2004, compared to 19% of men and 21% of women in 1999.

In UK school children aged 11-12 years at baseline and followed up for 5 years, black girls had almost double the prevalence of obesity than white girls.[23] The difference was not apparent in boys. Other evidence about the effect of ethnic group differences in overweight and obesity in children comes from cross-sectional studies. A cross-sectional analysis of the NDNS of young people conducted in 1997, noted a strikingly high prevalence of obesity in Asians who were almost four times as likely to be obese as white participants (13.6% vs. 3.5%, p<0.001).[6] The proportion of overweight plus obese participants was similar in Asian and Afro-Caribbean participants and higher than in white participants (25.9 and 23.4 vs. 18.9%, p=0.06).[6] In a secondary analysis of the 1999 HSE data, Indian (8%) and Pakistani boys (9%) had the highest prevalence of obesity compared with boys in the general population (5.8%).[40] Indian (30%) and Pakistani (26%) boys also had the highest rates of overweight in comparison to boys in the general population (22%). Bangladeshi and Chinese males had the lowest prevalence of overweight (14%). In girls, Afro-Caribbeans had the highest prevalence of overweight (33%) compared with girls in the general population (22%) and the prevalence of obesity (13%) was twice that in the general population (6%). Pakistani (8%) and Irish (8%) girls also had obesity rates higher than the general population. In contrast, Chinese girls had the lowest prevalence of overweight and obesity (1.2%).

In the US, race, sex and age differences play a complex part in the association between SEP and overweight.[57 59 60] Using nationally representative data from the National Health and Nutrition Examination Surveys (NHANES) between 1971 and 2002 in children aged 2 to 18 years, an inverse association between overweight and SEP has been reported for white girls[57] and the prevalence of overweight is much higher in blacks than whites, consistently across almost all SEP groups.[57] Data from 1999-2000 have shown that black and Hispanic children are approximately twice as likely to be obese as white, non-Hispanic children.[56]

Summary

Globally, excess body weight is a relatively recent phenomenon, broadly associated with an imbalance of energy intake in relation to energy expenditure. In low income countries, obesity is most often seen in urban and affluent populations. In high income countries (including the UK), obesity has a strong social gradient with excess body fatness more commonly seen in lower income population groups.

Levels of childhood obesity appear to be increasing in high income countries as the global obesity epidemic grows. Accompanying this trend towards earlier development of excess body weight, socio-economic gradients in obesity have recently appeared in childhood, becoming established before the age of 11 years.

In the UK, low SEP in adulthood is associated with higher levels of obesity and with greater levels of weight gain over time. Lower SEP at birth and in childhood also predicts higher adult BMI.

Overweight and obesity in parents are strong predictors of overweight and obesity in offspring. This association extends to the phenomenon of early adiposity rebound (excessive weight gain in early childhood). In turn, there is a strong tracking of obesity from childhood to adulthood. However, whether the socio-economic gradient in overweight and obesity remains the same across the life course remains unclear.

The link between socio-economic patterning of the main risk factors (diet and PA) and socio-economic patterning of overweight and obesity also remain unclear. Children from lower socio-economic group households tend to eat a nutritionally poorer diet, though findings on socio-economic differences in energy intake are equivocal. Physical activity levels in children do not appear to be socio-economically patterned, however measured. Likewise, among adults, diet appears to be socially patterned, but the findings in relation to PA are less clear. Nevertheless, there is some evidence that lower socio-economic groups are less active.

Among ethnic minority groups in the UK, levels of obesity increased between 1999 and 2004, in line with the increase in the whole population. However, only Black Caribbean and Irish men have higher rates of obesity and overweight that white British men. However, Black, Pakistani and Irish girls and Asian boys have higher rates of obesity and overweight than their white counterparts.

Policy context

The growing epidemic of obesity in the UK has emerged against a background of declining rates of cardiovascular diseases and some cancers.[2] However, incidence of type 2 diabetes is increasing and there is concern that the decline of cardiovascular diseases may be halted or reversed as a result of greater levels of obesity and its consequence.[2 61] Obesity is also associated with greater levels of osteoarthritis and a range of other conditions, all of which have significant health care consequences and costs.[3] The House of Commons Health Select Committee recently updated estimates previously made by the National Audit Office of the costs of obesity and overweight in England. The total costs to society, including direct health care costs and costs to employment were estimated to be around £6.6-7.4 billion.[62] Of this, approximately £991-1124 were estimated to be direct health care costs, including costs of managing the consequences of obesity (e.g. cardiovascular diseases and diabetes), equating to about 2.3-2.6% of NHS expenditure.

Interventions to tackle obesity at a population level to date have been of limited effectiveness and evidence is urgently needed to address the growing epidemic.[63 64] Socio-economic position seems to be a key underlying determinant of obesity in the UK and is a known major underlying determinant of health-related behaviours.[4] There is emerging evidence that many types of preventive interventions are less effective in lower social groups,[65] and these include obesity interventions.

There is a range of national policy documents relating to obesity, though not all mention its social patterning or address the consequences for interventions to prevent and manage obesity.

Tackling obesity is an important element of the government's health strategy Choosing Health.[66] Implementation plans have focused on both promoting healthy diet and PA,[67-69] The action plan for diet includes references to the socio-economic patterning of diet and action needed to reduce inequalities.[69] However, the physical activity action plan makes more scant references to the role of socio-economic factors, though does make links to strategies for environmental regeneration in deprived areas.[68]

Several NHS NSFs mention obesity. The NSF for cardiovascular disease recommends actions to reduce overweight and obesity, and promote healthy eating and PA.[70] The Diabetes NSF includes standards to prevent type 2 diabetes, and recommends multi-agency action to reduce the numbers of people who are physically inactive, overweight and obese, by promoting a balanced diet and PA across the population.[71] It recommends that, in order to have the greatest impact, action must start in childhood, linking with existing work based in schools and the wider community.

This accords with the NSF for Children, Young People and Maternity Services, which sets out standards for the promotion of health and well-being of all children and young people through a co-ordinated programme of action, including prevention and early intervention wherever possible, to ensure long term gain, led by the NHS in partnership with local authorities.[72] The framework also highlights the problem of emerging inequalities in obesity in childhood, and the need to tackle these, though does not recommend specific interventions.

Obesity in childhood is also the subject of a government Public Service Agreement (PSA) target, proposed by the Treasury in its 2004 Comprehensive Spending Review and endorsed by the Health, Education and Skills, and Culture, Media and Sport Departments:[73] *"halting the year-on-year rise in obesity among children under 11 by 2010 in the context of a broader strategy to tackle obesity in the population as a whole"*

In the Older people's NSF, obesity is only mentioned as a risk factor for Stroke, the prevention of which is an element of NSF standard 5.[74] There is no reference to social patterning and no specific interventions are proposed.

The National Institute for Health and Clinical Excellence (NICE) has recently published clinical and public health guidance on interventions to prevent and manage obesity.[64] However, although detailed, this guidance does not mention the significant social patterning of obesity, nor the potential impact of this social patterning on the effectiveness of interventions to prevent or treat the condition.

The Department for Trade and Industry, as a part of its Foresight research programme, commissioned a series of reviews of research on obesity and sought expert opinion on potential future scenarios with regard to the epidemic in the UK. The 'short science reviews' have recently been published in a supplement to the journal *Obesity Reviews* (Volume 8, Supplement 1, 2007) and further reports will be published on the Foresight web site in due course (http://www.foresight.gov.uk/Obesity/Obesity.htm). The final report on potential future scenarios will be launched on 17th October 2007.

Overall aims

The UK has a range of datasets which permit cross-sectional, longitudinal and inter-generational analyses of socioeconomic trends in obesity, and in its suspected influences (diet, PA and parental body mass). We set out to use available datasets to investigate age, sex and socioeconomic trends in:

- overweight and obesity, using national cross-sectional and longitudinal data
- weight gain among parents and its influence on weight gain in children, using national cohort studies
- indicators of the changing epidemiology of diet and PA, using national cross-sectional and longitudinal data

Specific objectives for each of three studies and their associated analyses are set out in separate chapters below.

The changing social patterning of obesity in the 1958 British Birth Cohort Study

Introduction and aims

Our aim, using two generations of the 1958 cohort, is to investigate age and socioeconomic trends in overweight and obesity, and in diet and PA. An additional aim is to establish whether weight gain among parents influences body mass index (BMI) and levels of overweight and obesity in their children.

Specifically, we investigate (1) age trends in BMI, prevalence of overweight and obesity, and putative influences within a generation (cohort members), and whether (2) trends differ between SEP, such that social inequalities develop with increasing age. In particular, we will determine the extent to which inequalities in obesity are widening and the extent to which there are parallel trends in putative influences, notably diet and PA.

In respect of inter-generational comparisons, we sought to establish whether transmission of obesity within families underlies the development of the emerging epidemic among children. Specifically, we (1) assessed the extent of the increase in mean BMI and risk for overweight/obesity between two generations, and (2) determined whether BMI and change in BMI across the parent's life influence the BMI status of their child, in order to determine whether, for example, excess weight gain in the parents' adult life predicts offspring obesity better than excess weight gain in their childhood.

The project is organised in two parts (1) on longitudinal analyses of the cohort and (2) on inter-generational relationships.

Two generations of the 1958 British Birth Cohort Study

Data sources

The 1958 British birth cohort includes all born in a week of March 1958 in England, Wales and Scotland; approximately 17,000 study participants were followed at ages 7, 11, 16, 23, 33, 42, 45 years.[75] In most respects, the cohort followed-up from childhood to adulthood has been found to be representative of the original birth sample, although those who were most disadvantaged tended to be slightly under-represented (Table 1). In 1991, information was collected on approximately 4,000 offspring of a random sample of one-third of the cohort, thus allowing study of intergenerational effects, notably in the transmission of obesity within families. Thus, data collection now spans two generations: cohort members, their parents and their offspring. Information on height, weight and socioeconomic position is available at multiple time points for cohort members and at a single time-point for their offspring.

Anthropometric measurements

Height of each cohort member was measured without shoes to the nearest inch by trained medical personnel at 7, 11 and 16 years, to the nearest cm at 33 years, to the nearest mm at 45 years; self-reported data were collected at ages 23 and 42 years. All height measures were converted into cm and data checks have been conducted over time to detect errors.

Weight of each cohort member was measured in underclothes to the nearest pound at ages 7, 11 and 16 years, to the nearest 0.1 kg at ages 33 and 45 years and was self-reported at 23 and 42 years. Pregnant women were asked to report their pre-pregnancy weight at 23 and 42 years, were measured at age 33 years but were excluded from analyses (n=256), and were not measured at age 45 years (n=2). All weight measures were converted into kg. BMI was calculated as weight/height^2 (kg/m^2) at all ages.

Overweight and obesity in childhood for cohort members (7, 11, and 16 years) and for offspring (at one age over the range 4-18 years) were defined using age and sex specific international standards[1] corresponding to cut-off points of BMI at age 18 years for defining adult overweight (BMI >25 kg/m^2) and obesity (BMI >30.0 kg/m^2), as used by WHO.[76]

Physical activity and diet measures

Indicators of PA are based on information collected at ages 33 years and 42 years, when cohort members were asked how often they participated in any sport or leisure activity that involved physical exercise. The frequency of PA was measured using six categories: 6="everyday", 5="4-5 times a week", 4="2-3 times a week", 3="once a week", 2="2-3 times a month", 1="less often/not at all". The initial six categories were collapsed into four categories: 4="4-7 days a week", 3="2-3 times a week", 2="one day a week", 1="≤3 days a month". Using the 4-category variables an overall PA score (range 1-4) was defined as the cohort members' average frequency of exercise.

Information on diet was also collected at ages 33 years and 42 years: cohort members were asked how often they ate fruit, salad or raw vegetables, chips and fried food (excluding chips) from ''never'' to ''more than once a day''. At age 33 years questions referred to fresh fruit in summer and salad and/or raw vegetables in winter; at age 42 years questions were similar, except that season was not specified for fruits and salad and/or raw vegetables and food fried in oil or hard fat were separate questions. In our analyses fruit and salad and/or raw vegetables consumption were combined into a single indicator (fruit&salad). For each of three food types (fruit&salad, chips and fried food), the initial six frequencies of consumption categories (in 1999) and seven categories (in 2000) were collapsed into four categories: 1 indicates the least frequent consumption of fruit and salad intake and the highest frequency for chips and fried food intake, and 4 indicates the highest frequency of fruit and salad intake and the least frequency for chips and fried food intake. Using the 4-category variables an overall score (range 1-4) for quality of diet was constructed as:

$$\left(\frac{fruit\&salad + chips + friedfood}{3}\right),$$

where 1 indicates the lowest quality diet (highest frequency of chips and fried food intake and the lowest frequency of fruit and salad intake) and 4 indicates the highest quality diet (highest frequency of fruit and salad intake and the lowest frequency of chips and fried food intake). A combined dietary and PA score was derived from the 4-category variables as follows:

$$\left(\frac{fruit\&salad + chips + friedfood}{3}\right) + physical\ activity\ score,$$

in which 4 indicates the highest quality of diet and most frequent PA and 1 indicates the poorest quality of diet and least frequent PA.

Measures of socio-economic position

We used childhood social class (at birth, 7, 11 and 16 years), based on father's occupation, and in adulthood (ages 23, 33 and 42 years) on the cohort member's own current or most recent occupation. At age 33, the occupation of the partner was also recorded. Concurrent social class used in subsequent analyses refers to the social class at the age when the BMI measures were taken. Social class of origin was defined as social class at birth (or at age 7 if missing, n=807). Social class was classified as four categories: (1) I&II (professional, managerial and intermediate), (2) IIINM (skilled non-manual), (3) IIIM (skilled manual) and (4) IV&V (semi-skilled or unskilled manual). Households without a male head were classified as class IV&V. In some analyses social class was also combined into ''non-manual'' and ''manual'' groups. The social distribution of study participants at different ages is shown in Table 1.

Table 1: Social class distribution at all ages (study years) – 1958 cohort

	% in each social class group at age (study year)							
	Birth* (1958)	7 years (1965)	11 years (1969)	16 years (1974)	23 years (1981)	33 years (1991)	42 years (2000)	45 years (2003)
Men								
I/II	17.3	19.5	22.5	24.8	21.6	39.8	44.2	19.5
III nm	9.4	9.4	8.8	9.8	16.7	10.7	9.3	10.1
III m	49.1	44.3	41.4	44.6	40.7	33.2	32.8	48.8
IV/V	24.3	26.8	27.3	20.8	21.0	16.3	13.7	21.6
Total n	*9184*	*7452*	*6956*	*5412*	*5925*	*5273*	*6188*	*4457*
Women								
I/II	17.2	19.4	22.9	26.0	21.1	32.5	35.5	18.5
III nm	9.2	10.0	8.9	9.3	48.8	36.5	34.2	9.7
III m	48.7	44.0	40.4	44.2	9.2	7.4	7.5	48.6
IV/V	25.0	26.6	27.7	20.5	21.0	23.6	22.8	23.2
Total n	*8589*	*7085*	*6637*	*5088*	*6084*	*5307*	*6041*	*4512*

*Social class at birth has been combined with social class at 7 years when missing

Data analysis

To examine social differences in BMI, diet and PA scores at each age, we used two-sample t-tests for comparisons of means in manual and non-manual social groups; for comparison of proportions of overweight and obese we used Chi-squared tests. We also calculated odds ratios (OR) and 95% confidence intervals for manual vs. non-manual social groups at different ages; analyses were repeated for overweight/ obesity.

Study participants remaining in the cohort over time were found to have a lower BMI at ages 7 to 33 years compared to the maximum number participating at any specific age, although differences tended to be small. For example, at age 33 years men with data had a mean BMI of 25.57 kg/m^2 compared to 25.45kg/m^2 among men with who also had data at age 45 years (Table 2). Social differences in BMI are largely unaffected by differential sample attrition (Table 3).

Table 2: Mean BMI at ages 7, 16 and 33 years in the samples with data at these ages and in the sample with data at age 45 years.

	Original sample		Sample with data at age 45 years and at ages		Mean BMI difference (original – age 45)
	Mean BMI (SD)	n	Mean BMI (SD)	n	
Men					
7 years	15.94 (1.63)	*6874*	15.91 (1.51)	*3726*	0.03
16 years	20.24 (2.72)	*5698*	20.21 (2.68)	*3341*	0.03
33 years	25.57 (3.75)	*5487*	25.45 (3.55)	*3944*	0.12
Women					
7 years	15.87 (1.91)	*6422*	15.80 (1.84)	*3743*	0.07
16 years	21.00 (2.96)	*5342*	20.92 (2.82)	*3385*	0.08
33 years	24.64 (4.84)	*5669*	24.39 (4.51)	*4135*	0.25

Table 3: Social class difference in mean BMI at ages 7, 16 and 33 years in the samples with data at these ages and in the sample with data at age 45 years

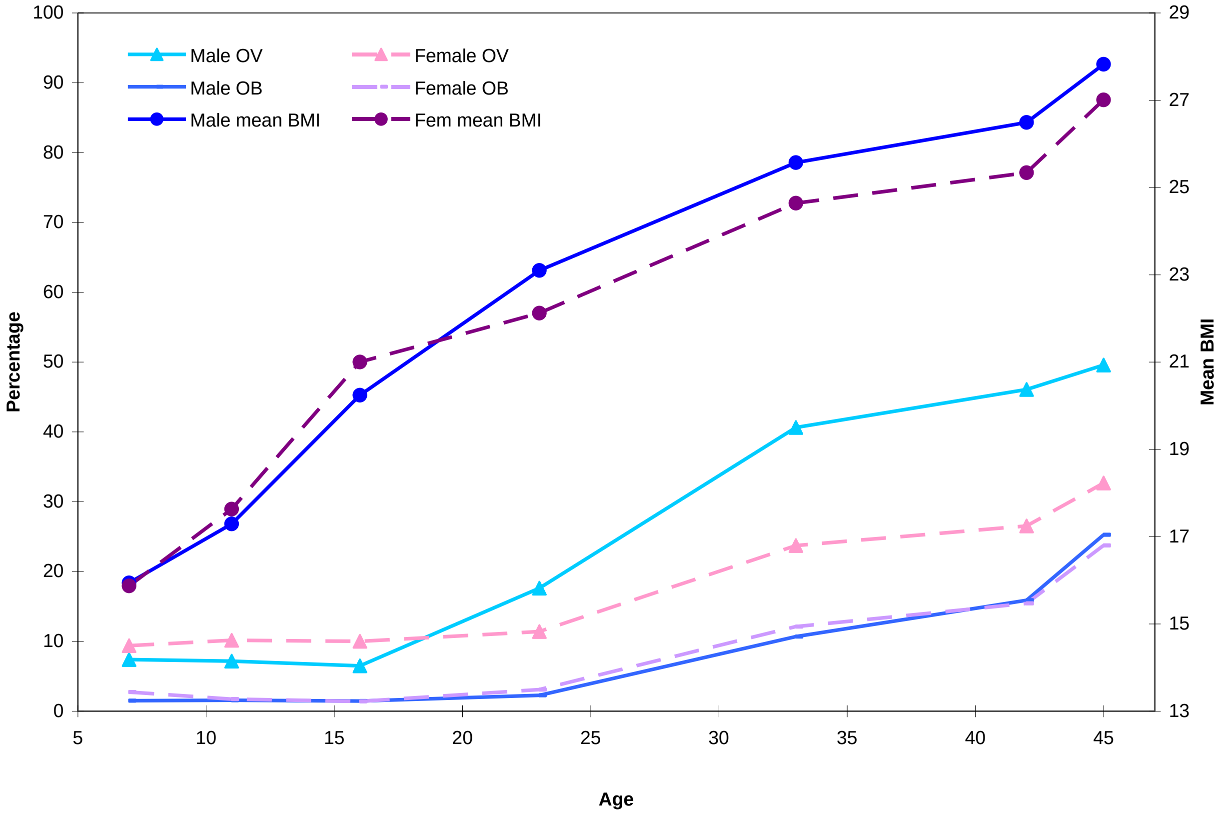
	Original sample		Sample with data at age 45 years	
	Mean BMI (SD)	n	Mean BMI (SD)	n
Men				
7 years	15.94 (1.63)	*6874*	15.91 (1.51)	*3726*
NMan	15.89 (1.59)	*1846*	15.87 (1.43)	*1110*
Man	15.96 (1.64)	*5023*	15.93 (1.55)	*2614*
Man – NMan (95% CI)	0.07 (-0.02;0.16)		0.06 (-0.05;0.16)	
p-value t	*0.114*		*0.295*	
16 years	20.24 (2.72)	*5698*	20.21 (2.68)	*3341*
NMan	20.02 (2.30)	*1513*	19.99 (2.23)	*993*
Man	20.35 (2.86)	*3910*	20.32 (2.84)	*2233*
Man – NMan (95% CI)	0.33 (0.17;0.49)		0.34 (0.14;0.54)	
p-value t	*<0.0001*		*0.001*	
33 years	25.57 (3.75)	*5487*	25.45 (3.55)	*3944*
NMan	24.99 (3.33)	*1531*	24.85 (3.11)	*1170*
Man	25.82 (3.88)	*3788*	25.72 (3.72)	*2661*
Man – NMan (95% CI)	0.83 (0.61;1.05)		0.86 (0.62;1.11)	
p-value t	*<0.0001*		*<0.0001*	
Women				
7 years	15.87 (1.91)	*6422*	15.80 (1.84)	*3743*
NMan	15.85 (1.96)	*1732*	15.79 (1.89)	*1066*
Man	15.88 (1.89)	*4684*	15.81 (1.82)	*2674*
Man – NMan (95% CI)	0.03 (-0.08;0.13)		0.02 (-0.11;0.15)	
p-value t	*0.606*		*0.746*	
16 years	21.00 (2.96)	*5342*	20.92 (2.82)	*3385*
NMan	20.78 (2.81)	*1424*	20.71 (2.60)	*942*
Man	21.10 (3.02)	*3709*	21.01 (2.89)	*2354*
Man – NMan (95% CI)	0.33 (0.15;0.51)		0.30 (0.09;0.51)	
p-value t	*0.003*		*0.006*	
33 years	24.64 (4.84)	*5669*	24.39 (4.51)	*4135*
NMan	23.85 (4.18)	*1509*	23.58 (3.77)	*1150*
Man	24.93 (5.04)	*4003*	24.70 (4.73)	*2878*
Man – NMan (95% CI)	1.08 (0.80;1.37)		1.12 (0.81;1.43)	
p-value t	*<0.0001*		*<0.0001*	

Results

Aim 1: age trends in BMI, prevalence of overweight and obesity, and putative influences

Figure 1 shows trends in mean BMI with age, with the expected steeper increases in childhood compared to adulthood. Average BMI is below the IOTF cut-off for overweight at age 16 for both sexes, whereas in adulthood, average BMI is greater than the cut-off for overweight ($25kg/m^2$) from 33 years-45 years in men and 42-45 years in women. There was no increase in the prevalence of obesity with age during childhood, but in adulthood from age 23 to 45 years, the prevalence increased from 2.3 to 25% in men and from 3.1 to 24% of women. A similar pattern of increasing prevalence only in adulthood was seen for overweight (Figure 1). At age 45 years, the majority of men (75%) and women (56%) are classified as overweight or obese.

Figure 1: Age-trends in mean BMI, prevalence of overweight* (OV) and obesity (OB)



* International cut off points for overweight at ages 7, 11 and 16 years are: 17.92, 20.55, 23.90 (males) and 17.75, 20.74, 24.37 (females); and for obesity, respectively: 20.63, 25.10, 28.88 (males) and 20.51, 25.42, 29.43 (females)

Data are presented in Table 4

Table 4: Mean BMI and % of overweight and obesity at all ages

	7 years	11 years	16 years	23 years	33 years	42 years	45 years
Men							
Mean BMI (SD)	15.94 (1.63)	17.29 (2.41)	20.24 (2.72)	23.10 (2.90)	25.57 (3.99)	26.49 (3.99)	27.82 (4.37)
% Overweight	7.4	7.2	6.5	17.6	40.6	46.1	49.6
% Obese	1.5	1.6	1.4	2.3	10.7	15.9	25.3
Total n *	*6874*	*6382*	*5698*	*6134*	*5487*	*5493*	*4651*
Women							
Mean BMI (SD)	15.87 (1.91)	17.63 (2.70)	21.00 (2.96)	22.12 (3.25)	24.64 (4.87)	25.34 (4.99)	27.01 (5.64)
% Overweight	9.4	10.2	10.0	11.4	23.7	26.5	32.7
% Obese	2.7	1.7	1.4	3.1	12.1	15.4	23.7
Total n *	*6422*	*6117*	*5342*	*6145*	*5669*	*5591*	*4697*

* Sample size observed with BMI at each age

Table 5 shows the frequency of PA at ages 33 and 42 years. The distribution of PA was similar at age 33 years and at 42 years for men and women, suggesting little change between these ages. However, previous longitudinal analysis has shown only a modest level of stability, with 39% and 37% of men and women respectively maintaining the same frequency of activity.[77]

Table 5: Distribution (%) of physical activity and dietary measures at 33 years and 42 years

Frequency	Physical activity*		Fruit & salad consumption†		Chips consumption‡		Fried food consumption‡	
	33 years %	42 years %	33 years %	42 years %	33 years %	42 years %	33 years %	42 years %
Men								
1 (lowest score)	24.8	27.1	2.5	1.1	0.3	0.2	0.9	2.5
2	7.0	7.1	10.9	13.1	2.5	1.0	5.5	5.5
3	21.0	19.6	25.9	19.3	16.3	11.2	10.5	16.6
4	23.3	21.5	18.7	19.2	49.9	40.9	39.4	31.9
5	7.1	9.2	31.1	29.6	26.9	43.5	34.2	33.6
6 (highest score)	16.9	15.4	11.0	17.7	4.1	3.3	9.6	9.9
Total n	*5574*	*5601*	*5581*	*5601*	*5579*	*5600*	*5583*	*5591*
Women								
1 (lowest score)	25.0	29.6	1.1	0.5	0.1	0.1	0.3	1.0
2	5.8	5.3	4.2	6.5	1.1	0.6	1.7	3.2
3	22.8	16.5	13.8	12.9	7.5	5.0	3.9	9.8
4	19.3	20.9	15.8	15.1	41.7	30.1	28.7	25.4
5	5.4	8.4	40.2	34.2	39.5	56.7	45.3	43.7
6 (highest score)	21.7	19.4	24.9	30.8	10.2	7.5	20.1	16.9
Total n	*5769*	*5771*	*5785*	*5771*	*5781*	*5772*	*5784*	*5772*

* 1 = “less often/not at all”, 2 = “2-3 times a month”, 3 = “1 time a week”, 4 = “2-3 times a week”, 5 = “4-5 times a week”, 6 = “everyday”
† 1 = “never”, 2 = “less than once a week”, 3 = “1-2 days per week”, 4 = “3-6 days a week”, 5 = “once a day”, 6 = “more than once a day”
‡ 1 = “more than once a day”, 2 = “once a day”, 3 = “3-6 days a week”, 4 = “1-2 days per week”, 5 = “less than once a week”, 6 = “never”

For fruit/salad/raw vegetables there was a tendency in both sexes towards increasing frequency of consumption (Table 5) and previous longitudinal analysis showed that whilst about 45% of men and women maintained the same consumption frequency, a greater proportion increased (30%) than decreased (25%) their consumption.[77] The frequency distributions for chips consumption differed between ages 33 and 42 years for both men and women: as we have shown elsewhere about a third of the study population reduced the frequency their consumption over this age interval.[77] For fried food, there was some suggestion of increasing frequency of consumption between ages 33 and 42 years (Table 5).

Aim 2: to establish whether trends in BMI, diet and physical activity differ between social classes and whether socio-economic inequalities develop with increasing age

Odds ratio (OR) were used to summarise the risk of overweight and obesity in manual vs. non-manual social groups, for different ages in childhood and adulthood (Table 6). For both males and females, there was an elevated risk in manual groups of obesity at all ages in adulthood, with a tendency for stronger associations when the social comparison was based on class of origin rather than concurrent class (i.e. at the age of BMI measurement). Similar associations were seen for overweight. Social differences in obesity were less consistent in childhood, with little evidence for associations at age 7 and for women at age 11 years. Odds ratios tended to be stronger for social class of origin than for concurrent class.

Table 6: Odds Ratios (95% CI) for overweight and obesity* for manual vs. non-manual class at all ages

	Social class of origin			Concurrent social class		
Age (years)	n	OR (95% CI) for overweight	OR (95% CI) for obesity	n	OR (95% CI) for overweight	OR (95% CI) for obesity
Men						
7	*6869*	1.20 (0.99;1.46)	1.21 (0.77;1.92)	*6793*	0.97 (0.81;1.16)	1.06 (0.68;1.64)
11	*6244*	1.28 (1.04;1.58)	1.97 (1.15;3.37)	*6224*	1.14 (0.94;1.38)	1.57 (0.97;2.54)
16	*5423*	1.63 (1.27;2.08)	3.43 (1.65;7.14)	*4506*	1.06 (0.84;1.32)	1.33 (0.79;2.25)
23	*5925*	1.86 (1.59;2.18)	2.97 (1.75;5.01)	*5801*	1.85 (1.61;2.13)	2.65 (1.72;4.08)
33	*5319*	1.44 (1.28;1.62)	1.77 (1.42;2.20)	*5166*	1.36 (1.22;1.52)	1.39 (1.16;1.66)
42	*5319*	1.44 (1.28;1.62)	1.73 (1.45;2.07)	*5283*	1.18 (1.06;1.32)	1.23 (1.06;1.42)
45	*4503*	1.36 (1.18;1.57)	1.62 (1.39;1.90)	*4468*	1.08 (0.94;1.23)	1.38 (1.21;1.58)
Women						
7	*6416*	0.94 (0.80;1.11)	0.90 (0.64;1.25)	*6367*	1.07 (0.90;1.26)	1.21 (0.85;1.70)
11	*5991*	1.04 (0.87;1.23)	1.10 (0.71;1.71)	*5991*	1.06 (0.90;1.26)	1.26 (0.81;1.93)
16	*5133*	1.56 (1.26;1.92)	1.22 (0.72;2.08)	*4241*	1.47 (1.20;1.81)	1.69 (0.94;3.04)
23	*5980*	1.99 (1.65;2.40)	2.35 (1.55;3.58)	*5964*	1.85 (1.59;2.15)	2.23 (1.65;3.01)
33	*5512*	1.54 (1.35;1.75)	1.89 (1.53;2.33)	*5183*	1.43 (1.27;1.61)	1.63 (1.37;1.93)
42	*5425*	1.63 (1.44;1.84)	1.78 (1.48;2.14)	*5251*	1.30 (1.15;1.47)	1.69 (1.45;1.98)
45	*4564*	1.52 (1.33;1.72)	1.68 (1.43;1.98)	*4458*	1.23 (1.08;1.41)	1.48 (1.28;1.72)

* International cut off points for overweight at ages 7, 11 and 16 years are: 17.92, 20.55, 23.90 (males) and 17.75, 20.74, 24.37 (females); and for obesity, respectively: 20.63, 25.10, 28.88 (males) and 20.51, 25.42, 29.43 (females)

At age 7, when the overall prevalence of obesity was low, there was no social difference in overweight or obesity. Even though the overall prevalence had not increased by age 16 years, inequalities had emerged by this age. Social inequalities in overweight and obesity persisted throughout adulthood when prevalence levels were increasing, although there was little evidence of widening inequalities over time. Inequalities were most pronounced in early adulthood, at age 23 years: the confidence intervals for the OR at this age overlap with those for other ages suggesting that the strength of the association at 23 years does not differ from other ages; nonetheless the OR for age 23 years appears to be consistently elevated for overweight and obesity and across social class measures.

The pattern of results for social differences based on a manual /non-manual dichotomy were confirmed in further analyses of social class as a continuous variable, ranging from 1 to 4 (Table 7).

Table *7*: Odds Ratios (95% CI)* for overweight and obesity by social class†

	Social class of origin			Concurrent social class		
	n	Overweight	Obesity	n	Overweight	Obesity
Men						
7	*6869*	1.03 (0.95;1.12)	1.04 (0.85;1.26)	*6793*	0.97 (0.89;1.05)	0.99 (0.82;1.19)
11	*6244*	1.09 (0.99;1.19)	1.20 (0.97;1.49)	*6224*	1.05 (0.97;1.14)	1.11 (0.91;1.34)
16	*5423*	1.21 (1.09;1.34)	1.56 (1.20;2.03)	*4506*	1.02 (0.92;1.12)	1.26 (1.00;1.60)
23	*5925*	1.31 (1.23;1.41)	1.56 (1.28;1.91)	*5801*	1.31 (1.23;1.40)	1.51 (1.26;1.82
33	*5319*	1.19 (1.13;1.25)	1.28 (1.17;1.41)	*5166*	1.14 (1.09;1.20)	1.15 (1.07;1.24)
42	*5319*	1.21 (1.14;1.28)	1.27 (1.18;1.37)	*5283*	1.07 (1.02;1.13)	1.11 (1.04;1.18)
45	*4503*	1.16 (1.09;1.24)	1.28 (1.20;1.38)	*4468*	1.02 (0.96;1.09)	1.16 (1.09;1.23)
Women						
7	*6416*	0.94 (0.87;1.02)	0.95 (0.82;1.11)	*6367*	1.02 (0.95;1.09)	1.07 (0.92;1.24)
11	*5991*	0.98 (0.90;1.05)	1.00 (0.82;1.21)	*5991*	0.99 (0.92;1.06)	1.06 (0.89;1.27)
16	*5133*	1.21 (1.11;1.33)	1.18 (.93;1.49)	*4241*	1.14 (1.05;1.25)	1.28 (0.99;1.65)
23	*5980*	1.39 (1.28;1.50)	1.43 (1.21;1.69)	*5964*	1.31 (1.22;1.40)	1.43 (1.24;1.64)
33	*5512*	1.20 (1.13;1.27)	1.29 (1.18;1.41)	*5183*	1.13 (1.07;1.18)	1.19 (1.10;1.27)
42	*5425*	1.24 (1.18;1.32)	1.24 (1.15;1.34)	*5251*	1.11 (1.06;1.17)	1.19 (1.12;1.27)
45	*4564*	1.22 (1.15;1.29)	1.24 (1.16;1.33)	*4458*	1.07 (1.02;1.13)	1.15 (1.08;1.22)

* For a unit decrease in social class.

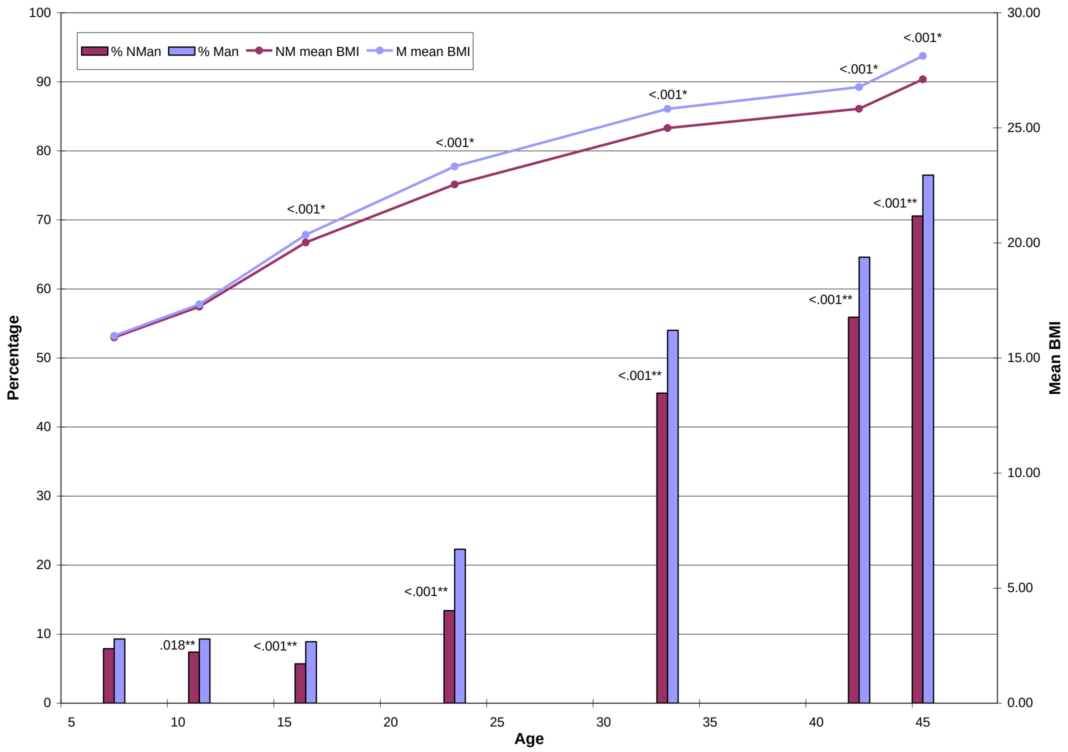
† Social class is defined as 4 categories: I/II, IIInm, IIIm and IV/V/nmh.

The trend in social differences between ages 33 and 42 years is of particular interest because it is between these ages that trends in social differences in PA and diet can be observed.

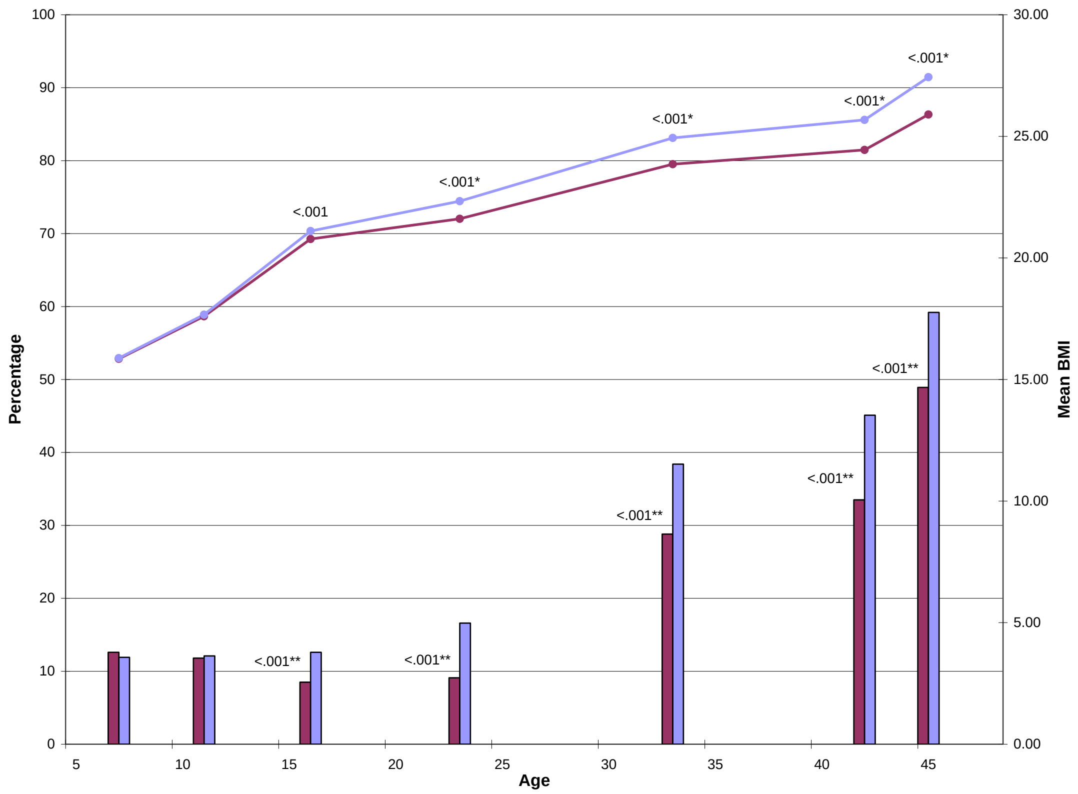
For men, between 33 and 42 years there was a persistent difference in mean BMI between manual and non-manual social origins (Figure 2) and in OR of overweight and obesity (Table 6), whereas results for concurrent social group suggested a slight weakening of the social difference. For women, the difference between manual and non-manual social groups did not differ at ages 33 and 42 years, irrespective of whether the comparison between ages was based on class of origin or concurrent class, or on mean BMI or OR for overweight and obesity (Figure 2, Figure 3).

Figure 2: Age-trends in mean BMI, overweight and obesity by class of origin

Men



Women

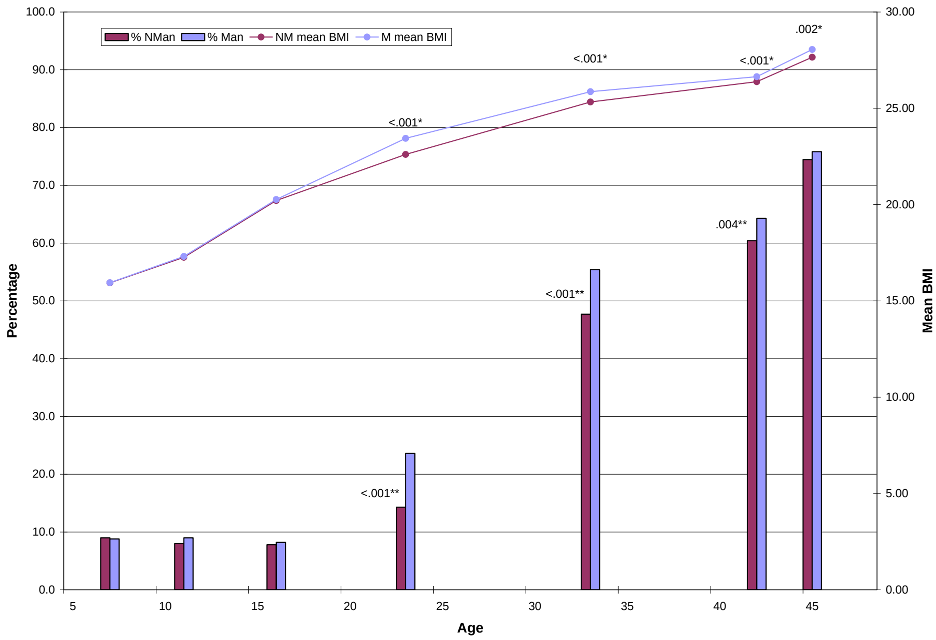


* p-value for the difference in mean BMI between manual and non-manual class (independent sample t test)

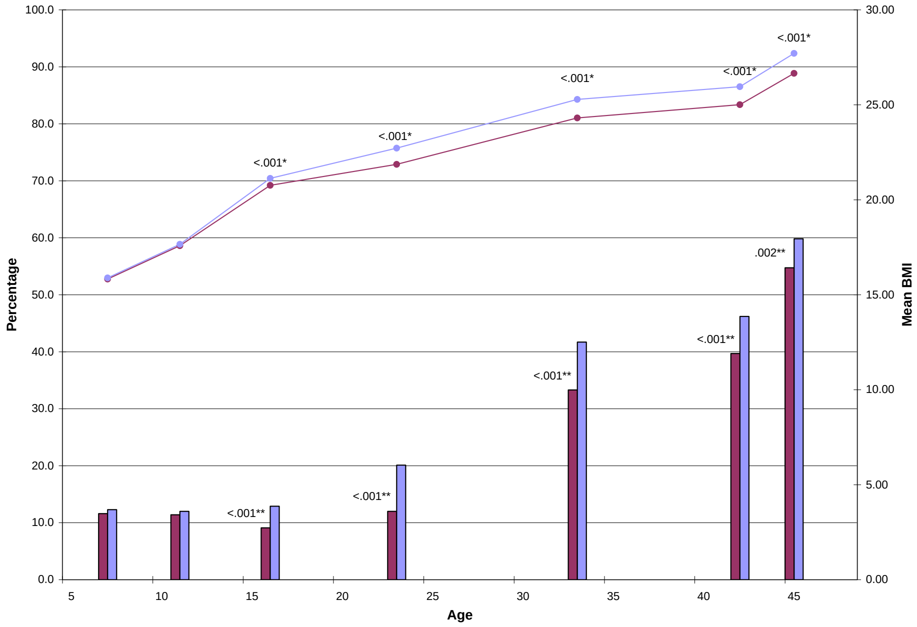
** p-value for the difference in the prevalence of overweight and obesity between manual and non-manual class (χ^2 test)

Figure 3: Age-trends in mean BMI, overweight and obesity by concurrent class

Men



Women



* p-value for the difference in mean BMI between manual and non-manual class (independent sample t test)

** p-value for the difference in the prevalence of overweight and obesity between manual and non-manual class (χ^2 test)

Social class differences were also observed for PA, with greater frequency of activity in non-manual groups, although differences in mean activity scores tended to be small and not always significant (Table 8, Figure 4, Figure 5). Differences between manual and non-manual groups were most consistently seen for the lowest rather than highest frequency of activity groups, with manual classes being more likely to be least active, as suggested by odds ratios in Table 8. The social difference in frequency of activity showed no consistent trend between ages 33 and 42 years.

Table 8: Mean (SD) physical activity (PA)* scores by social class and OR (95% CI) for the top and bottom physical activity scores for manual vs. non-manual class at 33 years and 42 years

	Social class of origin		Concurrent social class	
	33 years	42 years	33 years	42 years
Men (9596)				
n (%)	*5400 (56.3)*	*5421 (56.5)*	*5242 (54.6)*	*5381 (56.61)*
Overall	2.40 (1.16)	2.37 (1.19)	2.39 (1.16)	2.36 (1.18)
NMan	2.39 (1.15)	2.44 (1.15)	2.46 (1.13)	2.46 (1.15)
Man	2.40 (1.17)	2.34 (1.20)	2.32 (1.18)	2.25 (1.21)
NMan - Man	0.00	0.10	0.14	0.21
p-value	*0.962*	*0.006*	*<0.0001*	*<0.0001*
OR†	1.03 (0.90;1.19)	1.01 (0.88;1.16)	0.97 (0.85;1.10)	0.93 (0.82;1.05)
OR‡	1.06 (0.93;1.20)	1.34 (1.18;1.53)	1.45 (1.29;1.62)	1.71 (1.53;1.91)
Women (8959)				
n (%)	*5609 (62.6)*	*5605 (62.6)*	*5269 (58.8)*	*5418 (60.5)*
Overall	2.43 (1.18)	2.42 (1.22)	2.42 (1.18)	2.42 (1.22)
NMan	2.54 (1.15)	2.49 (1.20)	2.43 (1.15)	2.43 (1.19)
Man	2.39 (1.20)	2.39 (1.23)	2.41 (1.24)	2.38 (1.27)
NMan - Man	0.15	0.10	0.02	0.05
p-value	*<0.0001*	*0.008*	*0.660*	*0.166*
OR†	0.93 (0.81;1.06)	1.00 (0.88;1.14)	1.30 (1.14;1.47)	1.20 (1.06;1.37)
OR‡	1.48 (1.30;1.69)	1.26 (1.11;1.42)	1.27 (1.12;1.44)	1.30 (1.16;1.47)

* 1 = rarely ≤3 days a month), 2 = low frequency (1 day a week), 3 = medium frequency (2-3 days a week), 4 = high frequency (4-7 days a week)

† OR (95% CI) for most active (manual vs. non-manual social class)

‡ OR (95% CI) for least active (manual vs. non-manual social class)

Figure 4: Differences in mean PA scores between manual and non-manual class of origin at 33 years and 42 years

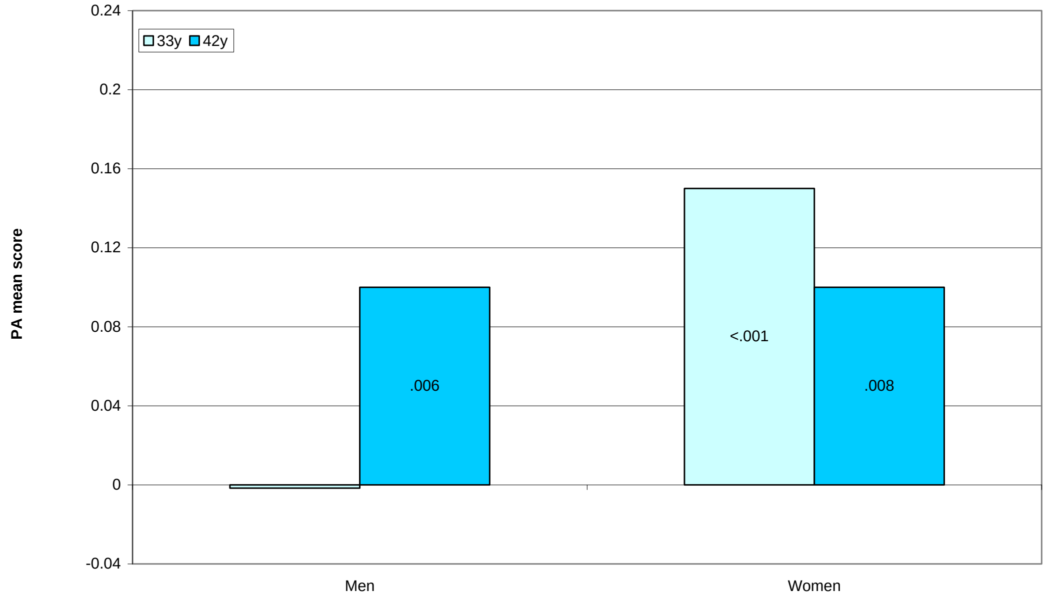
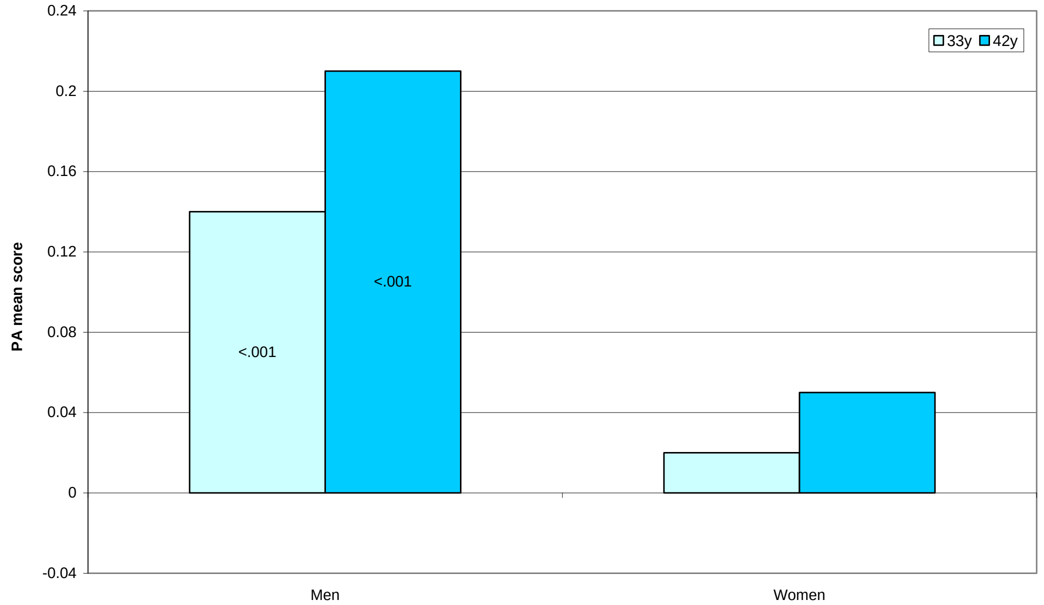


Figure 5: Difference in mean PA scores between manual and non-manual concurrent class at 33 years and 42 years



Likewise, there were social differences in diet.

Table 9 shows mean scores for consumption of fruit/salad, chips and fried food. The scores indicate greater frequency of fruit/salad and lower consumption of chips and fried food at age 33 years in non-manual groups compared to manual. The direction of association was similar at 42 years, except for fried foods, with manual groups having a lower frequency of consumption than non-manual groups. No consistent evidence was found for a change in the magnitude of social difference in frequency of fruit/salad consumption between ages 33 years and 42 years (Table 9, Figure 6 and Figure 7). There was, however, a slight weakening in the social difference in chip consumption, as well as the reversal of social differences in fried food.

Table 9: Mean (SD) specific diet scores by social class and OR (95% CI) for the top and bottom diet scores for manual vs. non-manual class at 33 years and 42 years

	Social class of origin						Concurrent social class					
	33 years			42 years			33 years			42 years		
	Fruit & Salad*	Chips†	Fried food†	Fruit & Salad*	Chips†	Fried food†	Fruit & Salad*	Chips†	Fried food†	Fruit & Salad*	Chips†	Fried food†
Men (9596)												
n (%)	*5407 (56.3)*	*5405 (56.3)*	*5409 (56.4)*	*5421 (56.5)*	*5420 (56.5)*	*5412 (56.4)*	*5249 (54.7)*	*5247 (54.7)*	*5252 (54.7)*	*5381 (56.1)*	*5380 (56.1)*	*5374 (56.0)*
Overall	2.39 (0.85)	2.15 (0.77)	2.37 (0.87)	2.50 (0.94)	2.37 (0.74)	2.29 (0.94)	2.40 (0.85)	2.16 (0.77)	2.37 (0.87)	2.52 (0.94)	2.38 (0.74)	2.29 (0.94)
NMan	2.44 (0.83)	2.31 (0.76)	2.46 (0.83)	2.59 (0.91)	2.48 (0.68)	2.23 (0.87)	2.45 (0.83)	2.31 (0.76)	2.50 (0.83)	2.62 (0.92)	2.49 (0.70)	2.27 (0.89)
Man	2.37 (0.86)	2.09 (0.77)	2.34 (0.89)	2.46 (0.95)	2.33 (0.76)	2.32 (0.97)	2.34 (0.87)	2.01 (0.75)	2.23 (0.90)	2.38 (0.95)	2.25 (0.76)	2.32 (1.00)
NMan - Man	0.07	0.22	0.13	0.13	0.15	-0.08	0.10	0.29	0.26	0.24	0.24	-0.05
p-value	*0.009*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.003*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.058*
OR‡	0.96 (0.79;1.16)	1.01 (0.75;1.37)	1.20 (0.98;1.47)	0.90 (0.77;1.05)	1.31 (0.92;1.87)	2.31 (1.82;2.94)	0.83 (0.70;0.99)	0.69 (0.52;0.92)	0.95 (0.79;1.14)	0.66 (0.57;0.76)	0.84 (0.62;1.15)	2.04 (1.70;2.46)
OR§	1.42 (1.18;1.71)	1.63 (1.39;1.92)	1.44 (1.22;1.71)	1.64 (1.36;1.97)	1.82 (1.49;2.23)	1.03 (0.90;1.18)	1.78 (1.51;2.09)	1.99 (1.72;2.29)	2.04 (1.76;2.37)	2.21 (1.88;2.59)	2.25 (1.90;2.66)	1.15 (1.01;1.30)
Women (8959)												
n (%)	*5625 (62.8)*	*5621 (62.7)*	*5624 (62.8)*	*5605 (62.6)*	*5606 (62.6)*	*5606 (62.6)*	*5282 (59.0)*	*5279 (58.9)*	*5281 (58.9)*	*5418 (60.5)*	*5419 (60.5)*	*5419 (60.5)*
Overall	2.84 (0.86)	2.51 (0.79)	2.80 (0.82)	2.89 (0.92)	2.66 (0.70)	2.65 (0.92)	2.85 (0.86)	2.53 (0.79)	2.82 (0.82)	2.91 (0.92)	2.67 (0.69)	2.64 (0.92)
NMan	2.99 (0.80)	2.72 (0.73)	2.88 (0.75)	3.03 (0.88)	2.74 (0.64)	2.51 (0.90)	2.92 (0.84)	2.63 (0.77)	2.88 (0.79)	2.98 (0.90)	2.73 (0.66)	2.62 (0.91)
Man	2.79 (0.87)	2.43 (0.80)	2.77 (0.85)	2.83 (0.94)	2.63 (0.72)	2.70 (0.92)	2.70 (0.87)	2.30 (0.79)	2.67 (0.86)	2.73 (0.95)	2.52 (0.74)	2.68 (0.94)
NMan - Man	0.20	0.29	0.11	0.20	0.12	-0.18	0.22	0.33	0.21	0.26	0.21	-0.06
p-value	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	*0.041*
OR‡	0.73 (0.64;0.84)	0.69 (0.57;0.83)	1.14 (0.98;1.32)	0.68 (0.60;0.77)	0.94 (0.75;1.17)	1.72 (1.45;2.05)	0.63 (0.55;0.73)	0.61 (0.50;0.75)	0.82 (0.71;0.95)	0.60 (0.52;0.68)	0.85 (0.67;1.06)	1.34 (1.15;1.56)
OR§	2.72 (1.93;3.85)	2.76 (2.10;3.62)	1.69 (1.27;2.26)	2.68 (1.99;3.62)	2.11 (1.55;2.87)	0.75 (0.64;0.89)	2.15 (1.68;2.76)	2.39 (1.96;2.91)	2.02 (1.59;2.56)	2.28 (1.84;2.83)	2.34 (1.84;2.97)	0.97 (0.82;1.15)

* 1 = rarely (<once a week), 2 = low frequency (1-6 days a week), 3 = medium frequency (once a day), 4 = high frequency (>once a day)

† 1 = high frequency (≥ 3 days a week), 2 = medium frequency (1-2 days a week), 3 = low frequency (<one day a week), 4 = rarely (never)

‡ OR (95% CI) for best diet (manual vs. non-manual social class)

§ OR (95% CI) for worst diet (manual vs. non-manual social class)

Figure 6: Differences in mean specific diet scores between manual and non-manual class of origin at 33 years and 42 years

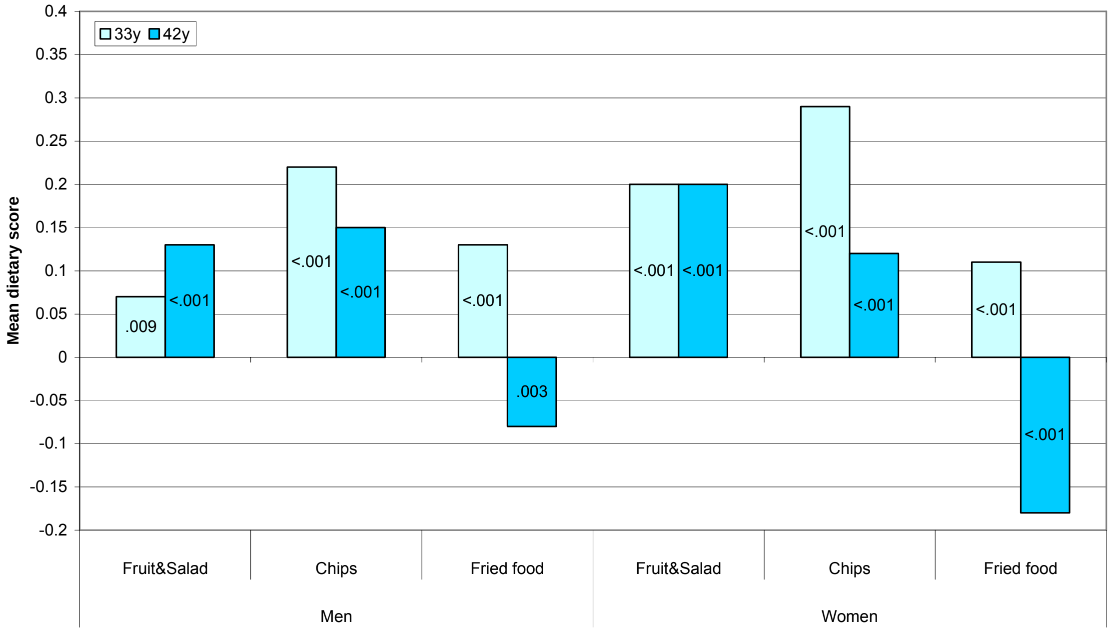
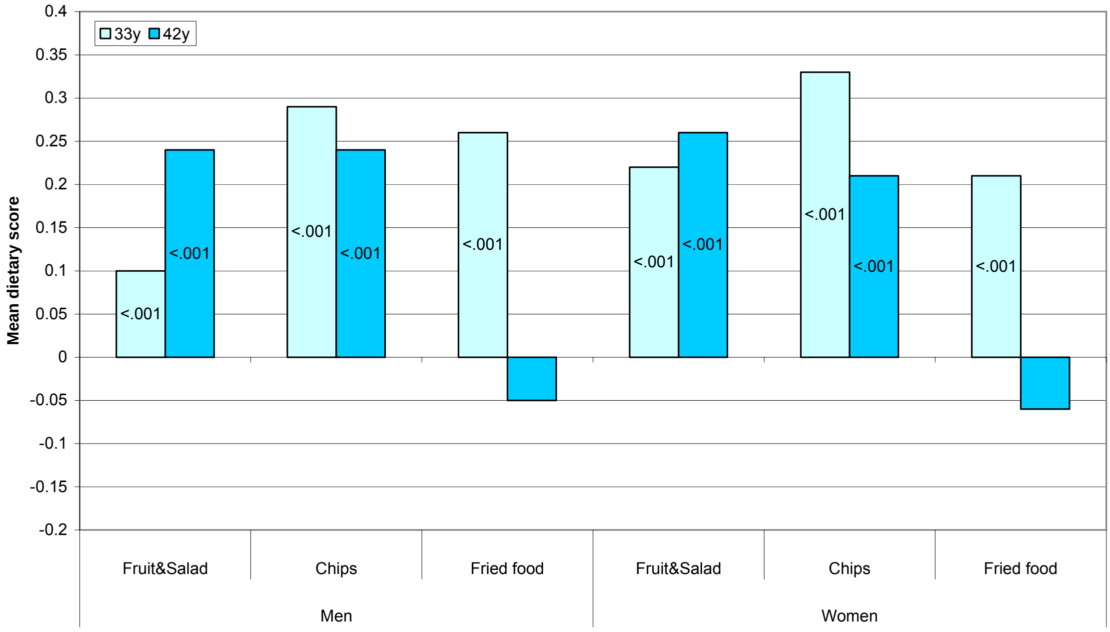


Figure 7: Differences in mean specific diet scores between manual and non-manual concurrent class at 33 years and 42 years



Finally, Table 10 presents social differences in a combined PA and dietary score (a higher score indicating more frequent activity and a better quality diet - i.e. more frequent consumption of fruit/salad and less frequent consumption of chips and fried food). As expected the mean combined PA and diet score was higher in non-manual than manual groups. Among men, the social difference in the score did not differ at ages 33 and 42 years, whereas among women, the social difference tended to weaken from 33 years to 42 years (Table 10).

Table 10: Mean (SD) PA&diet combined score* by social class and OR (95% CI) for the top and bottom PA&diet combined scores for manual vs. non-manual class at 33 years and 42 years

	Social class of origin		Concurrent social class	
	33 years	42 years	33 years	42 years
Men (9596)				
n (%)	*5392 (56.2)*	*5410 (56.4)*	*5235 (54.6)*	*5372 (56.0)*
Overall	4.70 (1.38)	4.76 (1.40)	4.70 (1.39)	4.76 (1.39)
NMan	4.79 (1.35)	4.87 (1.31)	4.87 (1.33)	4.92 (1.34)
Man	4.66 (1.39)	4.71 (1.43)	4.52 (1.41)	4.56 (1.42)
NMan - Man	0.13	0.16	0.35	0.35
p-value	*0.001*	*<0.0001*	*<0.0001*	*<0.0001*
OR†	0.92 (0.73;1.17)	1.10 (0.87;1.39)	0.69 (0.55;0.86)	0.72 (0.58;0.89)
OR‡	1.46 (1.23;1.73)	1.65 (1.38;1.98)	2.11 (1.82;2.46)	1.98 (1.70;2.30)
Women (8959)				
n (%)	*5598 (62.5)*	*5604 (62.6)*	*5259 (58.7)*	*5417 (60.5)*
Overall	5.15 (1.42)	5.15 (1.41)	5.16 (1.41)	5.16 (1.40)
NMan	5.40 (1.34)	5.25 (1.36)	5.24 (1.37)	5.21 (1.37)
Man	5.05 (1.43)	5.11 (1.43)	4.97 (1.47)	5.02 (1.48)
NMan - Man	0.35	0.14	0.27	0.19
p-value	*<0.0001*	*0.001*	*<0.0001*	*<0.0001*
OR†	0.67 (0.57;0.78)	1.03(0.87;1.22)	0.77 (0.65;0.91)	0.92 (0.77;1.09)
OR‡	2.69 (2.04;3.55)	1.59 (1.25;2.02)	2.36 (1.93;2.88)	2.15 (1.75;2.64)

* Mean PA&diet combined score = ((fruit&salad[a]+chips[b]+fried[c])/3) + PA3 [where: [a] 1 = rarely (<once a week), 2 = low frequency (1-6 days a week), 3 = medium frequency (once a day), 4 = high frequency (>once a day); [b] 1 = high frequency (***≥3*** days a week), 2 = medium frequency (1-2 days a week), 3 = low frequency (<one day a week), 4 = rarely (never); [c] 1 = rarely (≤ 3 days a month days a month), 2 = low frequency (1 day a week), 3 = medium frequency (2-3 days a week), 4 = high frequency (4-7 days a week)]

† OR (95% CI) for best quality of life (manual vs. non-manual social class).

‡ OR (95% CI) for worst quality of life (manual vs. non-manual social class)

Figure 8: Differences in mean PA&diet combined scores between manual and non-manual class of origin at 33 years and 42 years

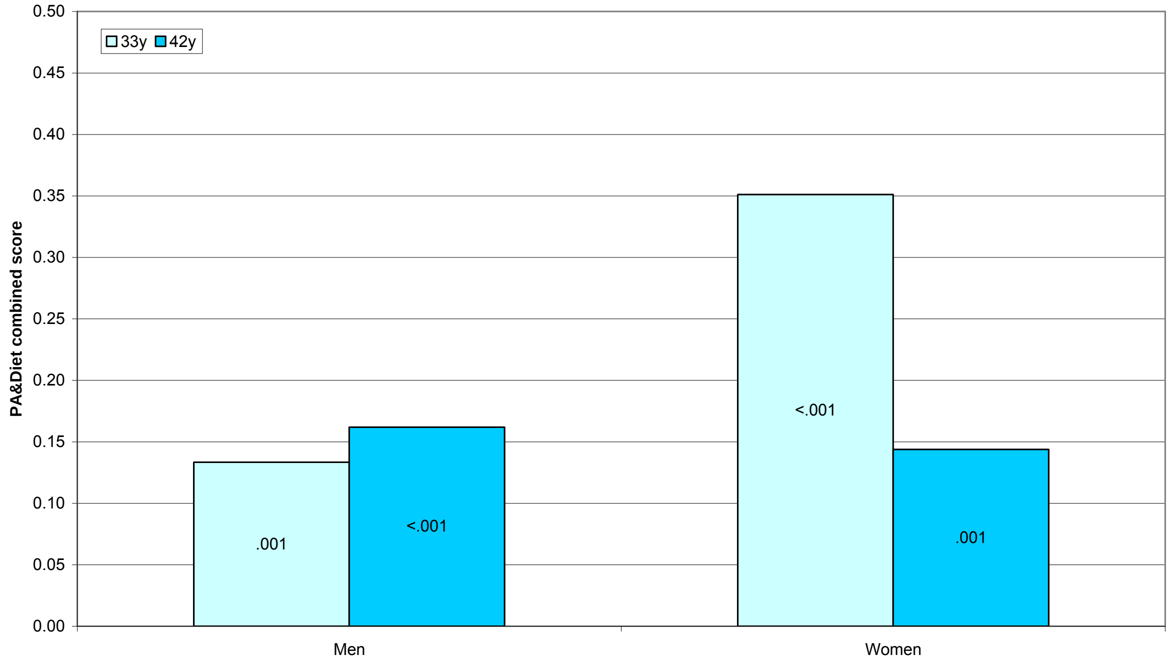
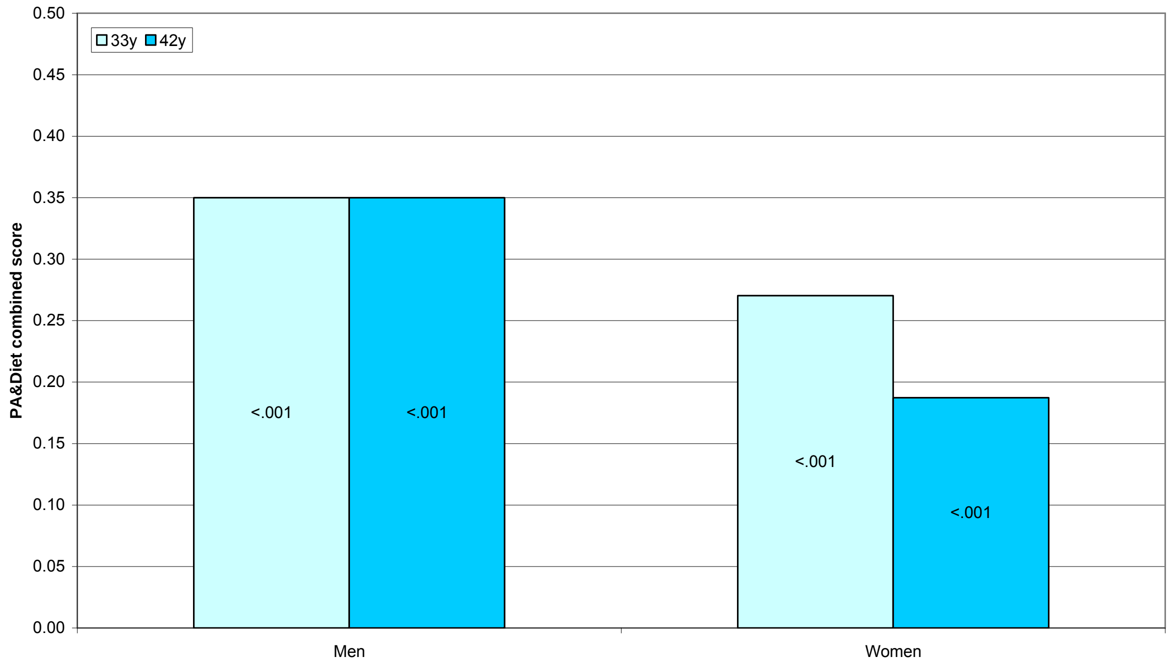


Figure 9: Difference in mean PA&diet combined scores between manual and non-manual concurrent class at 33 years and 42 years



Inter-generational relationships: offspring BMI and weight change across the parent's life-course

Data sources

As mentioned in section 2, offspring of a sub-sample (one-third) of cohort members were selected in 1991: the average age of offspring was 6.9 years (range from under one year to 18 years). Their parents (i.e. the selected one in 3 cohort members) were 26.1 years on average (range from 15 to 33 years) at childbirth. Only natural children of cohort members and those with a BMI measure were included in the study sample: the average age of this group was 8.7 years (range from 4 to 18 years) and the average age of their parent (i.e. cohort member) was 24.35 years at childbirth.

Anthropometric measurements

Height and weight of offspring who were 4 years or older were measured (data were not collected at younger ages) to the nearest centimetre and 0.1 kilogram using portable measuring equipment (n=2950). As described in section 2 above, height and weight of parents (cohort members) were measured by trained medical personnel using standard protocols at ages 7, 11, 16, and 33 years and were self-reported at 23 years. Body mass index was derived as weight/height^2 (kg/m^2) at each age for cohort members and at one age for offspring. Overweight and obesity for offspring and parents were defined as described above.

Internal BMI standard deviation scores (SDS) were derived at ages 7, 11, 16, 23, and 33 years for cohort members as the difference between the individual's BMI and mean BMI, divided by the standard deviation (SD) of BMI at each age and gender. These internally derived SDS were used to compare the effect of BMI of cohort members at different ages. A unit increase of an internal SDS corresponds to a SD increase in BMI at a given age and gender, for example, an increase of 1.63 kg/m^2 for a 7 year old boy (see Table 12).

In order to compare BMI between different samples, for example, between parents (cohort members) at 7 years and offspring of a similar age (i.e. within the 4-8 years range), the measures need to be standardised against a common reference sample. Given the exact age and gender of a child, external BMI SDS was calculated for offspring (4-18 years) and cohort members at ages 7, 11, and 16 years using the 1990 British growth reference sample.[78] The relationship between external BMI SDS and BMI (kg/m^2) is not linear, and thus, the transformation between these two measures can only be calculated for a specified value of BMI. To facilitate comparison between external BMI SDS and BMI (kg/m^2) we calculated changes in BMI associated with changes in SDS from the median BMI (for the 1990 British growth reference sample), at all ages from 4 to 16 years (Table 14).

Methods of analysis

The mean BMI and prevalence of overweight and obesity for the offspring sample were calculated for each age, for boys and girls separately. To establish whether cohort members with offspring in the study sample differed from the original cohort, we compared the two samples in respect of mean BMI, prevalence of overweight and obesity, and percent of manual social class in childhood and adulthood.

To assess the extent of the increase in obesity between two generations, the mean external BMI SDS was calculated at ages 7 and 11 years for cohort members and for two age groups (4-8 years and 9-18 years) for offspring. Mean BMI and prevalence of overweight/obesity for the offspring were compared across social class and the differences were tested using multilevel linear models (for BMI) and logistic models (for overweight/obesity), where families (i.e. cohort members) were level-2 units and children were level-1 units, to take into account the fact that children were clustered within families.

To determine whether BMI change across the parent's life-course influences the BMI of their offspring, we first examined the simple associations of offspring BMI (external SDS) with BMI of cohort members at each age (internal SDS), separately, using two-level linear models. Here we used internal SDS for cohort members because external reference data were not available for adult BMI. Second, the associations between change in BMI of cohort members between successive ages in childhood or in adulthood and offspring BMI were examined by conditioning on the prior BMI of cohort members, because growth during an interval may be influenced by BMI at the start of the interval.[79] For example, for the association between change in BMI of cohort members from ages 7 to 11 years and offspring BMI, the regression model was adjusted for BMI at 7 years: OFFSPRING BMI = a + b BMI7 + c (BMI11-BMI7). The coefficient (c) can be interpreted as the estimate of the change of offspring BMI associated with an increase in BMI of cohort members between ages 7 and 11 years, expressed as per unit increase of SDS at 11 years, given BMI at 7 years.

The analyses were repeated for the binary outcome (overweight/obesity) using multilevel logistic regression models. Analyses were also repeated adjusting for social class at 33 years. In order to assess whether the effect of parental BMI on offspring BMI differed by the age of the child, the analyses were also conducted for two age groups separately (4-8 years and 9-18 years). Due to the sample selection of the offspring, the age of the cohort member at childbirth was inversely correlated with the age of their offspring, we included age of the child as a covariate in all models to reduce possible confounding effects of maternal age. In all models male and female offspring were combined and gender of the child was added as a covariate, but analyses were conducted for fathers and mothers (i.e. male and female cohort members) separately.

Results

BMI of the offspring

The mean BMI (external) SDS for the offspring was 0.184 (SD=1.15) for boys and 0.196 (SD=1.09) for girls (Table 11). These means were significantly greater than zero, suggesting that BMI of the offspring were greater on average than the 1990 British growth reference sample,[78] for example by 0.3 and 0.4 for 7-year old boys and girls respectively. The standard deviation of offspring BMI SDS was greater than 1, indicating greater variation in offspring BMI compared to the British reference sample. BMI of children from the same family are correlated with a correlation of 0.35 ($p<0.05$). Among offspring, 12.4% boys and 18.7% girls were overweight or obese.

Table 11: Observed mean BMI (n) and % of overweight and obesity in the offspring

	Male offspring			Female offspring		
Age at	n	Mean (SD)	%*	n	Mean (SD)	%*
4 years	176	16.31 (1.44)	17.0	150	15.99 (1.52)	16.7
5 years	175	16.16 (1.87)	16.6	191	16.09 (1.64)	19.4
6 years	176	15.98 (1.77)	11.4	191	16.11 (2.06)	19.4
7 years	145	16.06 (1.65)	7.6	156	16.18 (2.38)	15.4
8 years	148	16.61 (2.58)	14.2	157	16.84 (2.15)	18.5
9 years	146	16.68 (2.09)	6.2	147	17.03 (2.69)	18.4
10 years	127	17.18 (2.15)	10.2	119	18.19 (2.76)	20.2
11 years	116	17.92 (2.90)	16.4	117	19.01 (3.48)	18.8
12 years	77	18.77 (4.05)	14.3	87	19.52 (2.90)	18.4
13 years	70	18.49 (2.57)	10.0	64	19.92 (2.68)	21.9
14 years	42	19.68 (3.23)	9.5	44	21.38 (4.63)	18.2
15 years	28	20.01 (2.31)	7.1	36	22.68 (4.84)	27.8
16 years	11	21.88 (3.21)	18.2	7	22.79 (2.34)	28.6
17 years	1	22.49	-	3	20.96 (2.40)	-
18 years	1	27.13	-			-
Total	1439	0.184 (1.15)	12.4	1469	0.196 (1.09)	18.7

* Prevalence of overweight and obesity defined by IOTF

Cohort members with offspring in the study sample and the full 1958 cohort sample

Cohort members with offspring in the study sample, that is, they had had children before age 30 years, had a similar mean BMI in childhood to all cohort members, but they were slightly heavier (i.e. by 0.22 and 0.28 kg/m^2 at age 33 for men and women respectively) and more likely to be overweight or obese in adulthood (Table 12). Cohort members with offspring in the study sample were also more likely to be from manual social class compared to others: 75.7% vs. 71.5% in childhood, and 53.8% vs. 49.5% (males) and 37.9% vs. 31.0% (females) respectively at 33 years (Table 12). However, the offspring sample has been previously reported as resembling the general population in respect of birth-weight, height and social class.[80]

Table 12: Characteristics for all cohort members and those with an offspring aged 4 years or over

	Male cohort (all)* (n=9593)		Male cohort (sub-sample of parents)† (n=754)	
BMI at	mean BMI (SD)	% overweight‡ (n)	mean BMI (SD)	% overweight‡ (n)
7 years	15.94 (1.63)	8.9 (6874)	15.89 (1.52)	8.0 (584)
11 years	17.29 (2.41)	8.8 (6382)	17.24 (2.28)	8.1 (557)
16 years	20.24 (2.72)	7.9 (5698)	20.12 (2.61)	7.2 (514)
23 years	23.10 (2.90)	19.9 (6134)	23.19 (2.78)	22.1 (614)
33 years	25.62 (3.99)	51.3 (5487)	25.84 (4.11)	53.4 (714)
Manual class§		71.5 (9181)		73.7 (727)
Manual class**		49.5 (5275)		53.7 (719)
	Female cohort (all)* (n=8960)		Female cohort (sub-sample of parents)† (n=1273)	
BMI at	mean BMI (SD)	% overweight‡ (n)	mean BMI (SD)	% overweight‡ (n)
7 years	15.87 (1.91)	12.1 (6422)	15.92 (1.81)	11.6 (984)
11 years	17.63 (2.70)	11.9 (6117)	17.71 (2.65)	11.5 (972)
16 years	21.00 (2.96)	11.4 (5342)	21.11 (2.83)	12.8 (892)
23 years	22.12 (3.25)	14.5 (6145)	22.34 (3.21)	16.3 (1038)
33 years	24.65 (4.87)	35.8 (5669)	24.89 (4.94)	38.7 (1195)
Manual class§		71.6 (8590)		76.9 (1237)
Manual class**		31.0 (5305)		38.7 (1150)

* All cohort members

† Cohort members of the study sample (n=2950), with natural children ≥ 4 years with BMI greater than 0

‡ Prevalence of overweight/obesity defined by IOTF

§ Childhood social class at 7 or at birth if missing

** Adult social class at 33 years

Childhood BMI of parents and offspring

Offspring were on average fatter than their parents (Table 13). The difference in external BMI SDS between younger offspring (4-8 years average age 6.4 years) and cohort members at age 7 was 0.158 in boys and 0.251 in girls (equivalent to a BMI increase of 0.23 and 0.44 kg/m^2 from the median BMI, for 7-year-old boys and girls respectively) (Table 13, Table 14). The difference between older offspring (9-18 years average age 11.7 years) and cohort members at age 11 was greater, at 0.209 in boys and 0.464 in girls (equivalent to a BMI increase of 0.41 and 1.11 kg/m^2 from median BMI, for 11-year-old boys and girls respectively) (Table 13, Table 14).

Table 13: Observed mean (SD) for external BMI SDS* and prevalence of overweight for cohort members and the offspring

	Male cohort members†		Male offspring		
	Mean (SD)	% (n)‡	Mean (SD)	% (n)‡	Increase
7§	0.0864 (1.01)	8.6 (6861)	0.2445 (1.19)	13.5 (820)	0.158
11§	-0.1053 (1.05)	8.3 (6378)	0.1040 (1.08)	11.1 (619)	0.209
	Female cohort members†		Female offspring		
7§	-0.0786 (1.00)	11.5 (6405)	0.1726 (1.09)	18.0 (845)	0.251
11§	-0.2353 (1.10)	11.3 (6111)	0.2286 (1.10)	19.7 (624)	0.464

* BMI at 7 and 11 years for cohort members and at one age (4-18 years) for the offspring was standardised against 1990 British growth reference sample

† All cohort members

‡ Prevalence of overweight defined by IOTF

§ BMI for offspring ages 4-8 years (average 6.4 years) and 9-18 years (average 11.7 years) were compared with BMI of cohort members at 7 and 11 years respectively

Table 14: Transformation between a change in BMI SDS to an equivalent change in BMI (kg/m^2) from median by age and gender*

	Age (year)												
Boys	4	5	6	7	8	9	10	11	12	13	14	15	16
Median(kg/m^2)	15.75	15.55	15.50	15.56	15.75	16.04	16.42	16.89	17.43	18.04	18.68	19.32	19.94
0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.05	0.05
0.04	0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09
0.06	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.14
0.08	0.10	0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.18	0.19
0.10	0.12	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
0.12	0.15	0.15	0.16	0.17	0.19	0.20	0.22	0.23	0.25	0.26	0.27	0.28	0.29
0.14	0.17	0.17	0.18	0.20	0.22	0.24	0.26	0.27	0.29	0.30	0.31	0.32	0.33
0.16	0.20	0.20	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.34	0.36	0.37	0.38
0.18	0.22	0.22	0.24	0.26	0.28	0.31	0.33	0.35	0.37	0.39	0.40	0.42	0.43
0.20	0.25	0.25	0.26	0.29	0.32	0.34	0.37	0.39	0.41	0.43	0.45	0.47	0.48
0.22	0.27	0.27	0.29	0.32	0.35	0.38	0.41	0.43	0.46	0.48	0.50	0.52	0.53
0.24	0.30	0.30	0.32	0.35	0.38	0.41	0.45	0.47	0.50	0.52	0.55	0.56	0.58
0.26	0.32	0.33	0.35	0.38	0.41	0.45	0.48	0.52	0.54	0.57	0.59	0.61	0.63
0.28	0.35	0.35	0.37	0.41	0.45	0.49	0.52	0.56	0.59	0.62	0.64	0.66	0.68
0.30	0.37	0.38	0.40	0.44	0.48	0.52	0.56	0.60	0.63	0.66	0.69	0.71	0.73
0.32	0.40	0.40	0.43	0.47	0.51	0.56	0.60	0.64	0.68	0.71	0.74	0.76	0.79
0.34	0.42	0.43	0.46	0.50	0.55	0.60	0.64	0.68	0.72	0.75	0.79	0.81	0.84
0.36	0.40	0.40	0.43	0.47	0.51	0.56	0.60	0.64	0.68	0.71	0.74	0.76	0.79
0.38	0.48	0.48	0.51	0.56	0.62	0.67	0.72	0.77	0.81	0.85	0.88	0.91	0.94
0.40	0.50	0.51	0.54	0.59	0.65	0.71	0.76	0.81	0.86	0.90	0.93	0.97	0.99
Girls													
Median(kg/m^2)	15.66	15.48	15.49	15.68	15.99	16.40	16.90	17.48	18.12	18.77	19.40	19.96	20.44
0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05
0.04	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.09	0.10	0.10	0.10	0.10
0.06	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.15	0.15	0.16
0.08	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.20	0.21	0.21
0.1	0.14	0.15	0.16	0.17	0.19	0.20	0.22	0.23	0.24	0.25	0.25	0.26	0.26
0.12	0.17	0.18	0.19	0.21	0.23	0.24	0.26	0.27	0.29	0.30	0.31	0.31	0.32
0.14	0.19	0.21	0.22	0.24	0.26	0.28	0.30	0.32	0.33	0.35	0.36	0.37	0.37
0.16	0.22	0.23	0.25	0.28	0.30	0.33	0.35	0.37	0.38	0.40	0.41	0.42	0.43
0.18	0.25	0.26	0.29	0.31	0.34	0.37	0.39	0.41	0.43	0.45	0.46	0.47	0.48
0.20	0.28	0.29	0.32	0.35	0.38	0.41	0.44	0.46	0.48	0.50	0.51	0.53	0.54
0.22	0.31	0.33	0.35	0.39	0.42	0.45	0.48	0.51	0.53	0.55	0.57	0.58	0.59
0.24	0.34	0.36	0.38	0.42	0.46	0.49	0.53	0.56	0.58	0.60	0.62	0.64	0.65
0.26	0.36	0.39	0.42	0.46	0.50	0.54	0.57	0.60	0.63	0.66	0.68	0.69	0.70
0.28	0.39	0.42	0.45	0.49	0.54	0.58	0.62	0.65	0.68	0.71	0.73	0.75	0.76
0.30	0.42	0.45	0.48	0.53	0.58	0.62	0.67	0.70	0.73	0.76	0.78	0.80	0.82
0.32	0.45	0.48	0.52	0.57	0.62	0.67	0.71	0.75	0.79	0.81	0.84	0.86	0.87
0.34	0.48	0.51	0.55	0.60	0.66	0.71	0.76	0.80	0.84	0.87	0.89	0.91	0.93
0.36	0.51	0.54	0.59	0.64	0.70	0.76	0.81	0.85	0.89	0.92	0.95	0.97	0.99
0.38	0.54	0.57	0.62	0.68	0.74	0.80	0.85	0.90	0.94	0.98	1.01	1.03	1.05
0.40	0.57	0.60	0.65	0.72	0.78	0.84	0.90	0.95	0.99	1.03	1.06	1.09	1.11
0.42	0.60	0.63	0.69	0.75	0.82	0.89	0.95	1.00	1.05	1.09	1.12	1.14	1.16
0.44	0.63	0.67	0.72	0.79	0.87	0.94	1.00	1.05	1.10	1.14	1.17	1.20	1.22
0.46	0.66	0.70	0.76	0.83	0.91	0.98	1.05	1.10	1.15	1.20	1.23	1.26	1.28
0.48	0.69	0.73	0.79	0.87	0.95	1.03	1.10	1.16	1.21	1.25	1.29	1.32	1.34
0.50	0.72	0.76	0.83	0.91	0.99	1.07	1.14	1.21	1.26	1.31	1.35	1.38	1.40

* ($M((SL+1)^{\frac{1}{L}}-1)$)

The observed prevalence of overweight and obesity also increased between the two generations: 13.5% male and 18.0% female offspring aged 4-8 years were overweight compared to 8.6% and 11.5% of cohort members at age 7, respectively. Similarly, 11.1% of male and 19.7% of female offspring aged 9-18 years were overweight compared to 8.3% and 11.3% of cohort members at age 11 years (Table 13).

Table 15 provides a comparison of BMI for offspring and parents at the same ages. Although the number of offspring is reduced for an age by age comparison, results in the table confirm the greater BMI and prevalence of overweight and obesity among offspring.

Table 15: Mean BMI (n) and % of overweight and obesity in the two generations

	Cohort members*		Cohort members†		Offspring‡	
Males	Mean (n)	%§	Mean (n)	%§	Mean (n)	%§
Age at 4 years					16.27 (177)	16.9
5 years					16.10 (180)	16.7
6 years					15.88 (179)	11.2
7 years	15.94 (6874)	8.6	15.89 (601)	7.8	16.06 (145)	7.6
8 years					16.47 (150)	14.0
9 years					16.64 (147)	6.1
10 years					17.17 (129)	10.9
11 years	17.29 (6381)	8.3	17.24 (574)	7.9	17.92 (116)	16.4
12 years+					19.16 (231)	11.7
Total**	0.086 (6854)		0.060 (600)		0.184 (1439)	
Females						
Age at 4 years					16.14 (151)	17.2
5 years					16.01 (193)	19.2
6 years					16.07 (192)	19.3
7 years	15.87 (6422)	11.5	15.94 (1018)	12.0	16.07 (158)	15.2
8 years					16.79 (158)	18.4
9 years					16.95 (148)	18.2
10 years					18.19 (119)	20.2
11 years	17.63 (6118)	11.3	17.71 (1003)	11.6	19.01 (117)	18.8
12 years+					20.40 (244)	20.5
Total**	-0.079 (6399)		-0.033 (1017)		0.196 (1469)	

* All cohort members

† Cohort members with children ≥ 4 years in 1991

‡ Natural children of cohort members

§ Prevalence of overweight and obesity defined by IOTF

** Mean Z-scores for BMI at 7 (cohort members) and at all ages (offspring). Z-scores were standardised against 1990 British growth reference sample

BMI and BMI gain at different life stages of cohort members and offspring BMI

As expected, parental BMI at all ages was positively associated with offspring BMI and risk for overweight and obesity in childhood. At most ages for Associations with offspring BMI tended to be stronger for mothers than for fathers BMI in childhood (Table 16), but this difference was not evident for offspring obesity status (Table 17). Importantly, the effect of parental BMI in childhood (7-11 years for fathers and 7-16 years for mothers) remained significant even when allowing for current parental BMI at 33 years (data not shown).

Table 16: Change (SE) in offspring BMI SDS* for a SD increase of parental BMI† at different life stages

Father's age (years)	Offspring age group (years)	Adjusted‡	Adjusted§	Adjusted**
7	4 – 8	0.174 (0.051)††	-	-
	9 – 18	0.142 (0.073)††	-	-
	All	0.179 (0.045)††	-	-
11	4 – 8	0.236 (0.053)††	0.245 (0.073)††	0.231 (0.075)††
	9 – 18	0.184 (0.075)††	0.220 (0.095)††	0.179 (0.095)††
	All	0.224 (0.046)††	0.240 (0.062)††	0.216 (0.064)††
16	4 – 8	0.147 (0.054)††	0.052 (0.091)	0.027 (0.092)
	9 – 18	0.185 (0.074)††	0.133 (0.118)	0.094 (0.118)
	All	0.160 (0.047)††	0.086 (0.077)	0.061 (0.077)
23	4 – 8	0.246 (0.050)††	0.179 (0.078)††	0.185 (0.079)††
	9 – 18	0.357 (0.066)††	0.350 (0.100)††	0.297 (0.108)††
	All	0.282 (0.043)††	0.231 (0.066)††	0.214 (0.069)††
33	4 – 8	0.202 (0.040)††	0.141 (0.051)††	0.134 (0.052)††
	9 – 18	0.225 (0.059)††	0.001 (0.080)††	0.015 (0.083)††
	All	0.213 (0.036)††	0.115 (0.046)††	0.111 (0.047)††
Mother age (years)				
7	4 – 8	0.272 (0.046)††	-	-
	9 – 18	0.245 (0.045)††	-	-
	All	0.264 (0.034)††	-	-
11	4 – 8	0.241 (0.045)††	0.202 (0.066)††	0.201 (0.069)††
	9 – 18	0.256 (0.042)††	0.165 (0.064)††	0.144 (0.068)††
	All	0.256 (0.032)††	0.191 (0.047)††	0.177 (0.050)††
16	4 – 8	0.328 (0.047)††	0.233 (0.071)††	0.230 (0.075)††
	9 – 18	0.274 (0.043)††	0.226 (0.063)††	0.224 (0.071)††
	All	0.306 (0.034)††	0.230 (0.049)††	0.220 (0.054)††
23	4 – 8	0.170 (0.048)††	0.004 (0.074)	0.022 (0.078)
	9 – 18	0.195 (0.038)††	0.010 (0.057)	0.003 (0.063)
	All	0.187 (0.031)††	0.009 (0.047)	0.000 (0.051)
33	4 – 8	0.236 (0.039)††	0.176 (0.059)††	0.206 (0.061)††
	9 – 18	0.243 (0.035)††	0.187 (0.057)††	0.179 (0.060)††
	All	0.245 (0.027)††	0.189 (0.043)††	0.192 (0.045)††

* Z-score for offspring BMI was standardised against 1990 British growth reference sample
† Z-score for cohort member BMI was internally standardised
‡ adjusted for age and sex, estimates from multi-level models
§ adjusted for age and BMI at the previous age and sex
** adjusted for age, BMI at the previous age, sex, and CM social class at 33 years (1991),
†† p<0.05

Table 17: OR (95% CI) for overweight of offspring for a SD increase of BMI of cohort members*

Father age (years)	Offspring age (years)	Adjusted†	Adjusted‡	Adjusted§
7	4 – 8	1.61 (1.27;2.04)**	-	-
	9 – 18	1.16 (0.81;1.67)	-	-
	All	1.47 (1.20;1.80)**	-	-
11	4 – 8	1.77 (1.41;2.23)**	1.72 (1.25;2.37)**	1.73 (1.24;2.40)**
	9 – 18	1.40 (0.98;1.99)	1.59 (1.01;2.51)**	1.42 (0.89;2.26)**
	All	1.65 (1.35;2.01)**	1.69 (1.29;2.21)**	1.63 (1.24;2.15)**
16	4 – 8	1.53 (1.21;1.94)**	1.15 (0.77;1.73)	1.07 (0.70;1.62)
	9 – 18	1.45 (1.03;2.05)**	1.34 (0.75;2.40)	1.24 (0.67;2.31)
	All	1.51 (1.23;1.85)**	1.24 (0.89;1.74)	1.16 (0.82;1.64)
23	4 – 8	1.74 (1.38;2.18)**	1.48 (1.04;2.10)**	1.51 (1.04;2.18)**
	9 – 18	1.84 (1.30;2.60)**	1.81 (1.08;3.04)**	1.75 (1.00;3.07)**
	All	1.76 (1.45;2.13)**	1.56 (1.16;2.11)**	1.55 (1.14;2.12)**
33	4 – 8	1.48 (1.22;1.80)**	1.28 (1.03;1.59)**	1.27 (1.02;1.58)**
	9 – 18	1.31 (0.96;1.79)	0.78 (0.42;1.42)	0.79 (0.41;1.52)
	All	1.43 (1.21;1.70)**	1.18 (0.97;1.43)	1.17 (0.97;1.42)
Mother age (years)				
7	4 – 8	1.66 (1.34;2.05)**	-	-
	9 – 18	1.45 (1.14;1.84)**	-	-
	All	1.56 (1.32;1.83)**	-	-
11	4 – 8	1.47 (1.19;1.80)**	1.34 (0.98;1.82)	1.33 (0.97;1.84)
	9 – 18	1.56 (1.27;1.92)**	1.57 (1.13;2.17)**	1.42 (1.00;2.03)**
	All	1.53 (1.32;1.78)**	1.45 (1.15;1.83)**	1.35 (1.06;1.73)**
16	4 – 8	1.76 (1.42;2.19)**	1.56 (1.13;2.15)**	1.61 (1.14;2.27)**
	9 – 18	1.57 (1.26;1.95)**	1.40 (1.01;1.94)**	1.43 (0.99;2.08)
	All	1.68 (1.43;1.97)**	1.47 (1.16;1.87)**	1.48 (1.15;1.92)**
23	4 – 8	1.62 (1.30;2.01)**	1.23 (0.87;1.74)	1.28 (0.89;1.85)
	9 – 18	1.47 (1.22;1.76)**	1.11 (0.82;1.50)	1.07 (0.76;1.50)
	All	1.51 (1.31;1.74)**	1.13 (0.90;1.42)	1.11 (0.87;1.43)
33	4 – 8	1.54 (1.29;1.83)**	1.15 (0.88;1.50)	1.18 (0.89;1.56)
	9 – 18	1.54 (1.30;1.82)**	1.40 (1.07;1.85)**	1.54 (1.13;2.09)**
	All	1.54 (1.36;1.75)**	1.30 (1.07;1.59)**	1.35 (1.10;1.67)**

* Z-score for cohort member BMI was internally standardised
† adjusted for age and gender of the offspring, estimates from multi-level models
‡ adjusted for age and gender of the offspring, and BMI of cohort member at previous age
§ adjusted for age and gender of the offspring, BMI of cohort member at previous age, and social class of cohort members at 33 years (1991)
** p<0.05

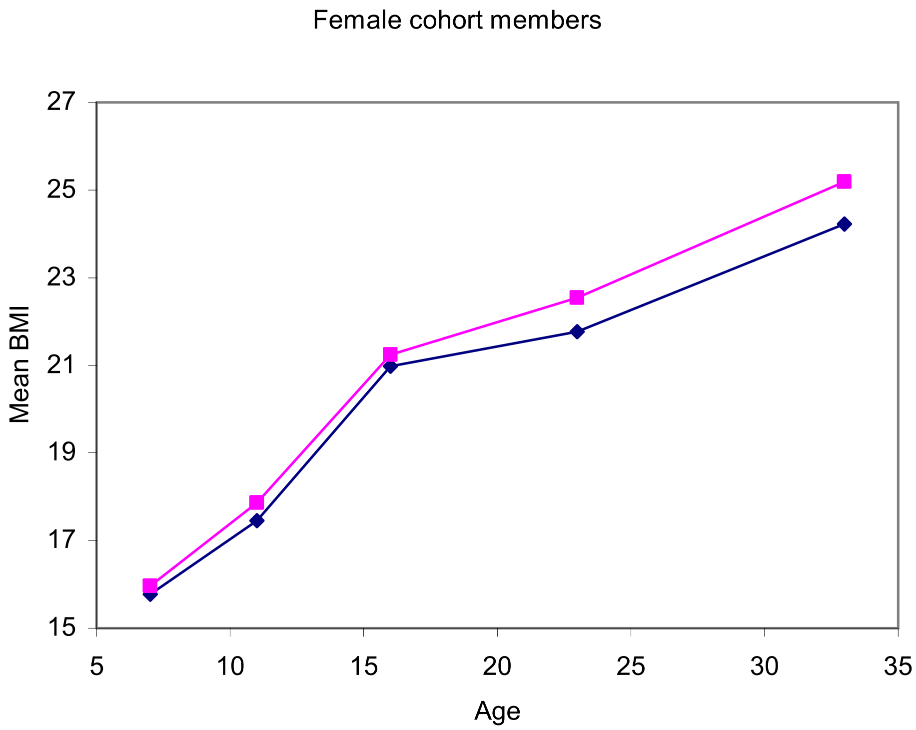
Large increases in BMI across the parent's life-course, both in childhood and adulthood, were associated with increased BMI in their offspring and the pattern of association appeared to differ between mothers and fathers. Table 16 (column 2) shows that gains in paternal BMI during childhood (7-11 years) and from early adulthood (16-33 years) were significantly associated with BMI of their offspring; for every SD increase in paternal BMI between ages 7-11 years (2.41 kg/m^2) or 16-23 years (2.90 kg/m^2), the BMI of his offspring increased on average by 0.24 SDS and 0.23 SDS respectively (equivalent to a BMI increase of 0.35 and 0.34 kg/m^2 from the median BMI for a 7 year old boy) (Table 16, Table 14), and the OR for being overweight and obesity was 1.69 (95% CI: 1.29; 2.21) and 1.56 (95% CI: 1.16; 2.11) respectively (Table 17).

Large increase in maternal BMI in childhood (7-16 years) and recent increase in adulthood (23-33 years) also had a significant impact on offspring BMI; for every SD increase in BMI of the mother between ages 11-16 years (2.96 kg/m^2) or 23-33 years (4.87 kg/m^2), the BMI of her offspring increased on average by 0.23 SDS and 0.19 SDS respectively (equivalent to a BMI increase of 0.34 and 0.28 kg/m^2 from the median, for a 7 year old boy) (Table 16, Table 14) and the OR for being overweight and obesity was 1.47 (95% CI: 1.16;1.87) and 1.30 (95% CI: 1.07;1.59) respectively (Table 17).

Social class differences in BMI in two generations

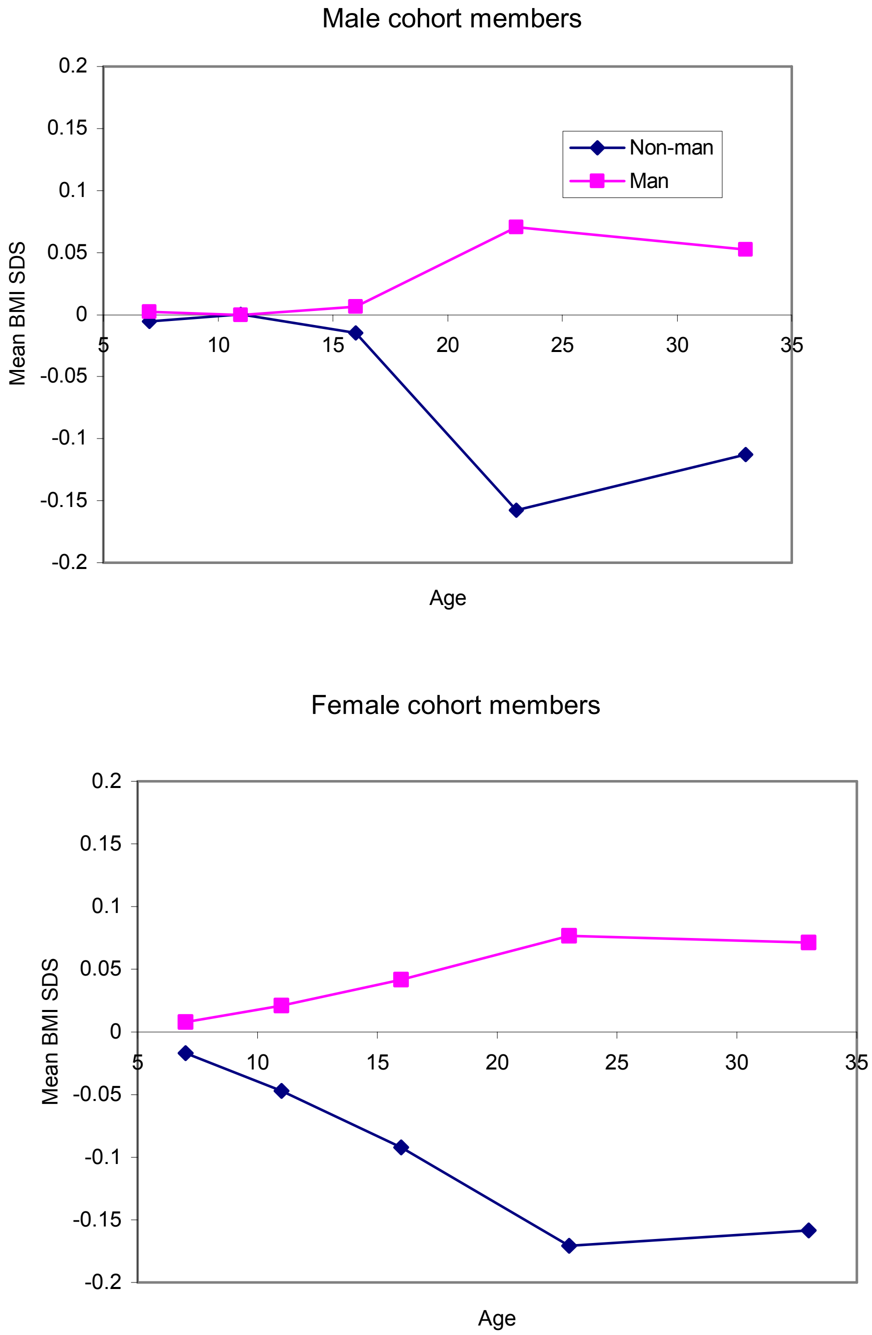
Figure 10 shows that BMI trajectory of cohort members was affected by social class in childhood: there was little difference in childhood BMI between manual and non-manual social class, but from early adulthood, those from manual class gained BMI at a faster rate and the difference was greater (and significant) in adult BMI. This pattern was more evident in the age trends of internal BMI SDS as variation was much greater in adult than in childhood BMI (Figure 11).

Figure 10: Trajectories for BMI of all cohort members by social class*



* Social class at 7 years or at birth if missing
Males: n=6869 at 7 years and 5319 at 33 years
Females: n=6416 at 7 years and 5512 at 33 years

Figure 11: Trajectories for internal BMI SDS of all cohort members by social class*



* Social class at 7 years or at birth if missing
Males: n=6869 at 7 years and 5319 at 33 years
Females: n=6416 at 7 years and 5512 at 33 years

There was no consistent evidence for a social class difference in offspring BMI, or for prevalence for overweight/obesity (Table 18). The associations between changes in BMI at different life stages in parents and offspring BMI or obesity status were not affected by adjustment of social class (Table 16, Table 17, column 3).

Table 18: Mean external BMI SDS* (SE) and % of overweight for offspring by cohort members social class at 33 years

Boys	Mean (SD)	%	n	Mean (SD)	%	n
Social class	4-8 years			9-18 years		
I&II	0.150 (0.076)	11.6	249	0.003 (0.103)	7.3	109
IIINM	0.313 (0.154)	12.5	216	0.147 (0.225)	10.3	136
IIIM	0.145 (0.182)	9.9	142	0.296 (0.233)	14.3	98
IV&V	0.391 (0.178)	19.8	167	0.003 (0.220)	9.5	189
p-value†	0.12	0.23		0.14	0.45	
Total	0.245 (0.042)	13.5	774	0.110 (0.045)	11.0	532
Girls						
I&II	0.200 (0.070)	16.0	243	0.300 (0.119)	20.4	93
IIINM	0.276 (0.159)	19.8	227	0.185 (0.255)	22.4	161
IIIM	0.210 (0.166)	19.5	154	0.272 (0.265)	18.8	96
IV&V	0.089 (0.164)	16.8	167	0.153 (0.252)	18.4	201
p-value†	0.42	0.68		0.70	0.85	
Total	0.184 (0.038)	18.0	791	0.226 (0.046)	19.7	551

* Offspring BMI was standardised against 1990 British growth reference sample

† Test for significant difference between social classes

Summary of main findings

Longitudinal study of cohort members

In this representative cohort of males and females born in Britain in 1958, large increases in BMI were observed with age once adult height was achieved. Social differences in mean BMI and in overweight and obesity were evident from age 16 years, at least when using social class of origin, and persisted throughout adulthood. Social differences in the frequency of PA in adulthood were consistent with social class differences in BMI, with non-manual groups having higher frequency of activity. BMI was associated with social class in both early life and adulthood, although there was a tendency for social differences to be greater for class of origin than for concurrent class. In contrast, social differences in dietary factors, and for men for PA, tended to be greater for concurrent class. This suggests that the origins of social inequalities may vary for BMI, activity and dietary habits. Given this, we would not necessarily expect social inequalities in activity and diet to mirror those for BMI over time.

There was a reversal of the pattern of in consumption of fried foods, such that manual groups had a higher frequency of intake at age 33 but a lower frequency at age 42 years, in men at least. This reversal may underlie the concurrent trend in social differences in mean BMI in men (i.e. there was a significant difference at 33 years but not at 42 years). Apart from this, social trends with age in PA and diet were inconsistent. However, a combined PA and diet score suggested that social differences in healthier behaviours had reduced among women, although there was no evidence of parallel reductions in social differences in BMI.

Inter-generational relationships: offspring BMI and weight change across the parent's life-course

The secular trend in obesity is evident in this comparison across two generations: offspring had higher BMIs than their parents when they were children. Both parents appeared to influence offspring BMI independently and risk of obesity in childhood. Recent BMI gain in parents was associated with offspring BMI in childhood. This could be due to their shared genetic and environmental influences. Importantly, parental BMI in childhood, independently of adult BMI, also had an impact on the BMI of offspring in childhood.

Paradoxically, whilst BMI gain in parents was socially patterned, this did not appear to have generated a social trend in BMI in offspring. There was no consistent evidence for social inequalities in BMI in childhood among the offspring sample.

Methodological considerations

Longitudinal study of cohort members

There were a number of limitations of the measurement methods used. The questions on PA did not include occupational activity, duration or intensity of activity and so present only a summary measure of level of leisure time activity. The dietary index used in these analyses was limited to the number of variables on frequency of consumption that were available for comparison across two ages; these might be regarded as markers for different diets in social groups, but only assess limited elements of the overall diet. Furthermore, the activity and dietary variables were only available in adult life and not in adolescence, when the social difference in BMI appears to have emerged in this generation, thus limiting our ability to draw causal inferences about the relationship between these risk factors and BMI.

Lastly, in these analyses we cannot distinguish between time trends and ageing trends.

Inter-generational relationships: offspring BMI and weight change across the parent's life-course

The offspring were born between 1973 and 1987 and in 1991 were aged 4-18 years (average 8.7 years); their parents were aged all aged under 30 years at the birth of their child (average age 24.3 years), rather than a randomly selected population sample. We have previously reported that this sample resembles the general sample in respect, for example, of birth weight and height.[80] Information on BMI for the parents of offspring was available only for the cohort member and not the other parent.

The changing social patterning of obesity in the Millennium Cohort Study

Introduction

The analysis of data from the Millennium Cohort Study (MCS) aimed to examine socioeconomic trends in weight gain among parents and its influence on weight gain in children over the corresponding period. We identified two strategies to explore this association and present the results of both analyses in this report:

Strategy one: Does maternal, and/or partner, weight gain predict infant weight gain? Does this vary by socioeconomic position?

Strategy two: Are there socioeconomic differences in weight gain of children? Is this due to differences in maternal, and/or partner, weight gain?

Methods

Study population

The MCS is a longitudinal study, which was set up to examine the social, economic and health-related circumstances of the new century's babies and their families.[81] The first contact (MCS1) with the cohort was at infant age 9 months, when it comprised 18 819 babies born between September 2000 and January 2002, living in the UK and eligible to receive child benefit. The overall response rate was 72%, and details on the representative nature of the sample are reported elsewhere.[82] Surviving and extant children were eligible to participate in the second contact (MCS2),[83] which took place between September 2003 and April 2005, when the children were approximately 3 years old. Of the 18296 singleton infants in the first contact, 14630 (80%) participated in the second sweep. Non-response was highest in Northern Ireland and electoral wards within England defined as ethnic minority (at least 30% of the total population 'Black' or 'Asian' in the 1991 Census of Population), and within disadvantaged wards (upper quartile of the ward-based Child Poverty Index) within all four UK countries.[83]

Survey interviews were conducted with the main carer (usually the mother and recorded as the main respondent) and their partners at both contacts and information obtained on a large number of factors, including self-reported parental weights and heights, maternal report of child's birthweight[84] and last weight (~ 9 months), socioeconomic position, ethnicity and a range of other covariates. Gestational age was obtained through linkage to maternity hospital episode statistics. Additionally, at the second contact, trained interviewers weighed the children using Tanita HD-305 scales (Tanita UK Ltd, Middlesex, UK) and weights were recorded in kilograms to one decimal place; heights were obtained using the Leicester Height Measure Stadiometer (Seca Ltd, Birmingham, UK) and recorded to the nearest completed millimetre.[85]

From the sample of 14630 children for whom there is information at both contacts, this study excluded those from multiple conceptions (including singletons with non-surviving siblings) (98), or from dual families (two infants in the cohort) (10), those born less than 32 weeks gestation (128), and those with mothers who had had a subsequent baby, as they would have had atypical weight gain (3927). Furthermore, we excluded information from non-female main respondents and non-male partners, at the first and second contact, (183) as they were atypical in various ways. Finally, we excluded children for whom conditional weight gain could not be calculated due to missing or implausible data for either weight at 9 months or 3 years (1846). As a result this study included 8561 children. Children were more likely to be included if they were white, living in England, or from a 'managerial & professional' household socioeconomic position (defined below) ($p<0.001$).

Outcome measure

The outcome for this study was the cohort children's conditional weight gain from 9 months to 3 years, that is, weight gain adjusted for weight at 9 months. Conditional weight gain z-scores were calculated as the standardised residuals from the linear regression of 3-year weight z-score on 9 month z-score, with age and sex entered as covariates. We also adjusted for 3-year height (length not available at 9 months) in an attempt to adjust for linear growth. The standardised residual is the 3-year weight z-score minus its value predicted from the regression, divided by the residual standard deviation from the regression.

Conditional weight gain z-score has a mean of 0 and a standard deviation of 1 and is normally distributed. A positive value indicates faster, and a negative value slower, weight gain than the population mean.

Explanatory measures

Maternal and partner weight change (kg) from when the cohort child was 9 months to when he/she was 3 years.

Socioeconomic classification (9 months)

At MCS1, maternal and partner socioeconomic position was classified according to the National Statistics Socioeconomic Classification (NS-SEC).[86] A collapsed version of this classification includes six groups: managerial & professional occupations; small employers & own account workers; intermediate occupations; lower supervisory & technical occupations; semi-routine & routine occupations; or, never worked or long-term unemployed.

For the purpose of this study, we created a household indicator of socioeconomic classification based on the 'dominance approach'.[86] Rose and Pevalin[86] outline 3 guidelines for creating this classification: if the NS-SEC work positions of the two family members are the same then this becomes the household class position. Otherwise, individual work positions derived from full-time work are dominant over those from part-time work. If each is in full-time work, or each is in part-time work, then the following order of precedence prevails from highest to lowest: managerial & professional occupations; small employers & own account workers; intermediate occupations; lower supervisory & technical occupations; semi-routine & routine occupations; or, never worked or long-term unemployed.

We modified this approach as the employment status information (i.e. if they were full-time or part-time work) for both parents at MCS1 was based on their employment at nine months postpartum, whereas their NS-SEC work positions were based on either their occupation at the time of MCS1, i.e. when their infants were 9 months, or on their most recent occupation. For women, their NS-SEC work position could therefore have been based on employment before birth. As such, we took the following approach: if the NS-SEC work positions of the two family members were the same then this became the household class position; otherwise, we took the higher of the two positions based on the order listed above.

Statistical analysis

The analyses were carried out on data downloaded form the UK Data Archive, University of Essex, in August 2006. Therefore the data do not include additions made to the dataset since that time. All analyses were conducted using STATA/SE 9.2. Sample weights and 'svy' commands[87] were used to allow for the cluster sampling design effect. Non-response weights were not available at the time of analysis. Descriptive analyses were conducted and multivariable linear regression models fitted.

Given that MCS is an ethnically diverse sample and that there are differences in weight gain by ethnic groups,[88] the multivariable linear regression models were also repeated on the white population only (n= 7317) to establish if important differences were present.

Results

Descriptive analyses

The characteristics of the 8561 children included in this study are shown in Table 19. 50.3% were male, 88.7% white, 62.3% resided in England, and 49.1%, and 19.9%, of the cohort children's households were classified as 'managerial and professional', and 'semi-routine and routine', respectively. 34.1% were born to primiparous mothers and 32.4% of the mothers smoked during pregnancy. Furthermore, 34.9% of mothers, and 33.7% of partners were aged 30–34.9 years.

Table 19: Sample characteristics

Measures		% * (n)
Sex		
	Male	50.3 (4328)
	Female	49.7 (4233)
Ethnic group		
	White	88.7 (7317)
	Mixed	2.9 (246)
	Asian	4.5 (644)
	Black	1.9 (227)
	Other ethnic group	1.0 (114)
Birth weight		
	0.5-1.49 kg	0.1 (13)
	1.5-1.99 kg	1.0 (85)
	2-2.49 kg	3.9 (359)
	2.5-2.99 kg	14.5 (1314)
	3-3.49 kg	36.6 (3153)
	3.5-3.99 kg	30.7 (2549)
	4-4.49 kg	11.6 (934)
	4.5-4.99 kg	1.6 (139)
Weeks of gestation		
	32-33.9	1.0 (86)
	34-35.9	2.4 (209)
	36-37.9	8.9 (753)
	38-39.9	34.5 (2979)
	40-41.9	49.1 (4194)
	40 +	4.1 (340)
UK Country of residence (at 9 months)		
	England	62.3 (5511)
	Scotland	11.6 (936)
	Wales	17.8 (1460)
	Northern Ireland	8.2 (654)
Household socioeconomic classification		
	Managerial & professional occupations	49.1 (3556)
	Intermediate occupations	13.5 (1170)
	Small employers & own account workers	7.0 (581)
	Lower supervisory & technical occupations	8.5 (784)
	Semi-routine & routine occupations	19.9 (2075)
	Never worked & LT unemployed	2.2 (319)
Parity		
	Cohort baby not first live born	65.9 (5599)
	Cohort baby first live born	34.1 (2906)
Smoked during pregnancy		
	Yes	32.4 (2970)
	No	67.6 (5560)
Maternal age at MCS1		
	Under 25	16.1 (1655)
	25-29.9	23.2 (2107)
	30-34.9	34.9 (2775)
	35-39.9	21.3 (1646)
	40+	4.5 (377)
Paternal age at MCS1		
	Under 25	6.0 (506)
	25-29.9	16.3 (1295)
	30-34.9	33.7 (2391)
	35-39.9	29.2 (1982)
	40+	14.8 (1030)

* Weighted percentages
Missing data for: ethnic group (13); socioeconomic position (76); parity (56); smoked during pregnancy (31); Parental); (1); paternal age (1357).

Table 20: Summary statistics for height at 3 years, weight at 9 months and 3 years, weight z-scores and weight gain z-score according to birth weight

Birth weight	Mean (SD) height (m)	Mean (SD) weight (Kg)		Mean weight (SD) z-score		Mean (SD) weight gain z-score
	3 years	9 months	3 years	9 months*	3 years†	
0.5-1.49 kg	0.94 (0.04)	6.97 (1.26)	13.75 (2.48)	-1.47 (1.03)	-0.72 (1.47)	-0.24 (1.34)
1.5-1.99 kg	0.94 (0.05)	7.36 (1.10)	13.87 (2.16)	-0.10 (1.15)	-0.61 (1.33)	-0.32 (1.18)
2-2.49 kg	0.94 (0.04)	7.95 (1.15)	14.42 (2.17)	-0.56 (1.18)	-0.23 (1.20)	-0.12 (1.05)
2.5-2.99 kg	0.95 (0.04)	8.19 (1.23)	14.76 (2.07)	-0.33 (1.16)	-0.02 (1.13)	-0.07 (0.99)
3-3.49 kg	0.95 (0.04)	8.59 (1.24)	15.18 (2.00)	0.15 (1.14)	0.26 (1.04)	-0.03 (0.95)
3.5-3.99 kg	0.96 (0.04)	9.02 (1.24)	15.79 (2.00)	0.42 (1.06)	0.56 (0.97)	0.04 (0.91)
4-4.49 kg	0.97 (0.04)	9.40 (1.26)	16.41 (2.03)	0.74 (1.08)	0.87 (0.98)	0.10 (0.90)
4.5-4.99 kg	0.98 (0.04)	9.74 (1.30)	16.93 (1.86)	0.97 (1.19)	1.15 (0.91)	0.16 (0.89)
All	0.96 (0.04)	8.73 (1.31)	15.41 (2.10)	0.14 (1.18)	0.35 (1.09)	0.00 (1.00)

* Adjusted for age and sex
† Adjusted for age, sex and height

The mean height of the cohort children was 0.96 metres at 3 years of age, while the mean weight at 9 months and 3 years was 8.7kg and 15.4kg, respectively (Table 20). There was a trend for faster weight gain from 9 months to 3 years for heavier babies at birth. Analysis of variance revealed significant differences for mean weight z-score at 9 months ($p<0.001$), mean weight z-score at 3 years ($p<0.001$) and mean weight gain z-score from 9 months to 3 years ($p<0.001$) according to birth weight.

Table 21: Summary statistics for height at 3 years, weight at 9 months and 3 years, weight z-scores and weight gain z-scores according to weeks of gestation (2 week intervals)

Weeks of gestation	Mean (SD) height (m)	Mean (SD) weight (Kg)		Mean weight (SD) z-score		Mean (SD) weight gain z-score
	3 years	9 months	3 years	9 months*	3 years†	
32-33.9	0.95 (0.04)	8.18 (1.28)	14.91 (2.31)	-0.01 (1.37)	0.00 (1.29)	-0.33 (1.04)
34-35.9	0.95 (0.05)	8.27 (1.36)	14.98 (2.19)	-0.01 (1.26)	0.08 (1.22)	-0.12 (1.02)
36-37.9	0.95 (0.04)	8.58 (1.32)	15.33 (2.27)	0.15 (1.28)	0.27 (1.18)	-0.02 (0.97)
38-39.9	0.95 (0.04)	8.67 (1.30)	15.31 (2.04)	0.15 (1.19)	0.29 (1.07)	-0.06 (0.93)
40-41.9	0.96 (0.04)	8.82 (1.30)	15.52 (2.08)	0.15 (1.16)	0.41 (1.07)	0.03 (0.94)
40 +	0.96 (0.04)	8.79 (1.36)	15.61 (2.17)	0.08 (1.14)	0.44 (1.11)	0.09 (1.03)
All	0.96 (0.04)	8.73 (1.31)	15.41 (2.10)	0.14 (1.18)	0.35 (1.09)	0.00 (1.00)

* Adjusted for age and sex
† Adjusted for age, sex and height

There was a trend for faster weight gain from 9 months to 3 years with increased weeks of gestation (Table 21). Analysis of variance revealed significant differences for mean weight z-score at 3 years ($p<0.001$), and mean weight gain z-score from 9 months to 3 years ($p<0.001$), according to weeks of gestation, but not for mean weight z-score at 9 months ($p=0.266$).

Table 22: Summary statistics for height at 3 years, weight at 9 months and 3 years, weight z-scores and weight gain z-scores according to household socioeconomic classification

Household socioeconomic classification	Mean (SD) height (m)	Mean (SD) weight (Kg)		Mean weight (SD) z-score		Mean (SD) weight gain z-score
	3 years	9 months	3 years	9 months*	3 years†	
Managerial & professional occupations	0.96 (0.04)	8.84 (1.21)	15.45 (1.95)	0.22 (1.11)	0.39 (1.02)	-0.02 (0.87)
Intermediate occupations	0.96 (0.04)	8.78 (1.24)	15.34 (2.04)	0.14 (1.13)	0.32 (1.06)	-0.06 (0.91)
Small employers & own account workers	0.96 (0.04)	8.62 (1.34)	15.44 (2.39)	0.09 (1.19)	0.31 (1.19)	-0.02 (1.04)
Lower supervisory & technical occupations	0.95 (0.04)	8.69 (1.40)	15.43 (2.13)	0.14 (1.25)	0.35 (1.10)	0.05 (1.02)
Semi-routine & routine occupations	0.95 (0.04)	8.59 (1.41)	15.38 (2.20)	0.06 (1.26)	0.30 (1.15)	0.02 (1.01)
Never worked & LT unemployed	0.96 (0.04)	8.51 (1.54)	15.43 (2.37)	-0.02 (1.46)	0.31 (1.23)	0.07 (1.04)
All	0.96 (0.04)	8.73 (1.31)	15.41 (2.10)	0.14 (1.18)	0.35 (1.09)	0.00 (1.00)

*Adjusted for age and sex
† Adjusted for age, sex and height

Children within 'never worked or long-term unemployed' households had faster weight gain from 9 months to 3 years, while those within the 'intermediate' households the slowest weight gain over this period (Table 22).

Analysis of variance revealed significant socioeconomic position differences for mean weight z-score at 9 months ($p<0.001$), mean weight z-score at 3 years ($p=0.034$), and mean weight gain z-score from 9 months to 3 years ($p=0.026$).

Table 23: Percentage (n) infants aged 9 months who had weight z-scores greater than 1 and less than 2, and greater than 2, according to household socioeconomic classification

Household socioeconomic classification	z-score >1 < 2*	z-score ≥ 2†
Managerial & professional occupations	16.95 (612)	5.15 (194)
Intermediate occupations	18.32 (202)	5.21 (62)
Small employers & own account workers	13.52 (89)	5.21 (30)
Lower supervisory & technical occupations	16.69 (140)	5.23 (48)
Semi-routine & routine occupations	15.92 (333)	5.02 (122)
Never worked & LT unemployed	13.44 (42)	8.58 (28)
All	16.59 (1418)	5.22 (484)

* Corresponds approximately to the 85th percentile
† Correspond approximately to the 95th percentile

17% of the cohort children had a weight z-score between 1 and 2; 5% had a weight z-score greater than or equal to 2 (Table 23). There were significantly more children from 'never worked or long-term unemployed' households with high weight z-scores (≥ 2).

Table 24: Percentage (n) children aged 3 years who were normal weight, overweight or obese* according to household socioeconomic classification

Household socioeconomic classification	Normal weight	Overweight†	Obese
Managerial & professional occupations	77.57 (2720)	18.22 (675)	4.21 (159)
Intermediate occupations	77.73 (905)	17.42 (210)	4.85 (55)
Small employers & own account workers	77.37 (449)	16.33 (96)	6.30 (36)
Lower supervisory & technical occupations	74.92 (576)	19.77 (163)	5.31 (45)
Semi-routine & routine occupations	75.85 (1565)	18.00 (372)	6.15 (137)
Never worked & LT unemployed	72.01 (233)	19.99 (60)	8.00 (26)
All	76.89 (6448)	18.11 (1576)	5.00 (458)

* Weight status defined using International Obesity Task Force cut-offs.[1]

† Not including obese

18% of the cohort children were overweight, and 5% obese, at 3 years (Table 24). A significant trend was found for more obese children in the 'lower' socioeconomic households (p=0.005).

Table 25: Parental summary statistics for weight and weight change (MCS1 to 2), according to household socioeconomic classification

Household socioeconomic classification	Mothers			Partners		
	Weight (SD) (kg) MCS1	Weight (SD) (kg) MCS2	Weight change (kg)	Weight (SD) (kg) MCS1	Weight (SD) (kg) MCS2	Weight change (kg)
Managerial & professional occupations	66.66 (12.87)	66.56 (12.93)	0.16 (5.23)	83.70 (12.77)	84.89 (13.17)	1.15 (5.29)
Intermediate occupations	67.09 (13.53)	67.41 (13.71)	0.37 (5.56)	82.04 (12.77)	83.13 (13.48)	1.00 (4.97)
Small employers & own account workers	66.54 (13.03)	66.69 (13.44)	-0.06 (5.50)	82.67 (13.42)	83.78 (14.06)	1.37 (5.33)
Lower supervisory & technical occupations	68.55 (14.79)	68.49 (14.19)	-0.02 (6.81)	82.00 (14.05)	83.21 (14.67)	1.14 (6.18)
Semi-routine & routine occupations	65.99 (14.24)	66.88 (14.77)	0.84 (6.59)	79.93 (14.89)	82.43 (15.42)	1.57 (6.89)
Never worked & LT unemployed	62.45 (13.53)	64.24 (14.37)	2.19 (7.40)	75.81 (17.44)	75.79 (12.82)	1.62 (7.32)
All	66.58 (13.57)	66.85 (13.73)	0.37 (5.92)	82.53 (13.41)	83.78 (13.89)	1.20 (5.61)

Overall, mothers gained on average 0.4kg, and partners 1.2kg, between the first and second MCS contacts (~ 2 year period) (Table 25).

A trend was found for a socioeconomic gradient in weight gain for both parents; those within 'never worked and long-term unemployed' households gained significantly more weight over this period.

Table 26: Parental summary statistics for weight and weight change (MCS1 to 2), according to age

Age	Mothers		Partners	
	Weight (SD) (kg) MCS1	Weight change (kg)	Weight (SD) (kg) MCS1	Weight change (kg)
< 25	64.24 (13.57)	1.26 (6.69)	76.24 (13.66)	3.09 (7.51)
25-29.9	66.60 (13.63)	0.78 (6.33)	81.47 (14.14)	1.33 (6.36)
30-34.9	67.21 (13.14)	0.15 (5.76)	83.37 (13.21)	1.32 (5.78)
35-39.9	67.64 (14.00)	0.22 (5.38)	83.65 (12.97)	1.29 (5.20)
40 +	67.48 (13.24)	-0.14 (6.09)	82.67 (12.82)	0.68 (5.33)
All	66.58 (13.57)	0.37 (5.92)	82.53 (13.41)	1.20 (5.61)

Younger parents (under 25-year olds) gained significantly more weight over the two year period. For mothers and their partners, a trend was found for less weight gain with increasing age.

Strategy One

Does maternal, and/or partner, weight gain predict infant weight gain? Does this vary by socioeconomic position?

Table 27: Linear regression analyses* for the association between maternal weight change and conditional weight gain (9 months to 3 years)

Household socioeconomic classification	Unadjusted regression coefficient† (95% CI)	Adjusted regression coefficient†‡ (95% CI)
Managerial & professional occupations	-0.003 (-0.010, 0.004); p=0.415	-0.003 (-0.009, 0.004); p=0.401
Intermediate occupations	-0.006 (-0.018, 0.005); p=0.280	-0.008 (-0.022, 0.005); p=0.214
Small employers & own account workers	-0.010 (-0.030, 0.010); p=0.337	-0.012 (-0.032, 0.008); p=0.239
Lower supervisory & technical occupations	0.002 (-0.008, 0.011); p=0.734	0.004 (0.007, 0.014); p=0.500
Semi-routine & routine occupations	-0.004 (-0.013, 0.005); p=0.399	-0.003 (-0.014, 0.008); p=0.571
Never worked & LT unemployed	0.015 (-0.004, 0.033); p=0.119	0.031 (0.002, 0.060); p=0.036
All	-0.002 (-0.007, 0.002); p=0.294	-0.002 (-0.007, 0.003); p=0.373

* Separate models were run for the whole sample and for each of the six socioeconomic classifications.

† Regression coefficients, calculated using sample weights.

‡ Adjusted for cohort child's ethnicity, and maternal and partner age at MCS1

No association was found between weight gain of mothers and their children for the whole sample (Table 27). However, in the adjusted analysis, weight gain in mothers was found to have a small but statistically significant relationship to their child's weight gain for those classified within 'never worked or long-term unemployed' households.

The analysis was repeated for just the white population: similar unadjusted results were found, however, for the adjusted analysis, no significant association was found between the mother and children's weight gain in 'never worked or long-term unemployed' households (0.015 (-0.037, 0.067); p=0.580).

Table 28: Linear regression analyses* for the association between partner weight change and conditional weight gain (9 months to 3 years)

Household socioeconomic classification	Unadjusted regression coefficient† (95% CI)	Adjusted regression coefficient†‡ (95% CI)
Managerial & professional occupations	0.001 (-0.007, 0.008); p=0.869	0.001 (-0.006, 0.008); p=0.789
Intermediate occupations	0.002 (-0.014, 0.019); p=0.767	0.003 (-0.013, 0.019); p=0.703
Small employers & own account workers	-0.015 (-0.033, 0.004); p=0.114	-0.010 (-0.028, 0.009); p=0.307
Lower supervisory & technical occupations	0.013 (0.000, 0.025); p=0.046	0.010 (-0.002, 0.023); p=0.114
Semi-routine & routine occupations	0.006 (-0.010, 0.021); p=0.473	0.005 (-0.011, 0.021); p=0.522
Never worked & LT unemployed	0.005 (-0.054, 0.064); p=0.871	0.033 (-0.015, 0.081); p=0.177
All	0.002 (-0.004, 0.007); p=0.589	0.001 (-0.004, 0.007); p=0.604

* Separate models were run for the whole sample and for each of the six socioeconomic classifications.

† Regression coefficients, calculated using sample weights.

‡ Adjusted for cohort child's ethnicity, and maternal and partner age at MCS1

No association was found between weight gain of the partners and the cohort children for the whole sample, or for the individual socioeconomic groups (Table 28).

The analysis was repeated for just the white population: similar unadjusted results were found. However, a small but significant association was found in the adjusted analysis for the 'never worked and long-term unemployed' household group (0.060 (0.009, 0.111); p=0.021).

Strategy Two

Are there socioeconomic differences in weight gain of children? Is this due to differences in maternal, and/or partner, weight gain?

Table 29: Linear regression analyses for the association between household socioeconomic classification and conditional weight gain (9 months to 3 years)

Household socioeconomic classification	Model 1: adjusted regression coefficient*† (95% CI)	Model 2: adjusted regression coefficient*‡ (95% CI)
Managerial & professional occupations	-	-
Intermediate occupations	-0.025 (-0.100, 0.049); p=0.504	-0.045 (-0.139, 0.050); p=0.354
Small employers & own account workers	0.055 (-0.038, 0.148); p=0.248	0.078 (-0.048, 0.205); p=0.223
Lower supervisory & technical occupations	0.122 (0.042, 0.202); p=0.003	0.093 (-0.028, 0.213); p=0.131
Semi-routine & routine occupations	0.081 (0.019, 0.144); p=0.011	-0.021 (-0.126; 0.085); p=0.703
Never worked & LT unemployed	0.156 (-0.007, 0.320); p=0.061	0.054 (-0.358; 0.466); p=0.797

* Regression coefficients, calculated using sample weights, represent the difference in conditional weight gain z-scores compared to the baseline group (managerial & professional socioeconomic classification).

† Adjusted for cohort child's ethnicity

‡ Adjusted for cohort child's ethnicity, maternal and partner weight change, and maternal and partner age at MCS1.

Socioeconomic differences in conditional weight gain of children were found in model 1; children within 'lower supervisory & technical', 'semi-routine & routine' and 'never worked & long-term unemployed' households gained weight faster than those within 'managerial and professional' households (Table 29). However, these statistically significant differences were no longer present following adjustment for additional factors (model 2), including parental weight change. This suggests that socioeconomic differences in weight gain of children may be accounted for by parental weight change over the corresponding period.

The analysis was repeated for just the white population: similar results were found for both models.

Summary of main findings

On average, mothers of the cohort children, and their partners, gained weight over the 2 year period (i.e. between the first and second MCS contacts); those who were younger gained significantly more weight. Furthermore, weight gain was found to be associated with socioeconomic classification, such that those within 'never worked and long-term unemployed' households gained significantly more weight.

Among the cohort children, greater weight gain from 9 months to 3 years was found for those who had had longer gestational periods and higher birth weights. Socioeconomic position was also found to be associated with weight gain, and obesity at age 3; those within 'never worked or long-term unemployed' households had faster weight gain from 9 months to 3 years, while at 3 years there were also more obese children in this group.

We identified two strategies for exploring socioeconomic influences on weight gain in early childhood, and its relationship with parental weight gain. Firstly, we investigated whether maternal, and/or partner, weight gain predicts infant weight gain and, if so, whether this varies by socioeconomic position. Overall, no association was found between weight gain of mothers, and their partners, with weight gain in the cohort children. However, an association was found between maternal and child weight gain in 'never worked or long-term unemployed' households. In contrast, in the analysis restricted to just the white population, weight gain of the partner, but not the mother, was found to be significantly associated with weight gain of the cohort children in 'never worked and long-term unemployed' households.

Our second strategy was to investigate if socioeconomic differences in weight gain of children are due to differences in maternal, and/or partner, weight gain. Socioeconomic differences in weight gain of the children were established, which were found to be accounted for by parental weight change over the corresponding period.

Methodological considerations

The MCS represents a large UK-wide heterogeneous and contemporary cohort of children. It is unique in having over-sampled to achieve significant representation of the ethnic minority groups, and children living in deprived areas.

Although BMI could not be examined as data on length was not available at 9 months, this study examined conditional weight gain adjusted for height at 3 years, allowing differences in stature at the older age to be accounted for. While the cohort child's weight at 9 months was based on maternal report, this weight was confirmed by 85% of the mothers by referring to the personal child health record, a booklet used by mothers and health professionals in the UK to monitor a child's early growth and development.[89] Anthropometric measures at 3 years, height and weight, were carried out by trained interviewers using standard protocols.

An important limitation was that parental height and weights were based on self-report, and weight change could not be calculated for 1651 mothers and 3694 partners in our sample due to missing data. However, we believe that the use of these data is justified for a number of reasons. First, weight gain is not available in many (cross-sectional) surveys and MCS therefore represents an unusual opportunity to investigate this longitudinal variable. Second, the 1958 cohort analysis focused on weight/BMI gain at different periods of cohort members lives. Assessing the influence of weight gain on offspring in a younger cohort (the MCS) was therefore complementary to the analysis of the 1958 cohort. Third, weight gain may be more amenable to intervention than established obesity (many adults gaining weight will not be obese but will become so if their weight gain continues). Despite the potential weaknesses of self-report data, the results are in the expected direction with overall weight gain of the population over the 2 year period, and with a socioeconomic gradient.

Further work on these data might focus on building more complex models using multivariable analysis to assess mediating and confounding factors in the observed relationships.

The changing social patterning of obesity in the Health Survey for England and Scottish Health Survey

Introduction

National health surveys have been undertaken annually in England since 1991 and intermittently in Scotland since 1995, and provide the most comprehensive available data at a national level on body weight and a range of other health and social variables. Although limited by their cross-sectional design in individual years, together this series of regular surveys is intended to provide a lens through which the changing health and risk factors in the UK population can be viewed and evaluated.

In the analyses presented here we set out to document the socio-economic patterning of obesity and overweight and their risk factors over time in adults and children in England and Scotland, in order to identify emerging trends which may be of relevance to future policy and practice. In particular we have explored the social patterning of risk.

Methods

Study design

Separate, annual, national cross-sectional surveys were brought together and analysed to derive time-trends in the key variables of interest.

Data sources

The HSE is an annual cross sectional survey that was commissioned by the NHS Health and Social Care Information Centre. This annual survey monitors the health of the English population and covers a broad range of topics. Each year a specific area of health, such as heart disease or asthma, is investigated, in addition to general health.

A specific population group, such as people over the age of 65, ethnic minorities or mothers and children, may be the focus of additional research. The results are used very widely, for instance to estimate the proportion of the population with specific health conditions, to look at risk factors associated with those conditions, and to monitor targets in the government's health strategy.

Each year the Health Survey involves face-to-face interviews with up to 16,000 adults and 4,000 children in England, and covers a representative cross-section of the population. The results represent people of different ages and states of health, living in different areas and from differing backgrounds.

The HSE was first carried out in 1991. Since 1994 it has been conducted by the National Centre for Social Research (NatCen) and the Department of Epidemiology and Public Health at the Royal Free and University College London Medical School, which together form the Joint Health Surveys Unit. For further details, see: http://www.natcen.ac.uk/natcen/pages/or_health.htm.

The survey consists of a detailed interview, followed by a visit from one of NatCen's Survey Nurses. Nurses take a range of measurements and tests which provide information about risk factors including cholesterol levels and blood pressure.

Closely modelled on the HSE, the SHS is commissioned by the Scottish Executive Health Department. The survey was carried out in 1995, 1998 and 2003 by NatCen. The SHS provides reliable information on the health and health-related behaviours of people living in private households. Among the Survey's aims are to estimate the prevalence of a range of health conditions and to monitor progress towards Scottish health and dietary targets. The 2003 survey is the third in a series which began in 1995 with a survey of adults aged 16-64. The 1998 survey included children aged 2-15 and adults aged 65-74. The 2003 survey did not have any age limits and included children from 0 upwards and adults aged 16+. Physical measurements (e.g. height, weight, waist and hip measurements, blood pressure and lung function) were carried out and blood samples taken in all surveys.

The SHS is commissioned by what is now the Scottish Executive Health Department. The first two surveys were conducted by the Joint Health Surveys Unit (JHSU) of the National Centre for Social Research (NatCen) and the Department of Epidemiology and Public Health at University College London (UCL). In 2003, the JHSU collaborated with the MRC Social and Public Health Sciences Unit (MRC SPHSU) at the University of Glasgow. For further information, see: http://www.esds.ac.uk/government/shes/.

Data availability

The HSE provides data on a total of over 175,000 adults and almost 40,000 children between 1991 and 2004. The SHS was carried out in 1995, 1998 and 2003 and provides data on over 25,000 adults and 7,200 children. Both the HSE and SHS data were available in the UK data archive from the onset of the project, with the exception of HSE 2004 and SHS 2003. The SHS 2003 data were obtained directly from NatCen.

Because the data from the SHS were only available for three years, comparisons between HSE and SHS were only made in these three years. For this reason, the results are presented in three sections: an analysis of the HSE data (1991-2004); an analysis of the SHS data (1995, 1998 and 2003); and an analysis of the regions of England together with Scotland in these same three years to provide a comparison of the data sets and highlight any differences in outcome measures and associated trends.

The outcome measures used for the analysis for adults were overweight (BMI >24.9 kg/m^2), obesity (BMI >29.9 kg/m^2), and high WHR (>0.85 for women, >0.95 for men). For children, we have used international cut-off points for BMI for overweight and obesity as described by Cole et al.[1] In addition, suitable variables were extracted from the data sets to describe SEP, dietary intake and PA.

A major difficulty has been the inconsistency of the variables in both data sets. The HSE has been evolving since 1991, and questions asked during interview have changed over time, often to reflect lifestyle changes of the population. For example, until 1999, questions about fruit and vegetable consumption resulted in data on the number of portions consumed on a weekly basis, whereas from 2000, questions led to data on portions consumed on a daily basis. In some years, questions were restricted to adults only, or not asked at all.

There was also a range of missing data for each variable. This was usually due to non-response from an interviewee. Data cleaning was carried out on each variable, checks were run and unlikely values were removed before analysis. Details of data availability and observations excluded from the analyses as a result of inconsistencies or data cleaning can be found in Table 30.

Table 30: Percentage of available observations in the HSE and SHS by year

	HSE 1991	HSE 1992	HSE 1993	HSE 1994	HSE 1995	HSE 1996	HSE 1997	HSE 1998	HSE 1999 *	HSE 2000	HSE 2001	HSE 2002	HSE 2003	HSE 2004 *†	SHS 1995	SHS 1998	SHS 2003
ADULTS																	
BMI	94.8	95.2	89.1	93.8	91.7	93.4	92.5	90.1	88.5	87.2	87.4	88.3	88.0	83.2	98.0	90.1	82.2
Waist-hip ratio	0	0	80.3	85	0	0	84.9	83.2	0	0	77	75.5	73.9	0	85.9	80.5	63.9
Occupational status of head of household	0	0	90.3	93.6	94.2	94.4	96.1	97.3	97.6	96.1	96.9	96.0	97.3	97.8	93.9	96.4	97.1
Age on leaving school	99.2	90.2	93.1	99.8	99.9	99.9	99.9	99.8	99.7	80.2	99.6	99.6	99.8	99.8	99.9	99.7	99.5
Portions of fruit and vegetables	0	0	0	0	0	0	0	0	0	0	100	100	100	100	0	0	99.6
Milk type	0	0	88.4	95.5	0	0	95.2	95.0	9.6	0	0	0	71.6	6.0	94.5	94.7	94.6
Physical activity level	0	0	0	0	0	0	0	99.8	99.9	0	0	0	99.7	99.8	0	100	99.9
CHILDREN																	
BMI	0	0	0	0	91.6	94.8	94.2	91.0	89.4	88.5	87.5	90.8	88.3	85.0	0	89.6	84.7
Occupational status of head of household	0	0	0	0	92.5	93.3	95.8	96.8	96.7	93.4	96.1	96.0	96.2	97.2	0	94.7	96.6
Portions of fruit and vegetables	0	0	0	0	0	0	0	0	0	0	81.0	81.9	82.6	81.8	0	0	81.7
Milk type	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	97.3	96.8
Physical activity level	0	0	0	0	0	0	0	0	0	0	0	98.7	0	98.3	0	0	100

* In 1999 and 2004 the ethnic boost sample has not been included in the calculations.
† In 2004 the care home sample has not been included in the calculations.

Variables selected for analysis

All analyses contained variables relating to age, gender and year of survey.

BMI was calculated from measures of height and weight collected at the end of the survey interview; and data were available in all survey years (BMI=height(m)^2/weight(kg)).

Waist and hip measurements were carried out during the nurse visit and applied to adults only. The WHR provides a good measure of abdominal obesity and the cut-off points used in the analysis for high WHR were 0.85 for women and 0.95 for men. In 1999 and 2004 the main focus of the HSE was the health of ethnic minorities. Only members of ethnic minorities received nurse visits in these years, resulting in a sample of unrepresentative WHR measurements. For this reason WHR was excluded in these years. Similarly, the focus of the 2000 survey was the health of older people and only people over the age of 60 received in the nurse visits, so again WHR measurements had to be excluded.

The socioeconomic position of the participants was described by an indicator of social class and one of educational attainment. Social class was classified using the Registrar General's classification of occupations[90,91] as follows:

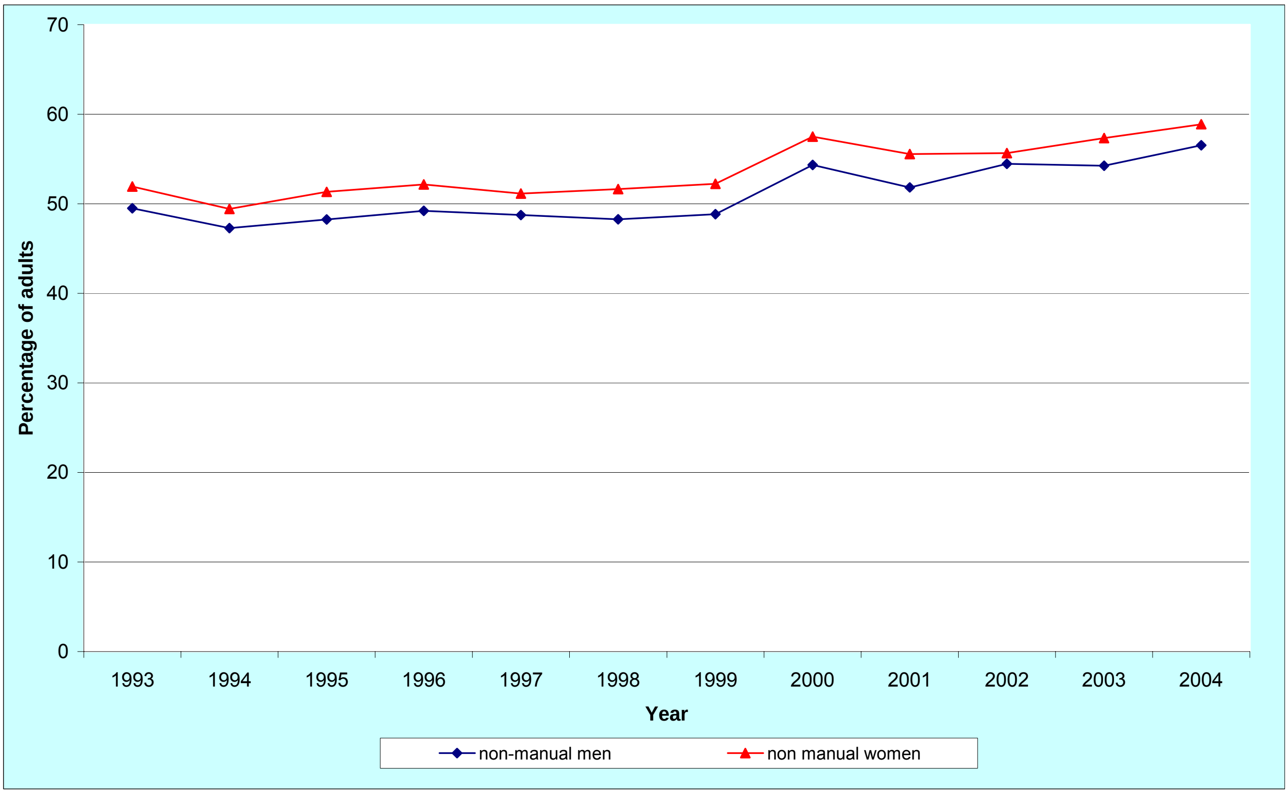
Non-manual
I Professional
II Managerial and technical/ intermediate
IIIN Skilled non-manual

Manual
IIIM Skilled manual
IV Partly skilled
V Unskilled

All members of a household were assigned the social class of the head of their household. The categories were classed as Non-Manual or Manual for the analysis. Other categories (armed forces, unclassified etc.) were omitted due to small numbers.

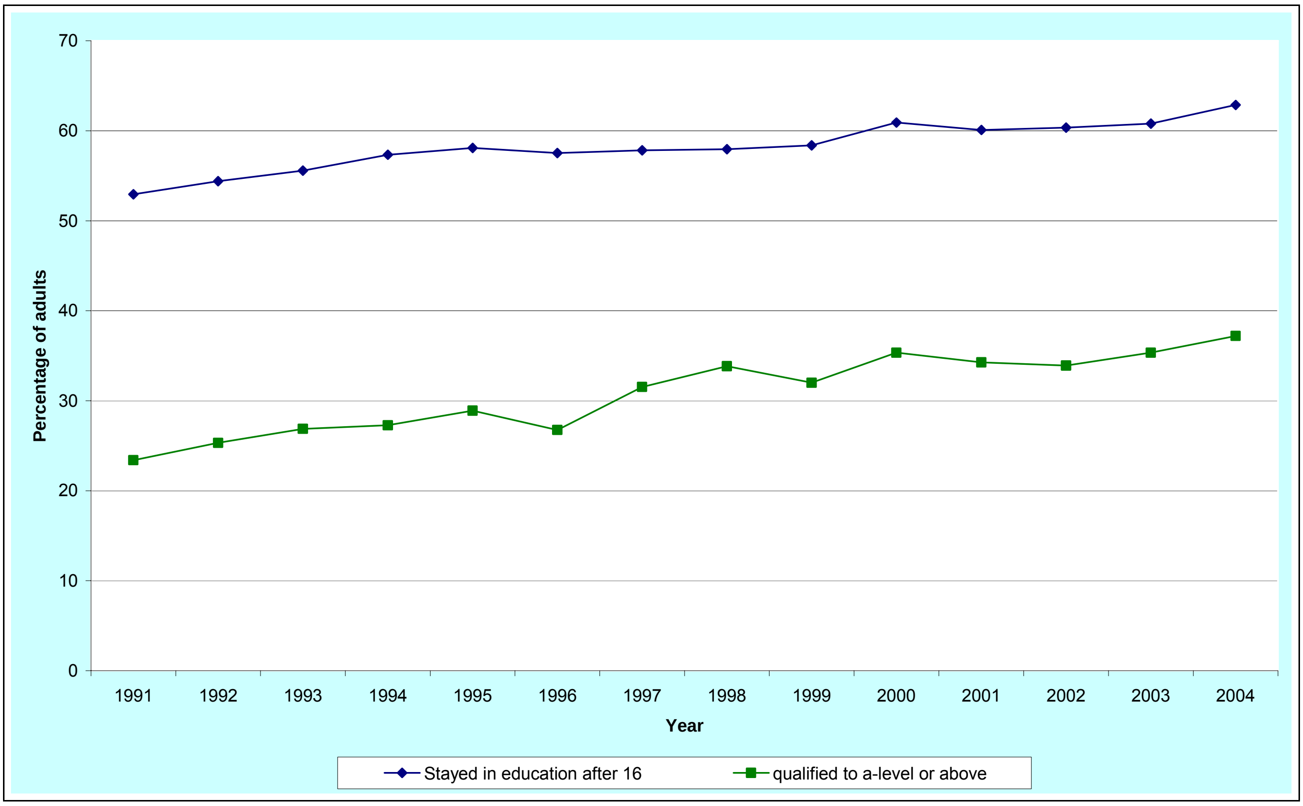
Until 2000 this variable had been based on the Standard Occupational Classification 1990 (SOC1990), however, SOC was reviewed in 2000 and the social class variable was then based on the new classification, SOC2000. This resulted in a significant rise in the numbers of individuals in the non-manual class in 2000, which is illustrated in Figure 12. This may have some bearing on the analysis. There is a reported agreement level of 94.8% between SOC1990 and SOC2000 (http://www.iser.essex.ac.uk/nssec/derivations.php)

Figure 12: Percentage of adults in non-manual social class group (HSE)



There were two potential variables that would provide a measure of educational attainment: age leaving school and highest educational qualification. Both variables had a similar low level of missingness, and were available in all survey years. They showed a similar trend over time, but age leaving school was slightly more consistent (Figure 13) and so was this was the variable chosen for analyses. This variable was categorised as those leaving school at 16 or younger, and those staying at school after 16. Obviously, this measure was not available for children.

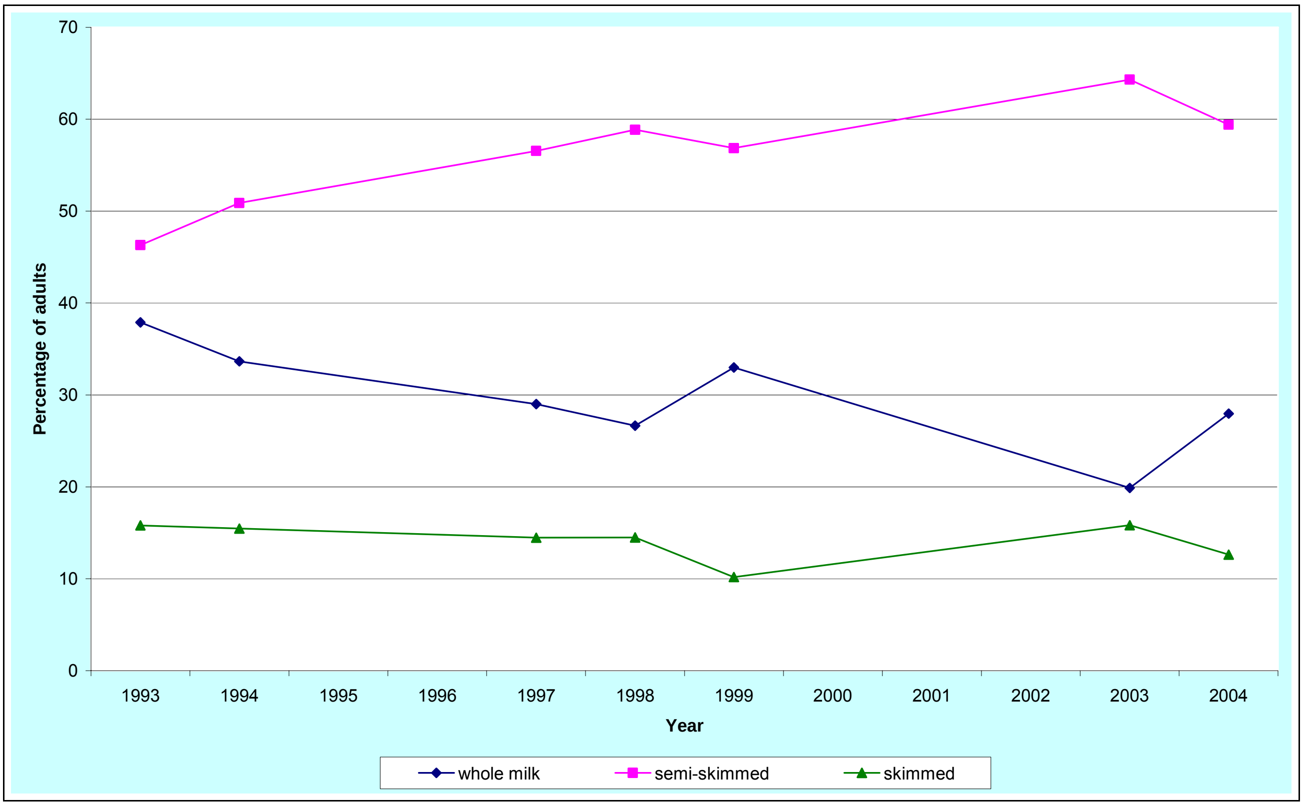
Figure 13: Percentage of adults who stayed in full time education after age 16 years and those qualified to 'A-level' and above, by survey year (HSE)



Choosing variables to reflect dietary intake was made difficult by the variability of questions asked across the survey years. There was no dietary information in HSE 1991, 1992, 1995 and 1996 and SHS in 1995. In HSE 2001 and 2002 there were only questions on fruit and vegetable intake.

Questions on the type of milk consumed were asked consistently in the available years, and so this variable was included in the analysis. Three types of milk were considered, whole milk (including evaporated milk), semi- skimmed and skimmed milk. Other types of milk such as rice and soya, which were only consumed by a very small proportion of the population, were excluded. For HSE, in both 1999 and 2004 (both survey years with ethnic minority boosted samples), there was a high level of missing data on milk consumed, and the results were at variance with other years (Figure 14) and so these were excluded from the analyses. Unfortunately, children were only asked about milk consumption in HSE in 1997, and so there was no benefit to including it in analyses.

Figure 14: Percentage of adults consuming whole, semi-skimmed and skimmed milk, by survey year (HSE)



Fruit and vegetable consumption was considered an important variable to reflect diet and this was available in all survey years that dietary information was collected. For HSE up to 1999, the interviewees were asked how many portions of fruit and vegetables they consumed each week. From 2001 there was a detailed set of questions about daily fruit and vegetable consumption asking specifically about portions of dried and frozen fruit, vegetables and fruit in desserts etc. The two sets of data were not comparable, and for this reason a summary variable of portions of fruit and vegetables has been included in our analysis from 2001-2004. The number of daily portions have been categorised as less than 2, 2-3 and 4 or more.

In SHS 1995 and 1998 questions on vegetable consumption were in three groups, root vegetables, green vegetables and raw vegetables. The responses were inconsistent with HSE data and SHS 2003 data and were therefore excluded from the analysis.

Unfortunately, the questions about fruit and vegetable intake were only completed for children aged 5 or over and sample sizes were small. The data has been included in analyses of the HSE data set, but the reliability of the data is questionable.

Choosing a reliable measure of PA was a particular problem. No questions were asked on PA for adults in HSE 1995, 1996, 2000 and 2001. In 2002, only the 16-24 age group were questioned. A further problem was that, up to 1994, questions were based on 20 minute episodes of activity, whereas from 1997 they were based on 30 minute episodes. On the advice of NatCen, a variable was selected that grouped adults into 3 categories of PA, low, medium and high. This was based on the number of days per week where moderate or vigorous PA was undertaken for at least 30 minutes. For 'low' this was 0 or 1 day, 'medium' was 2 or 3 days and 'high' was 4 or more days. This variable was available in HSE 1998, 1999, 2003 and 2004 and in SHS 1998 and 2003.

Unfortunately, the data collected on PA in children varied in almost every year that questions were asked. This made it very difficult to find a consistent measure, and the variable that was recommended by NatCen was only available for HSE 2002 and 2004. This grouped children into three categories, those children doing 60+ minutes of activity every day, those doing 30-59 minutes of activity and those doing less than 30 minutes.

The ethnic origin of participants was collected each year, though the coding was not consistent. However, except for the years in which the sampling of ethnic minority groups was increased (HSE 1999 and 2004) there were too few participants in many ethnic groups for a useful analysis. Unfortunately, given difficulties in finding a weighting structure which would allow the ethnic-minority-boosted sample to be combined with the general population sample in these years, analyses were only possible on the general population (see Table 30). So, ethnic origin was not included in any analyses.

Data weighting

The use of data weights was necessary in all analyses in order to correct for the fact that the achieved samples did not accurately reflect the demographic structure of the population. The weighting strategy was informed by the technical reports on the HSE and SHS, together with direct correspondence with NatCen. A full description of the weighting procedures can be found in Appendix 1. The tables reporting the prevalence of obesity include unweighted sample sizes, while those reporting the results of logistic regression include weighted sample sizes: differences between weighted and unweighted samples sizes were not usually very great.

Methods of analysis

Analyses were undertaken using the statistical software STATA v9. Descriptive and inferential statistics used the appropriate data weights (see above). Logistic regression was chosen as the main form of inferential technique to describe the relationship between the three main binary outcomes (obesity, overweight and high WHR) and a number of explanatory variables (e.g. age, year, gender and the lifestyle factors). Results are given in the form of odds ratios and their associated 95% confidence intervals, adjusted to allow for the simultaneous effect of the other variables in the model.

Each section of the results (analysis of HSE, SHS and comparison of the two) follows a similar format. For each of the lifestyle factors, there is an overview of trends in the survey population followed by descriptive statistics and graphs showing population trends and percentages of the outcome measures. Finally, there is a detailed analysis of the association between each outcome measure and the demographic, time-period and lifestyle factors.

Given the difference in availability of data and the patterns seen in adults and children, separate models were fitted and reported for adults and children. In adults, all analyses resulted in a significant interaction with gender and therefore the results have been reported from separate models for men and women. In children, there were many analyses in which there was significant interaction with gender, so for consistency, separate models for boys and girls were fitted and reported throughout.

Age was categorised in the analysis rather than entered as a continuous variable. The relationships of the outcomes with age were not linear, and it was thought easier to interpret the odds ratios (in particular for interactions) associated with ordered categories rather than polynomials. For much of the analysis of HSE data, the years have been paired. Where there were only a few years' data available, they were separated.

Each logistic regression model includes the variables age-group and time-period and, usually, one of the lifestyle factors. From each model looking at main effects, several more models were analysed containing interaction terms. For example, a model containing age-group, time-period and social class led to further models including interactions between age group and time period, age group and social class, and time period and social class. All possible combinations of interactions were modelled, but only those that were statistically significant are reported. Wald tests were carried out to check for statistical significance of groups of dummy variables (e.g. those encompassing all levels of a factor such as age–group, or the interaction between factors). Main effects were considered statistically significant if $P<0.05$ and interactions if $P<0.01$.

A number of models were fitted for each outcome variable to maximise the sample size when considering each explanatory variable. For instance, the odds ratios of outcomes with age-group and survey period were available for all years and are estimated using data from all years. Whereas social class is only available from 1993, and the odds ratios for social class were estimated in a logistics regression on a smaller sample after adjusting for age group and survey period: the odds ratios for the explanatory variables, such as age group, are not reported from these analyses on smaller datasets.

Results

Health Survey for England: adults

Trends in overweight, obesity and waist hip ratio over time and by age group

Table 31 and Table 32 show the percentage of obese and overweight individuals and individuals with a high WHR, by year group and by age group in men and women. Since WHR data were excluded in 2004, the results for high waist hip ratio for the period 2003/4 only include data from 2003 in this and all subsequent tables.

Table 31: Percentage (unweighted sample size) of men obese, overweight and with high waist-hip ratio by age group and year (HSE)

	Survey years						
	1991/92	1993/94	1995/96	1997/98	1999/00	2001/02	2003/04*
Obese							
16-24	6.0 (465)	5.6 (1960)	6.2 (1782)	5.5 (1301)	8.0 (789)	9.8 (2310)	8.7 (941)
25-39	10.5 (922)	11.2 (4251)	13.2 (3998)	15.4 (2999)	19.1 (1843)	19.9 (2467)	20.6 (2177)
40-59	15.5 (1023)	16.8 (4609)	19.7 (4555)	21.3 (3482)	23.6 (2214)	24.8 (3251)	27.4 (2999)
60-74	16.6 (625)	17.8 (2672)	20.7 (2651)	21.6 (1877)	22.9 (1189)	26.9 (1741)	28.0 (1697)
75+	12.6 (223)	12.4 (839)	15.2 (959)	14.7 (626)	17.5 (429)	18.4 (606)	20.1 (596)
Overweight							
16-24	27.7 (465)	29.0 (1960)	30.0 (1782)	28.4 (1301)	28.4 (789)	35.1 (2310)	32.7 (941)
25-39	49.1 (922)	52.7 (4251)	56.2 (3998)	58.7 (2999)	61.7 (1843)	63.7 (2467)	63.8 (2177)
40-59	64.1 (1023)	67.5 (4609)	69.0 (4555)	72.2 (3482)	72.9 (2214)	75.1 (3251)	76.4 (2999)
60-74	65.4 (625)	70.4 (2672)	71.3 (2651)	75.0 (1877)	73.5 (1189)	77.3 (1741)	76.7 (1697)
75+	57.4 (223)	59.4 (839)	63.2 (959)	63.3 (626)	69.5 (429)	70.2 (606)	71.5 (596)
High waist-hip ratio*							
16-24		2.3 (1690)		2.3 (1101)		3.8 (1782)	4.0 (475)
25-39		11.3 (3875)		12.9 (2680)		17.9 (2068)	18.8 (1223)
40-59		30.6 (4215)		33.0 (3254)		40.6 (2887)	42.3 (1845)
60-74		44.8 (2431)		48.0 (1795)		55.4 (1617)	57.2 (1022)
75+		37.7 (759)		42.0 (666)		50.9 (618)	50.6 (397)

*High WHR data only available and reported for 2003

Table 32: Percentage (unweighted sample size) of women obese, overweight and with high waist-hip ratio by age group and year (HSE)

	Survey years						
	1991/92	1993/94	1995/96	1997/98	1999/00	2001/02	2003/04*
Obese							
16-24	6.8 (485)	8.1 (2041)	8.0 (2008)	10.1 (1413)	9.5 (821)	11.9 (2575)	13.3 (1082)
25-39	12.8 (1002)	13.6 (4651)	15.1 (4562)	17.0 (3420)	17.4 (2123)	20.4 (3154)	19.4 (2603)
40-59	20.7 (1099)	19.6 (4996)	20.4 (5089)	23.2 (3991)	23.7 (2543)	26.3 (3857)	25.8 (3651)
60-74	22.0 (728)	23.8 (3139)	25.4 (3010)	28.7 (2133)	29.8 (1304)	30.3 (1961)	30.3 (1992)
75+	18.2 (329)	16.2 (1441)	20.1 (1459)	21.1 (1027)	21.8 (611)	21.2 (884)	24.4 (897)
Overweight							
16-24	23.1 (485)	28.8 (2041)	27.3 (2008)	28.2 (1413)	30.6 (821)	34.0 (2575)	34.1 (1082)
25-39	35.3 (1002)	39.4 (4651)	42.2 (4562)	44.8 (3420)	46.0 (2123)	48.7 (3154)	49.2 (2603)
40-59	52.3 (1099)	54.9 (4996)	57.4 (5089)	58.8 (3991)	59.2 (2543)	61.9 (3857)	60.8 (3651)
60-74	60.4 (728)	63.9 (3139)	68.0 (3010)	69.4 (2133)	71.2 (1304)	69.4 (1961)	70.3 (1992)
75+	53.8 (329)	55.2 (1441)	59.6 (1459)	59.7 (1027)	62.7 (611)	63.3 (884)	66.5 (897)
High waist-hip ratio*							
16-24		3.4 (1823)		5.4 (1219)		8.6 (2059)	11.6 (605)
25-39		8.3 (4217)		9.6 (3079)		15.0 (2716)	20.3 (1489)
40-59		17.8 (4618)		20.4 (3726)		26.7 (3466)	31.2 (2186)
60-74		31.1 (2778)		32.5 (1972)		40.6 (1763)	45.1 (1151)
75+		45.6 (1237)		44.5 (1026)		53.2 (873)	53.4 (564)

*High WHR data only available and reported for 2003

The trends in obesity, overweight and high WHR are illustrated graphically in Figure 15. Table 33 summarises the results of the logistic regressions over time and age group for obese and overweight adults, and those with a high WHR. Note that the baseline for WHR comparisons in Table 33 is 1993/94, not 1991/92.

For men, there were significant increases in the prevalence of obesity, overweight and high WHR over time. The odds of the three outcomes differed significantly across survey years and age groups. The trend across age groups for men was similar for all outcome measures, with an increase in prevalence with age until the 60-74 age group followed by a drop in prevalence in the 75+ age group. In men, the odds ratios for being obese or overweight in 2003/04 compared to 1991/92 were 2.0 and 1.7 respectively, but the odds ratio for obesity 2003/04 to 1993/94 was 2.0.

For women, there were significant increases in the prevalence of all three outcomes over time. The trend across age-groups for women was similar to that in men for obesity and overweight: an increase in prevalence until the 60-74 age-group followed by a drop in the 75+ age-group. However, for central obesity, the prevalence of high WHR continued to increase in women in the 75+ age group. In women, the odds ratios for being overweight or obese in 2003/04 compared to 1991/92 were similar at 1.5, but the odds ratio for a high WHR comparing 2003/04 to 1993/94 was 2.1.

Women had a higher prevalence of obesity in 1991/92 than men and there was a significant interaction between gender and year ($p<0.001$), in that this difference gradually decreased throughout the survey period. In contrast, men had a higher prevalence of being overweight throughout 1991-2004, and their increase over time was slightly greater than that of women, but this was not statistically significant ($p=0.06$). Interactions between gender and age group were significant for all three outcomes ($p<0.001$): the increase in prevalence of obesity, overweight and high WHR with age was stronger in men than women. There was a significant interaction between survey year and age group for women with a high WHR (p<0.001): the differing time trends in the age-groups are illustrated in Figure 16.

Table 33: Adjusted odds ratios (95% confidence intervals) for obesity, overweight and high waist-hip ratio among adult men and women for by age group and survey year (HSE)

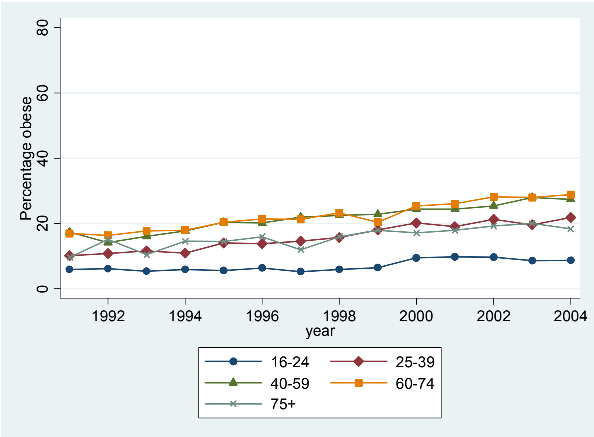
	Men	Women
	OR* (95%CI)	OR* (95%CI)
Obese		
Period	*[n=67065, P<0.001]* †	*[n=77927, P<0.001]* †
91/92	1	1
93/94	1.07 (0.95-1.20)	1.02 (0.92-1.12)
95/96	1.29 (1.15-1.44)	1.11 (1.01-1.23)
97/98	1.41 (1.25-1.58)	1.30 (1.18-1.44)
99/00	1.67 (1.48-1.89)	1.34 (1.21-1.49)
01/02	1.85 (1.65-2.08)	1.51 (1.37-1.67)
03/04	2.00 (1.78-2.25)	1.51 (1.36-1.66)
Age group	*[n=67065, P<0.001]* †	*[n=77927, P<0.001]* †
16-24	1	1
25-39	2.45 (2.24-2.69)	1.85 (1.72-2.00)
40-59	3.61 (3.31-3.95)	2.72 (2.53-2.93)
60-74	3.81 (3.47-4.18)	3.49 (3.24-3.77)
75+	2.50 (2.22-2.81)	2.37 (2.17-2.60)
Overweight		
Period	*[n=67065, P<0.001]* †	*[n=77927, P<0.001]* †
91/92	1	1
93/94	1.16 (1.07-1.25)	1.16 (1.08-1.25)
95/96	1.27 (1.17-1.38)	1.29 (1.20-1.39)
97/98	1.41 (1.30-1.53)	1.38 (1.28-1.49)
99/00	1.49 (1.36-1.63)	1.46 (1.35-1.59)
01/02	1.72 (1.58-1.87)	1.58 (1.46-1.71)
03/04	1.73 (1.59-1.89)	1.59 (1.47-1.72)
Age group	*[n=67065, P<0.001]* †	*[n=77927, P<0.001]* †
16-24	1	1
25-39	3.18 (3.01-3.36)	1.85 (1.76-1.95)
40-59	5.69 (5.39-6.00)	3.29 (3.13-3.46)
60-74	6.29 (5.92-6.68)	5.00 (4.72-5.29)
75+	4.25 (3.93-4.59)	3.58 (3.35-3.82)
High waist-hip ratio		
Period	*[n=36560, P<0.001]* †	*[n=42584, P<0.001]* †
93/94	1	1
97/98	1.14 (1.07-1.21)	1.12 (1.05-1.20)
01/02	1.59 (1.49-1.70)	1.65 (1.55-1.76)
03	1.70 (1.57-1.83)	2.06 (1.92-2.22)
Age group	*[n=36560, P<0.001]* †	*[n=42584, P<0.001]* †
16-24	1	1
25-39	5.68 (4.73-6.81)	2.03 (1.79-2.31)
40-59	18.65 (15.62-22.27)	4.41 (3.91-4.96)
60-74	34.41 (28.74-41.20)	8.51 (7.54-9.61)
75+	26.91 (22.22-32.58)	14.30 (12.55-16.28)

* Separate logistic regressions for each outcome by gender with survey year and age group

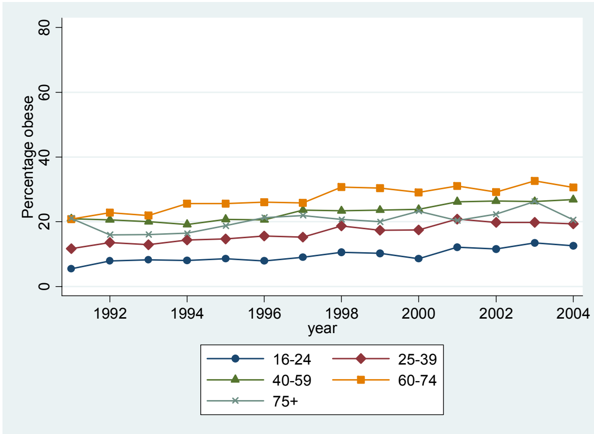
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Figure 15: Prevalence of obesity, overweight and high waist-hip ratio among adults by age group and survey year (HSE)

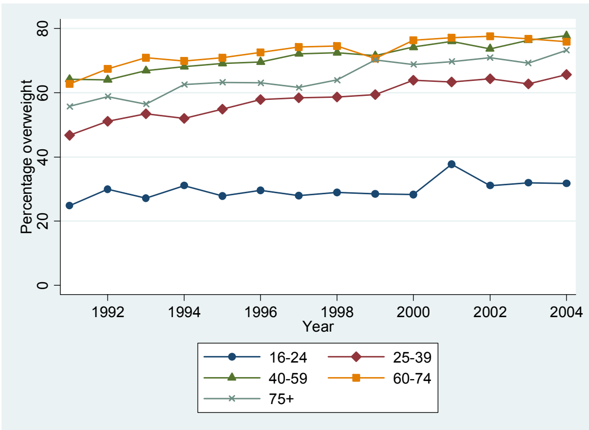
Obesity - HSE men



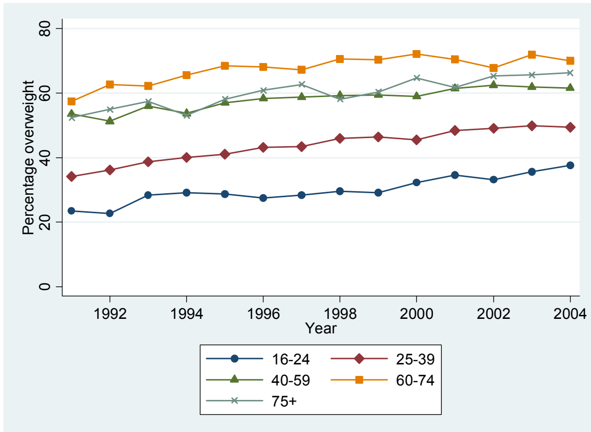
Obesity - HSE women



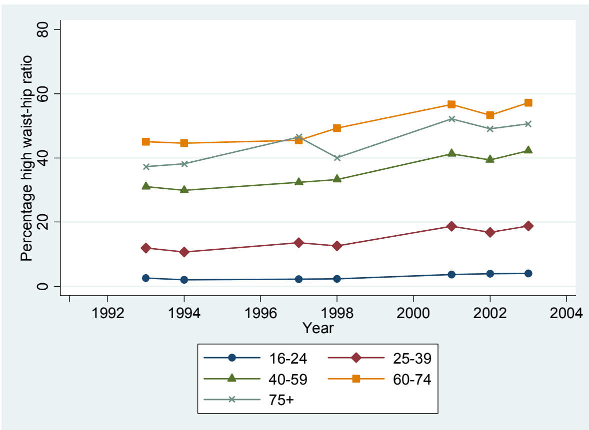
Overweight - HSE men



Overweight - HSE women



High waist-hip ratio - HSE men



High waist-hip ratio - HSE women

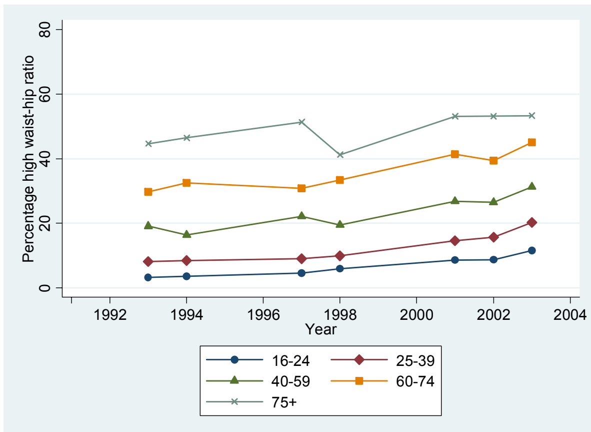
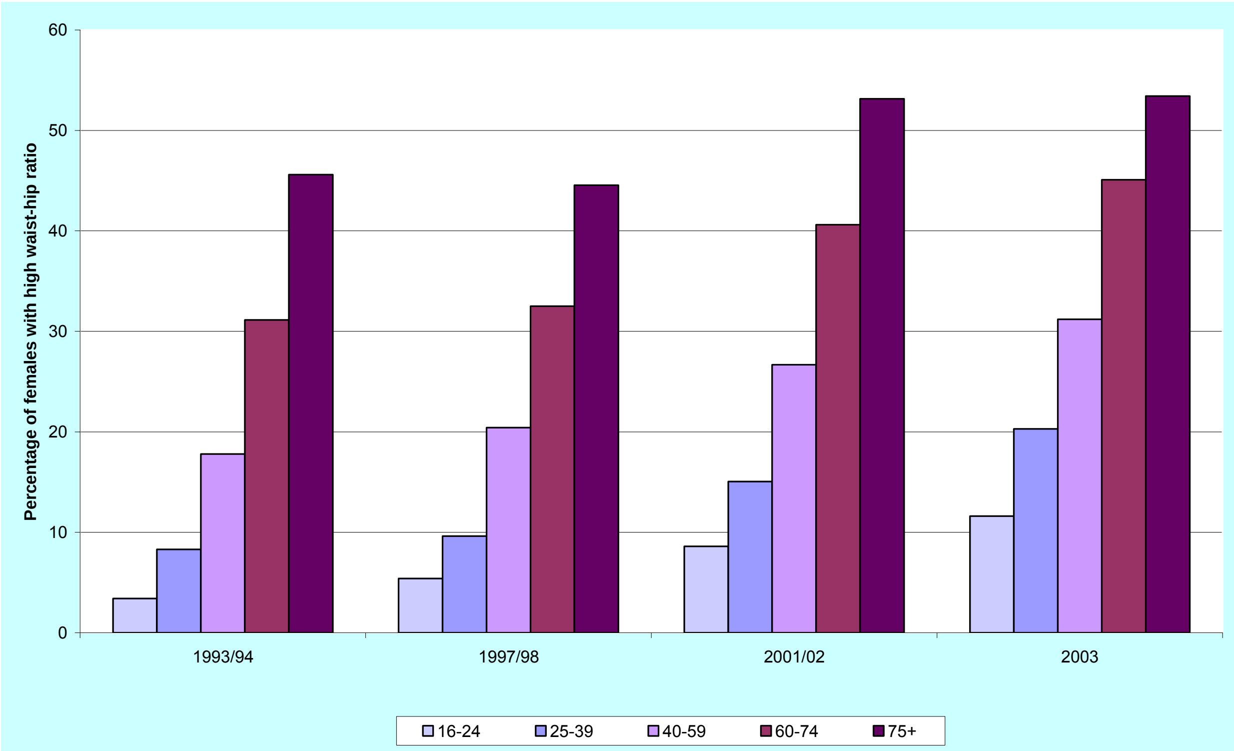


Figure 16: Interaction between age group and year of survey for high waist-hip ratio in women (HSE)

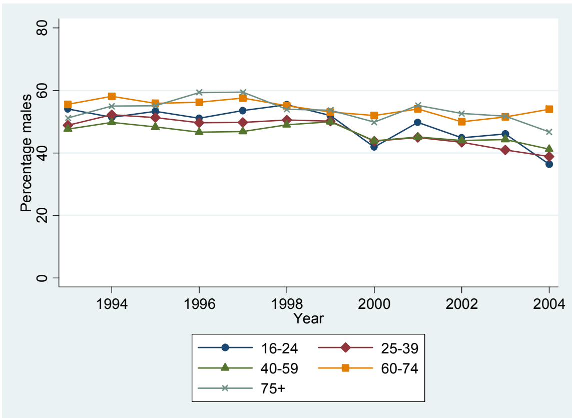


Trends in measures of socio-economic position

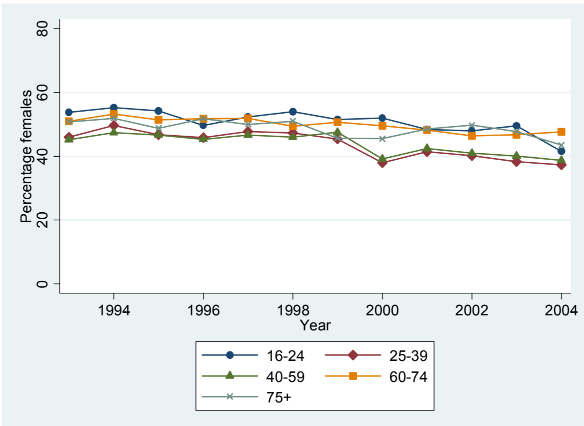
Results are first presented for SEP measured by social class and then for educational attainment. The proportions of men and women in the manual social class slowly decreased over time (Figure 17). The noticeable fluctuations in 2000 may be because this was the year that the new Registrar General's Standard Occupational Classification was introduced. It can also be seen that there is a higher proportion of men in the manual class in older age groups and a higher proportion of women in the manual class in both the older and youngest age groups.

Figure 17: Percentage of adults in manual social class group by age group and survey year (HSE)

HSE men



HSE women



Associations between obesity, overweight and high waist-hip ratio and socio-economic position

Table 34 shows prevalence of obesity, overweight and high WHR for men and women in each social class group.

Table 34: Percentage (unweighted sample size) of adults with obesity, overweight and high waist-hip ratio by social class group and survey year (HSE)

	Survey years					
	1993/94	1995/96	1997/98	1999/2000	2001/02	2003/04*
Men						
Obese						
Non-manual	12.6 (6745)	15.1 (6533)	16.0 (4917)	19.0 (3278)	20.1 (5382)	21.7 (4583)
Manual	14.9 (7089)	17.5 (6804)	18.8 (5111)	20.7 (3055)	23.6 (4727)	25.0 (3690)
Overweight						
Non-manual	58.2 (6745)	61.2 (6533)	63.0 (4917)	64.2 (3278)	67.5 (5382)	68.2 (4583)
Manual	58.8 (7089)	61.4 (6804)	63.1 (5111)	64.4 (3055)	67.8 (4727)	67.7 (3690)
High waist-hip ratio*						
Non-manual	21.5 (6163)		23.7 (4541)		32.0 (4674)	32.8 (2695)
Manual	27.9 (6378)		31.1 (4723)		32.7 (2810)	41.7 (2189)
Women						
Obese						
Non-manual	13.5 (7807)	14.6 (7813)	17.4 (5987)	18.4 (3927)	19.5 (6712)	20.0 (5761)
Manual	21.0 (7503)	22.5 (7262)	24.6 (5598)	24.7 (3205)	28.3 (5276)	28.8 (4179)
Overweight						
Non-manual	44.7 (7807)	48.1 (7813)	49.7 (5987)	51.7 (3927)	52.0 (6712)	53.6 (5761)
Manual	53.4 (7503)	56.4 (7262)	57.5 (5598)	58.3 (3205)	62.9 (5276)	62.8 (4179)
High waist-hip ratio*						
Non-manual	15.4 (7161)		17.3 (5524)		23.0 (5948)	27.0 (3396)
Manual	21.6 (6753)		22.9 (5136)		31.5 (4562)	37.2 (2436)

* High WHR data only available and reported for 2003

Figure 18 shows the results of the table graphically. Odds ratios for obesity, overweight and high WHR with social class are shown in Table 36.

Figure 18: Prevalence of obesity, overweight and high waist-hip ratio among adults by social class group and survey year (HSE)

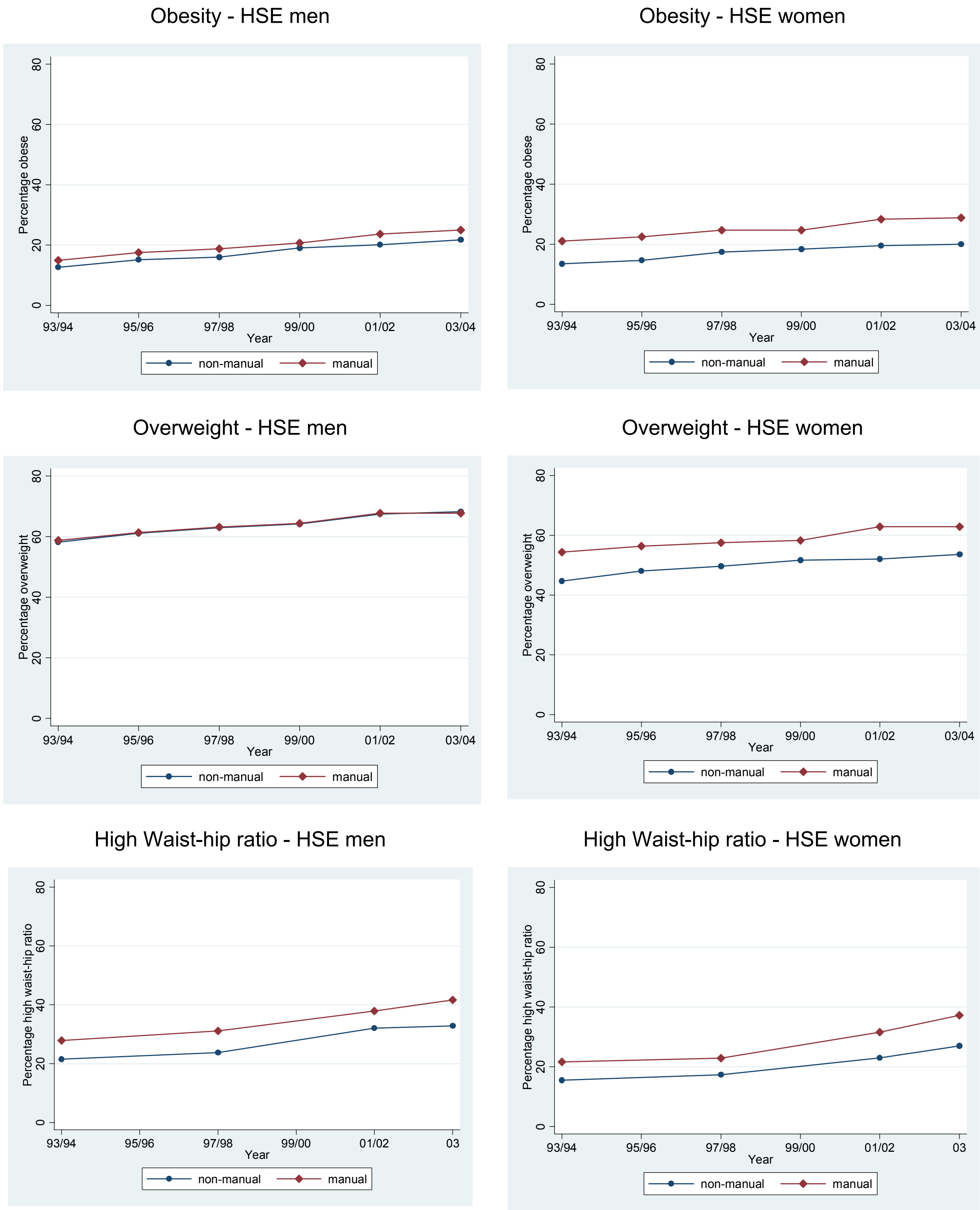


Figure 18, Table 34 and Table 36 show that prevalence of obesity, overweight and high WHR was higher among men and women in the manual compared to the non-manual social class group throughout the survey period: though the difference in overweight was minimal in men and not statistically significant.

Table 35: Percentage (unweighted sample size) of adults with obesity, overweight and high waist-hip ratio by educational attainment and survey year (HSE)

	Survey years						
	1991/92	1993/94	1995/96	1997/98	1999/00	2001/02	2003/04*
Men							
Obese							
Left School>16	10.4 (904)	10.7 (4377)	13.0 (4310)	13.7 (3259)	16.7 (2144)	17.6 (3520)	18.8 (3031)
Left School<=16	14.4 (2194)	15.6 (9287)	18.3 (8898)	19.6 (6434)	22.7 (3896)	25.1 (5692)	26.9 (4834)
Overweight							
Left School>16	47.7 (904)	53.5 (4377)	57.1 (4310)	58.9 (3259)	61.0 (2144)	63.1 (3520)	65.6 (3031)
Left School<=16	59.5 (2194)	62.5 (9287)	64.8 (8898)	67.3 (6434)	68.9 (3896)	72.5 (5692)	72.0 (4834)
High waist-hip ratio*							
Left School>16		15.1 (3988)		19.2 (2941)		24.7 (3026)	28.0 (1742)
Left School<=16		30.0 (8396)		32.8 (6037)		42.3 (5003)	43.7 (2923)
Women							
Obese							
Left School>16	8.9 (1016)	12.3 (4945)	13.8 (4943)	16.4 (3743)	17.2 (2480)	18.1 (4338)	18.4 (3756)
Left School<=16	20.6 (2462)	19.9(10628)	21.3(10396)	23.5 (7575)	24.3 (4474)	27.4 (6745)	28.1 (5791)
Overweight							
Left School>16	52.4 (2462)	54.7(10628)	57.5(10396)	58.5 (7575)	60.7 (4474)	62.9 (6745)	64.8 (5791)
Left School<=16	33.0 (1016)	40.0 (4945)	43.6 (4943)	45.8 (3743)	46.8 (2480)	49.1 (4338)	48.8 (3756)
High waist-hip ratio*							
Left School>16		10.8 (4507)		12.8 (3435)		18.3 (3825)	22.2 (2187)
Left School<=16		22.6 (9533)		24.8 (7002)		32.8 (5928)	38.0 (3419)

* High WHR data only available and reported for 2003

All possible interactions between factors were tested for each outcome. There was little evidence of a widening gap over time between the non-manual and manual social class groups for either men or women for any outcome (i.e. no significant interaction between year of survey and social class group (p>0.01)). There was a significant interaction between gender and social class group (p<0.001) for two outcomes: the difference between the social class groups was wider in women than men, both for obese and overweight. There was also a significant interaction between age group and social class group for being overweight in women (p<0.001) which is illustrated in Figure 19. Figure 20 illustrates the significant interaction between age and social class groups for having high WHR in women: the gap between the manual and non-manual group was wider in the middle age groups.

Figure 19: Interaction between age group and social class for being overweight in women (HSE)

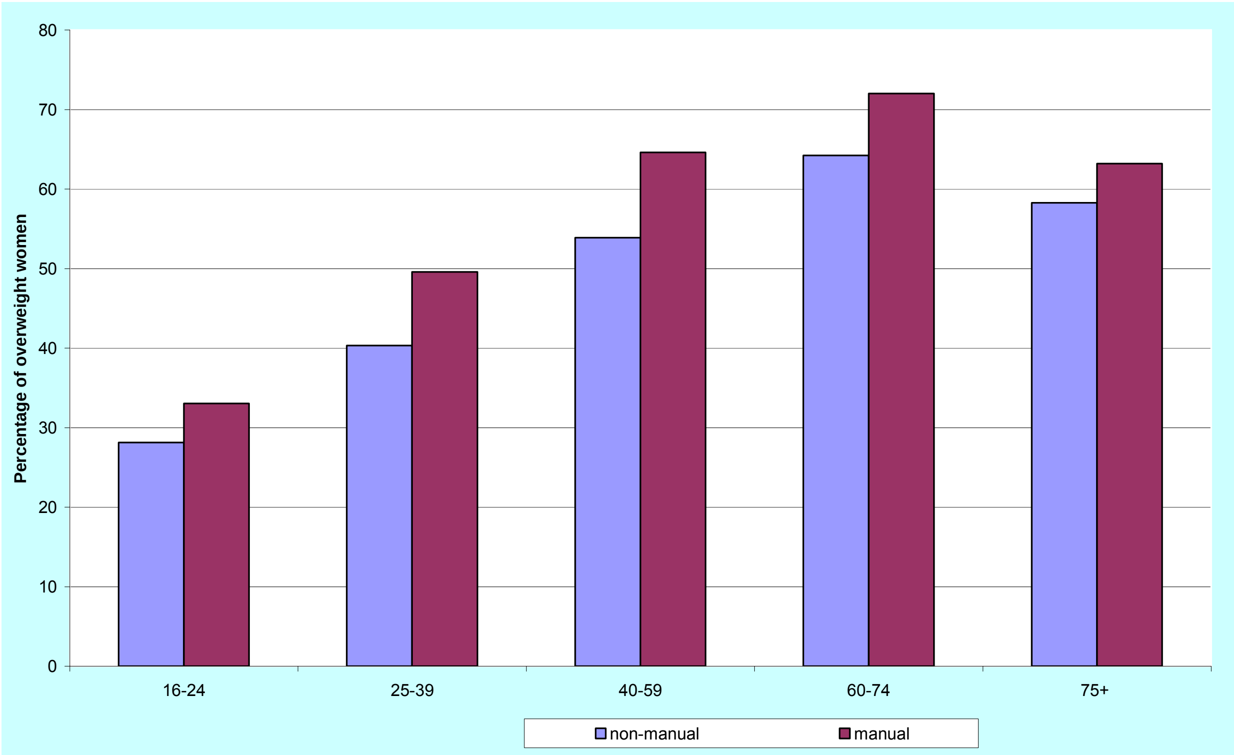
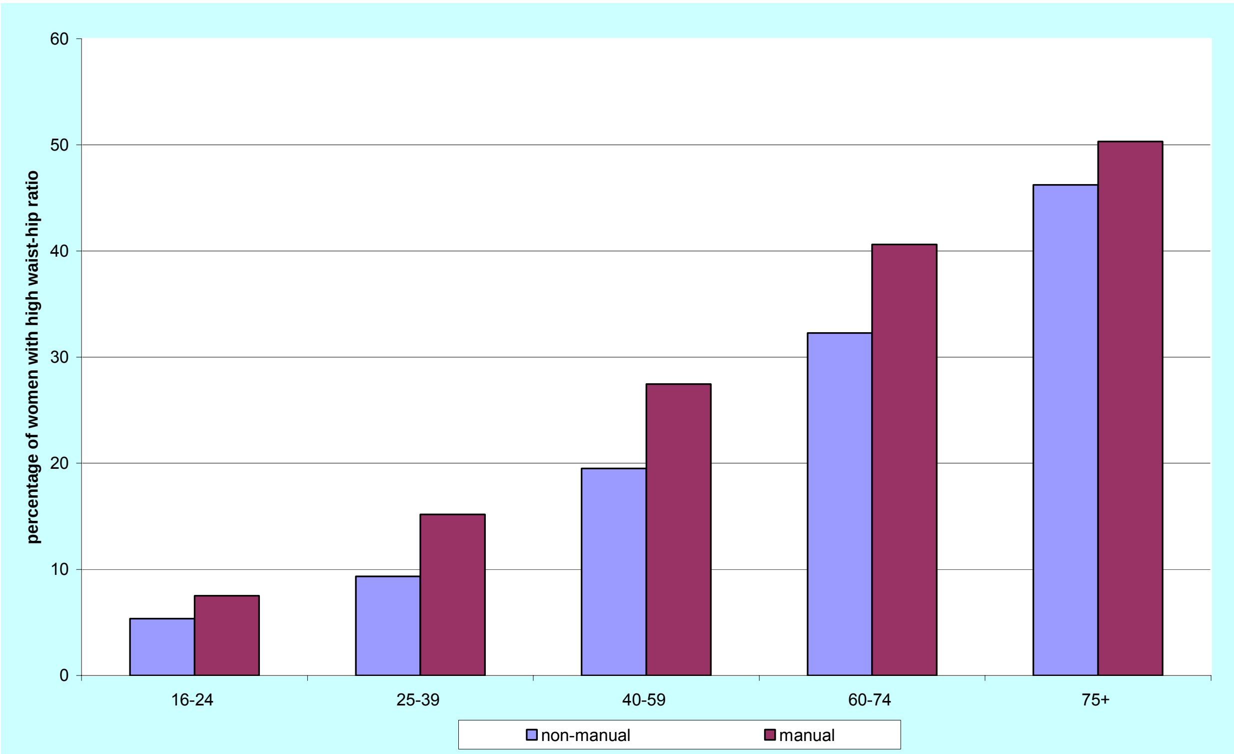


Figure 20: Interaction between age and social class group for having high waist-hip ratio in women (HSE)



The prevalence of obese and overweight adults and those having a high WHR in the two educational attainment groups is shown in Table 35 and are illustrated graphically in Figure 21. These show that there was a higher prevalence of obesity, overweight and high WHR in adults leaving school aged 16 or younger, compared with those leaving school after 16, in both men and women.

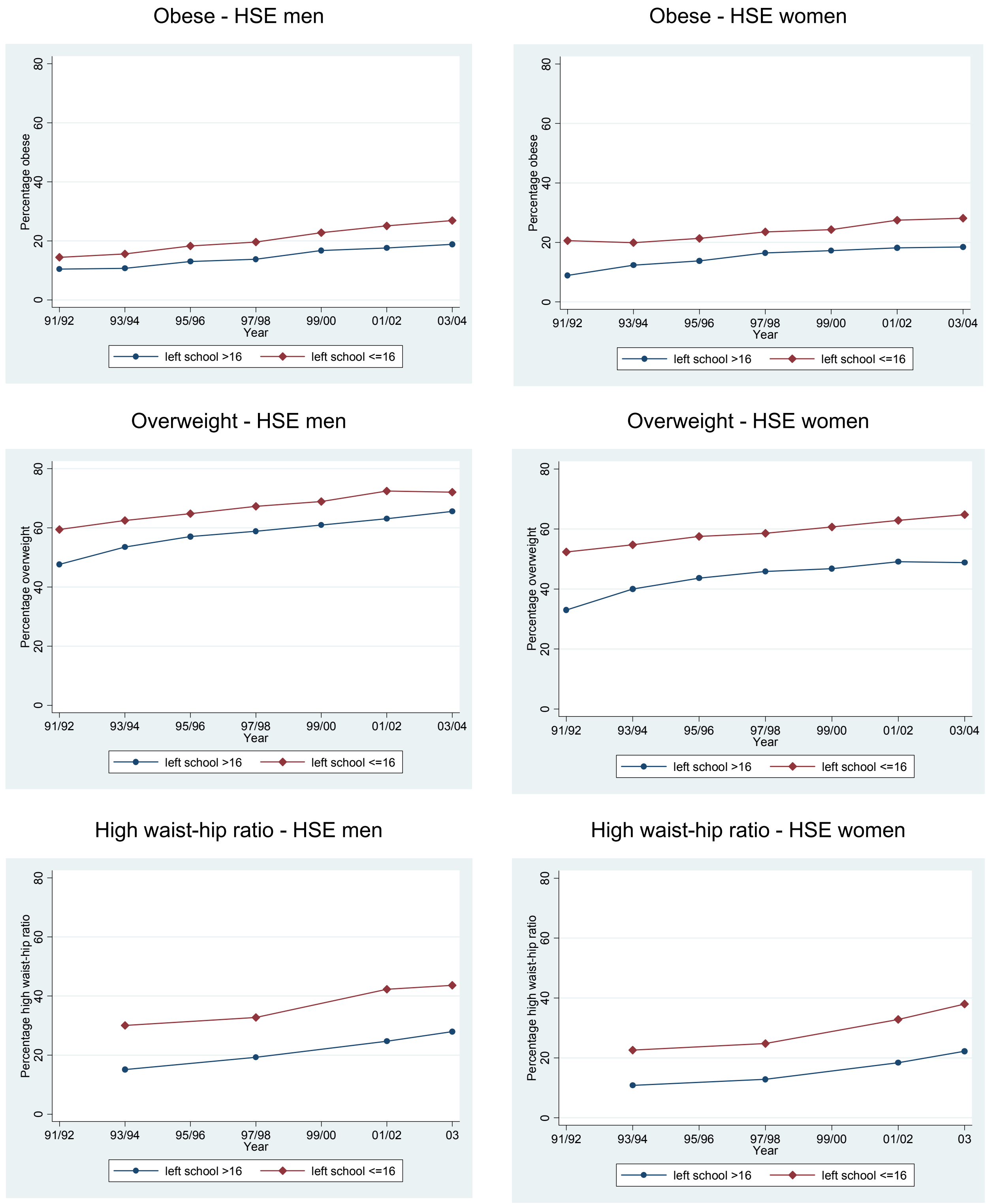
Odds ratios for educational attainment with obesity, overweight and high WHR are shown in Table 36. There was a significantly higher prevalence of obesity and overweight and a high WHR in those leaving school aged 16 or younger compared to those leaving later, among both men and women.

Table 36: Adjusted odds ratios for obesity, overweight and high waist-hip ratio, by social class and educational attainment (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Obese		
SEP	*[n=61960, P<0.001]*†	*[n=70930, P<0.001]*†
Non-manual	1	1
Manual	1.2 (1.15-1.25)	1.64 (1.58-1.70)
Age left school	*[n=63146, P<0.001]*†	*[n=73590, P<0.001]*†
Over 16	1	1
16 or younger	1.44 (1.37-1.51)	1.53 (1.47-1.60)
Overweight		
SEP	*[n=61960, P<0.711]*†	*[n=70930, P<0.001]*†
Non-manual	1	1
Manual	1.01 (0.97-1.04)	1.46 (1.42-1.51)
Age left School	*[n=63146, P<0.001]*†	*[n=73590, P<0.001]*†
Over 16	1	1
16 or younger	1.26 (1.21-1.30)	1.47 (1.43-1.52)
High waist-hip ratio		
SEP	*[n=35658, P<0.001]*†	*[n=40226, P<0.001]*†
Non-manual	1	1
Manual	1.39 (1.32-1.46)	1.54 (1.46-1.62)
Age left school	*[n=34496, P<0.001]*†	*[n=40451, P<0.001]*†
Over 16	1	1
16 or younger	1.62 (1.53-1.72)	1.56 (1.47-1.65)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age group, firstly for social class, and then for education group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Figure 21: Prevalence of obesity, overweight and high waist-hip ratio among adults by educational attainment and survey year (HSE)



All possible interactions between factors were tested for each outcome. There was little evidence of a widening gap over time between the educational groups for either men or women for any outcome ($p>0.01$). The difference between the educational groups was much wider in women than men, both for obesity and overweight ($p<0.001$). The trends over time were similar for educational groups for most outcomes. The exception was for obesity in women where there was a significant interaction between year and educational group. There was a slightly stronger upward trend in obesity in those who left school earlier ($p=0.0085$): this is illustrated in Figure

22. The significant interactions between educational group and age group for being overweight in men and women are shown in Figure 23 and Figure 24 ($p<0.001$). Figure 23 shows that there was a higher prevalence of overweight men who stayed in education after 16 in the lowest age group, whereas in all other age groups those leaving school early had the highest prevalence of overweight individuals. For women, Figure 24 shows that the gap between educational groups was smallest in the youngest age group.

Figure 22: Interaction between educational attainment and survey years for obesity in women (HSE)

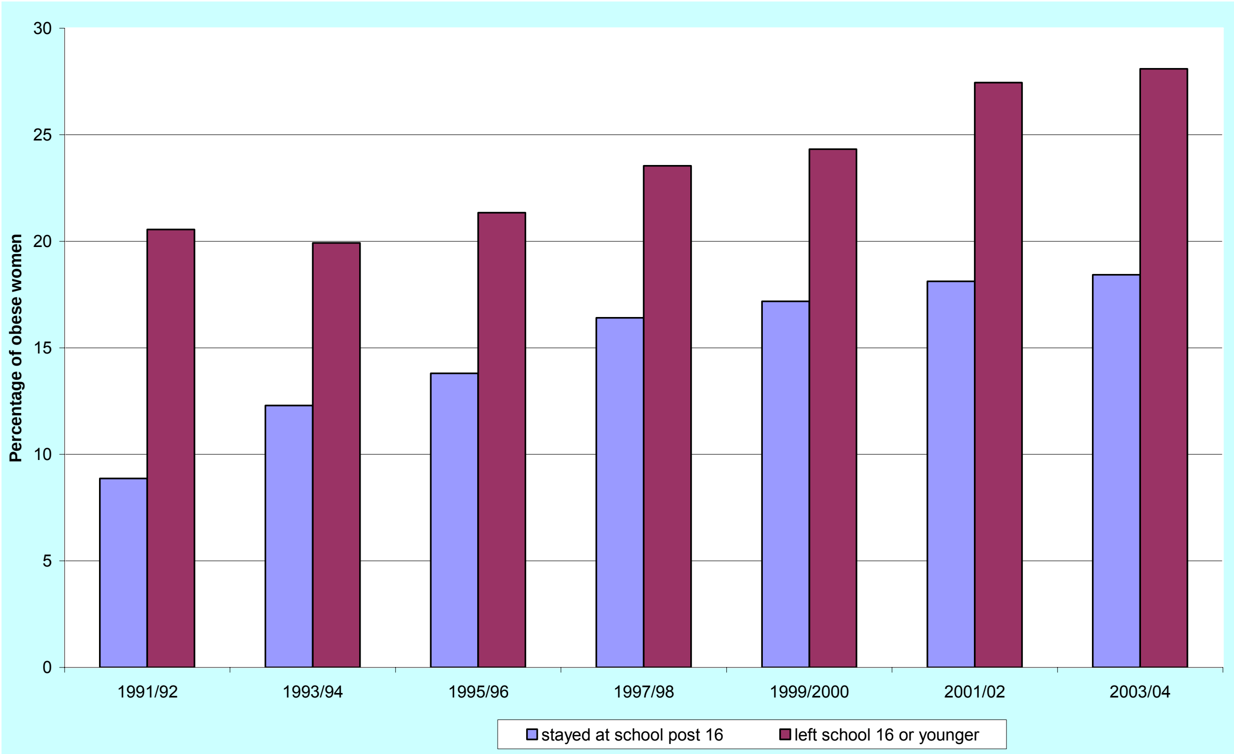


Figure 23: Interaction between age group and educational attainment for being overweight in men (HSE)

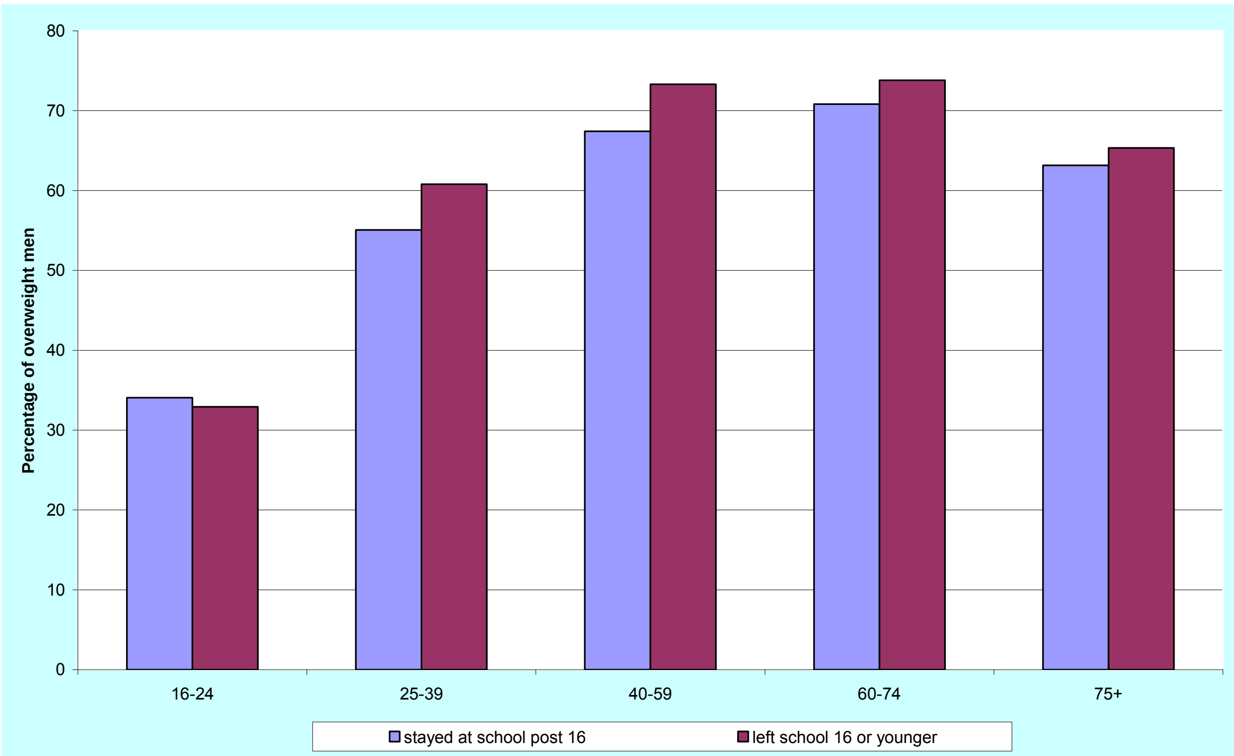
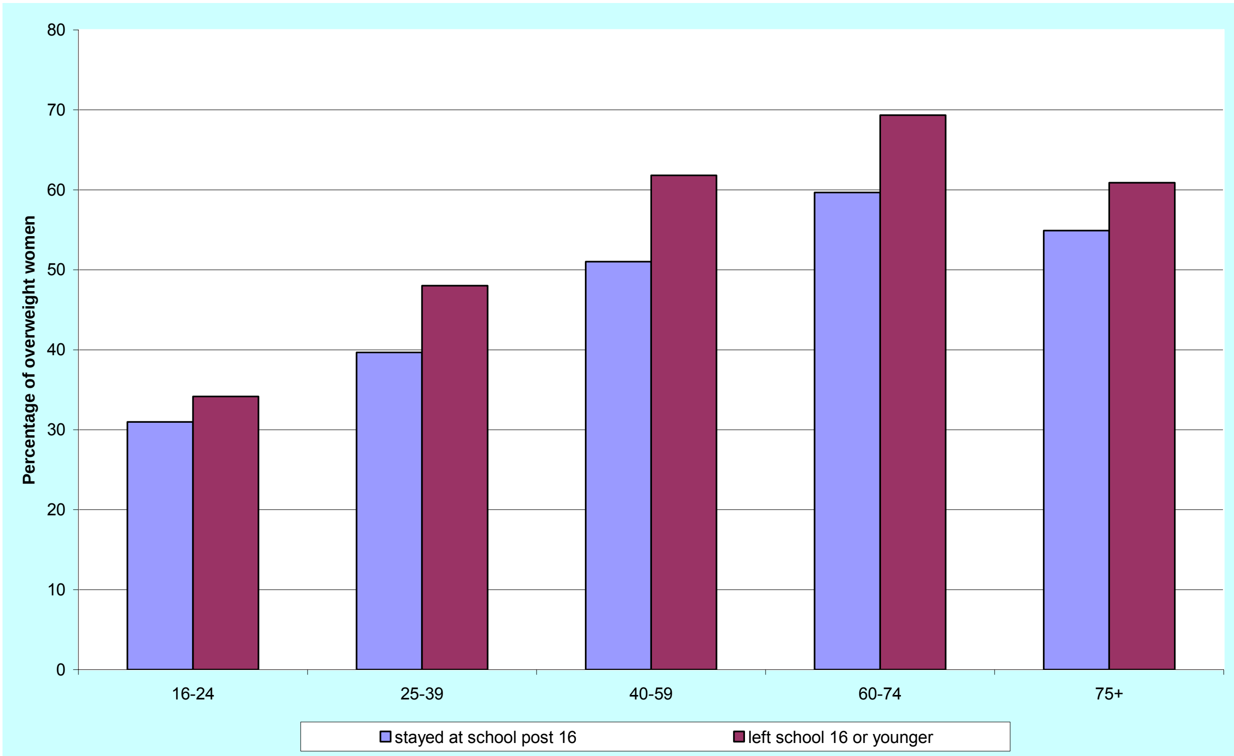


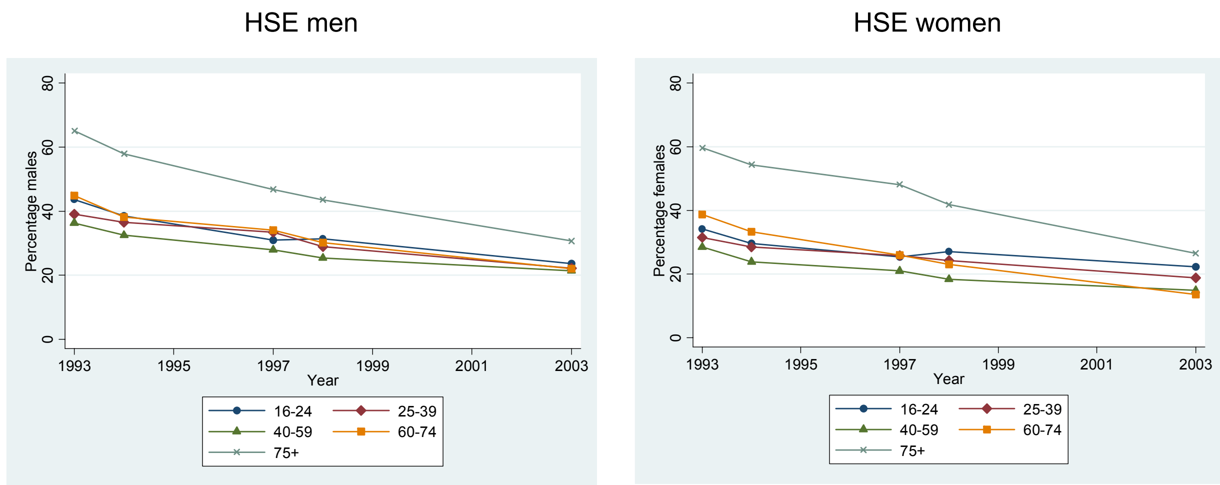
Figure 24: Interaction between age group and educational attainment for being overweight in women (HSE)



Trends in dietary measures

Figure 25 shows a clear decrease over time in the proportion of men and women who consumed whole milk in every age group. There were significant differences in the proportions of both men and women consuming whole milk by both survey year and age group. The 75+ age group had the highest consumption in every year, although over time, the differences between the age groups converged: this interaction between year and age group was significant (p=0.01) in both men and women.

Figure 25: Whole milk consumption among adults by age group and survey year (HSE)



Odds ratios from logistic regressions of milk consumption with survey year, age and social class group are shown in Table 37. The associations with social class were highly significant for both men and women, and are illustrated graphically in Figure 26. The manual social class group had a higher prevalence of drinking whole milk than the non-manual group in both men and women.

Figure 26: Whole milk consumption among adults by social class group and survey year (HSE)

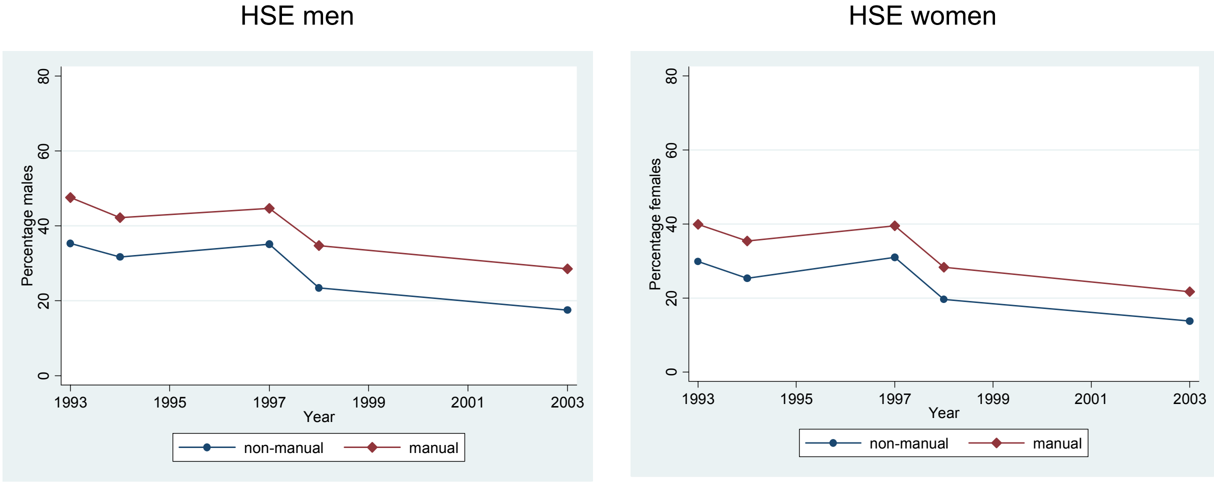


Table 37: Adjusted odds ratios for consumption of whole milk by survey year, age group and social class group (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Period	*[n=28598, P<0.001]†*	*[n=33571, P<0.001]†*
1993	1	1
1994	0.82 (0.76-0.88)	0.8 (0.75-0.85)
1997	0.65 (0.6-0.71)	0.66 (0.61-0.72)
1998	0.56 (0.52-0.6)	0.57 (0.53-0.61)
2003	0.41 (0.37-0.44)	0.39 (0.36-0.42)
Age group	*[n=28598, P<0.001]†*	*[n=33571, P<0.001]†*
16-24	1	1
25-39	0.91 (0.84-1)	0.93 (0.85-1.01)
40-59	0.79 (0.73-0.86)	0.74 (0.68-0.8)
60-74	0.98 (0.9-1.08)	1.01 (0.92-1.1)
75+	1.91 (1.7-2.13)	2.36 (2.13-2.61)
Social Class	*[n=28598, P<0.001]†*	*[n=33571, P<0.001]†*
Non-manual	1	1
Manual	1.67 (1.59-1.76)	1.61 (1.53-1.69)

* Separate logistic regressions by gender adjusting for other factors in the model
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Logistic regression analyses with eating ≥ 4 portions of fruit and vegetables daily as the binary outcome variable were run separately for men and women (Table 38). For both men and women, there were no significant changes over time but the age effect was highly significant. Figure 27 illustrate these patterns graphically.

Figure28 illustrates the effect of social class group. In men the non-manual class had the higher proportion who consumed ≥ 4 portions of fruit and vegetables daily, but there was no significant difference in fruit and vegetable consumption between the social class groups in women.

Figure 27: Consumption of ≥ 4 portions of fruit and vegetables among adults by age group and survey year (HSE)

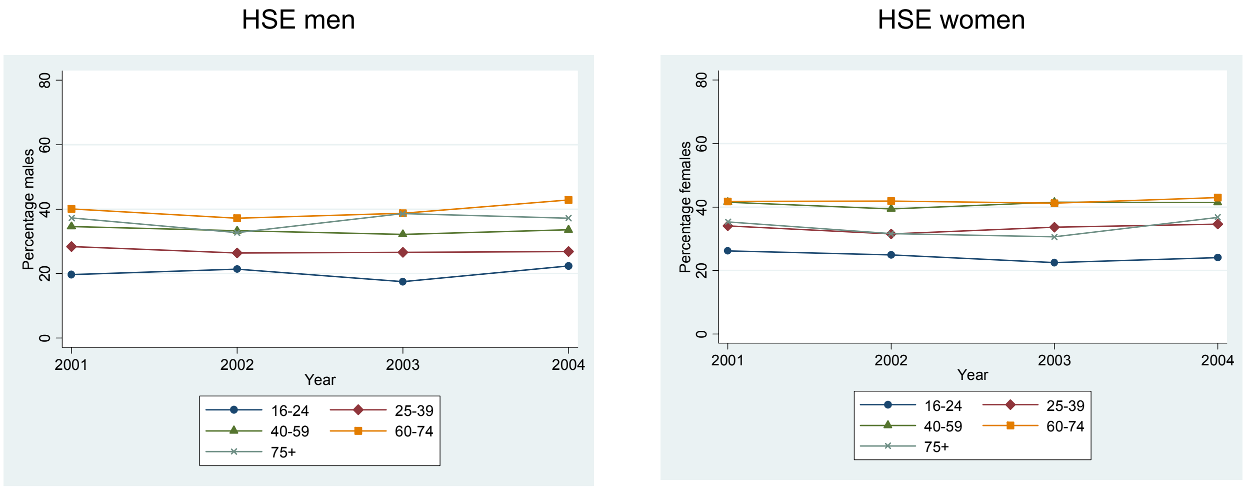


Figure 28: Consumption of ≥ 4 portions of fruit and vegetables among adults by social class group and survey year (HSE)

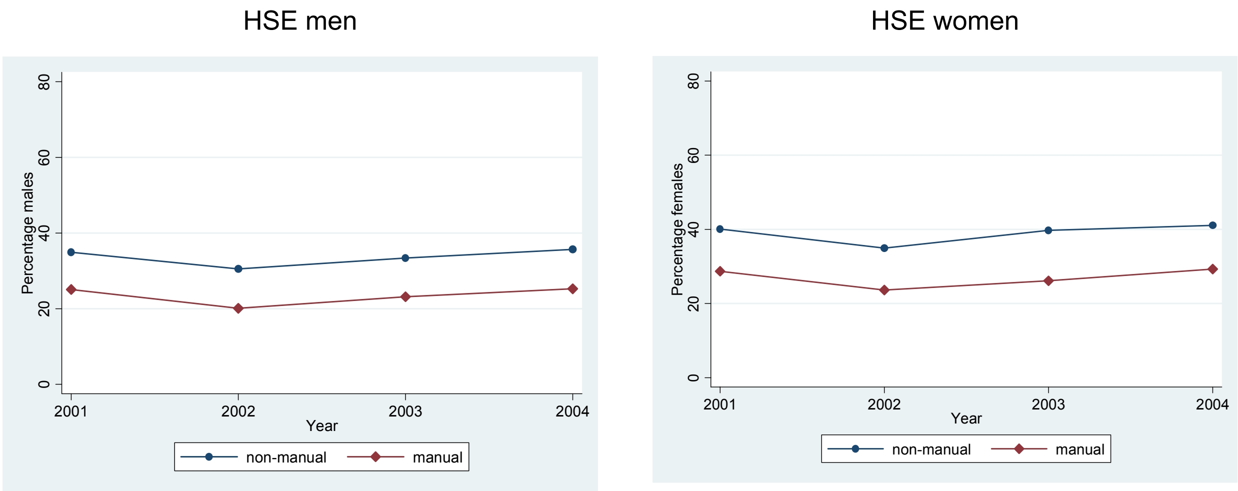


Table 38: Adjusted odds ratios for consumption of ≥ 4 portions of fruit and vegetables by survey year, age group and social class group (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Period	*[n=20586, P=0.7577]* †	*[n=25491, P=0.1322]* †
2001	1	1
2002	1.03 (0.94-1.13)	1.01 (1.01-1.18)
2003	1.03 (0.96-1.11)	1.01 (0.95-1.08)
2004	1.05 (0.95-1.15)	0.99 (0.91-1.08)
Age group	*[n=20586, P<0.001]* †	*[n=25491, P<0.001]* †
16-24	1	1
25-39	1.09 (0.98-1.21)	1.14 (1.04-1.25)
40-59	1.24 (1.12-1.37)	1.17 (1.07-1.28)
60-74	1.34 (1.2-1.49)	1.21 (1.09-1.33)
75+	1.50 (1.31-1.71)	1.52 (1.36-1.7)
Social Class	*[n=20586, P<0.001]* †	*[n=25491, P=0.259]* †
Non-manual	1	1
Manual	0.89 (0.84-0.95)	0.97 (0.92-1.02)

* Separate logistic regressions by gender adjusting for other factors in the model
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Associations between obesity, overweight and high waist-hip ratio and dietary measures

The prevalence of obesity, overweight and high WHR in adults by the type of milk they usually consumed is shown in Table 39.

Table 39: Percentage (unweighted sample size) of adult men and women obese, overweight and with high waist-hip ratio by survey year and by type of milk regularly consumed (HSE)

	Survey years				
	1993	1994	1997	1998	2003
Men					
Obese					
Whole milk	11.2 (2923)	12.7 (2415)	13.5 (1115)	15.1 (1823)	17.8 (990)
Semi-skimmed	14.0 (3201)	13.5 (3276)	18.3 (1981)	18.1 (3716)	24.2 (2907)
Skimmed	16.3 (927)	18.1 (855)	19.8 (424)	20.8 (756)	27.5 (560)
Overweight					
Whole milk	51.8 (2923)	52.7 (2415)	56.7 (1115)	54.8 (1823)	60.2 (990)
Semi-skimmed	61.0 (3201)	60.2 (3276)	63.5 (1981)	65.4 (3716)	71.2 (2907)
Skimmed	66.3 (927)	66.8 (855)	72.6 (424)	73.1 (756)	75.5 (560)
High Waist-hip ratio					
Whole milk	24.3 (2589)	23.3 (2188)	27.3 (1023)	28.5 (1670)	34.9 (1041)
Semi-skimmed	23.8 (2947)	22.7 (2995)	25.5 (1840)	26.1 (3461)	35.9 (3010)
Skimmed	29.1 (841)	26.7 (775)	31.2 (388)	32.3 (691)	41.8 (594)
Women					
Obese					
Whole milk	14.3 (2698)	14.6 (2302)	16.3 (1023)	18.9 (1731)	19.7 (904)
Semi-skimmed	16.0 (3695)	17.1 (3990)	19.9 (2343)	20.6 (4353)	23.2 (3437)
Skimmed	20.7 (1447)	22.8 (1335)	22.8 (685)	25.8 (1231)	28.9 (962)
Overweight					
Whole milk	45.3 (2698)	43.3 (2302)	46.0 (1023)	47.8 (1731)	49.0 (904)
Semi-skimmed	47.7 (3695)	49.6 (3990)	53.2 (2343)	53.2 (4353)	57.8 (3437)
Skimmed	58.3 (1447)	58.0 (1335)	59.6 (685)	62.3 (1231)	67.2 (962)
High Waist-hip ratio					
Whole milk	21.6 (2363)	23.2 (2052)	25.0 (927)	24.4 (1593)	34.5 (961)
Semi-skimmed	15.1 (3400)	16.2 (3617)	19.2 (2132)	18.6 (4013)	30.0 (3587)
Skimmed	18.1 (1306)	16.3 (1228)	17.4 (632)	19.0 (1166)	33.4 (1026)

Figure 29 shows the prevalence of obesity and overweight among men and women (analysed separately) by the type of milk they consumed. The highest prevalence of obesity and overweight is among men and women who consumed skimmed milk and the lowest in those who consumed whole milk; these associations between obesity and overweight and milk type were significant for both men and women.

From Figure 29 and the odds ratios in Table 40, it can be seen that there was little difference in the prevalence of a high WHR between the milk types consumed for both men and women. The prevalence of high WHR was highest in men who consumed skimmed milk, and lowest in those who consumed whole milk. In women, the prevalence of high WHR was greatest among those who consumed whole milk and lowest among those who consumed semi-skimmed milk.

The interactions between all factors in the model were tested. There were significant interactions between age group and type of milk for obesity in men (p=0.0012) and women (p=0.0122) and being overweight in women (p=0.0027). These interactions are illustrated in Figure 30, Figure 31 and Figure 32.

Figure 29: Prevalence of obesity, overweight and high waist-hip ratio among adults by type of milk consumed and survey year (HSE)

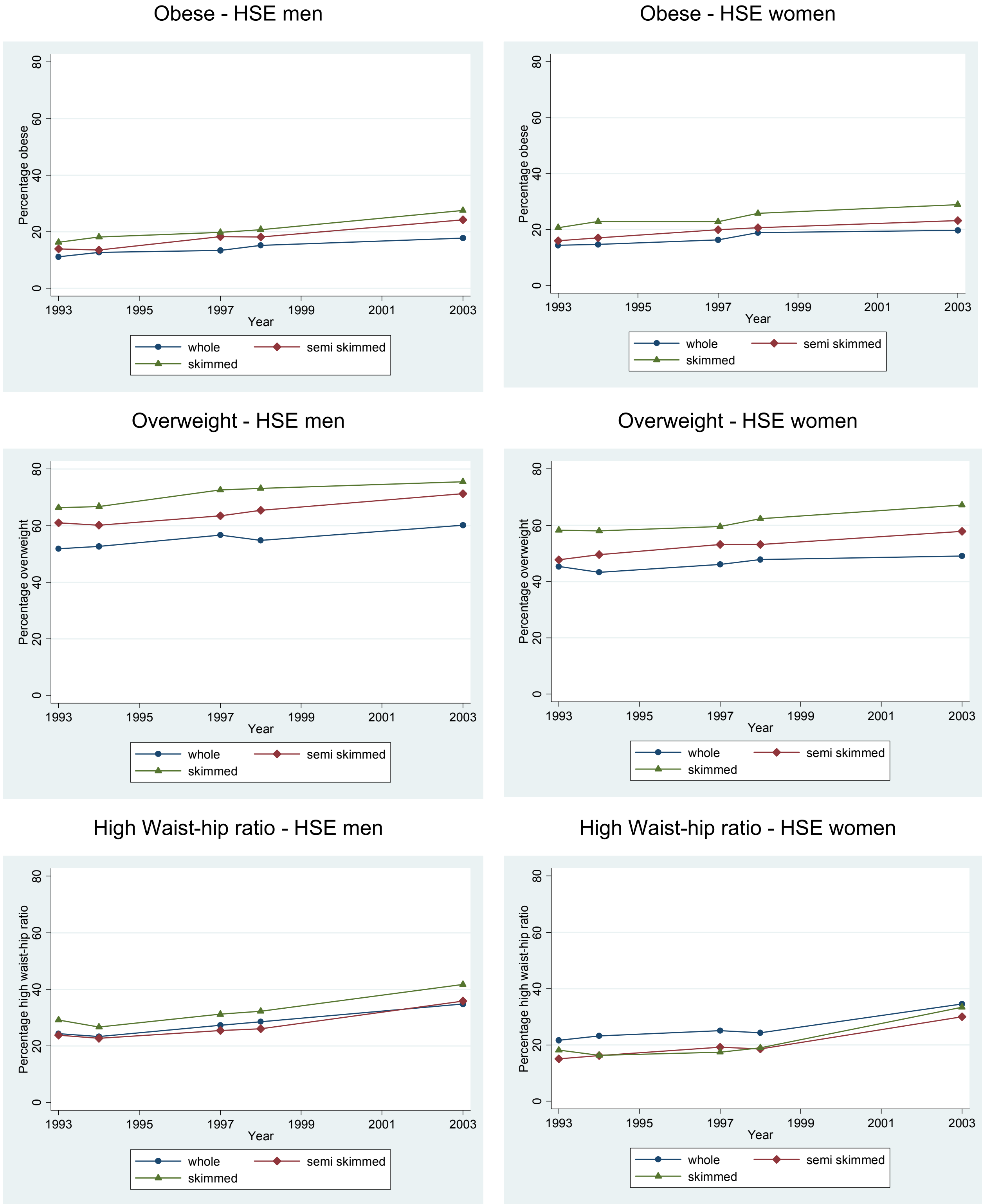


Figure 30: Interactions between age group and type of milk consumed for obesity in men (HSE)

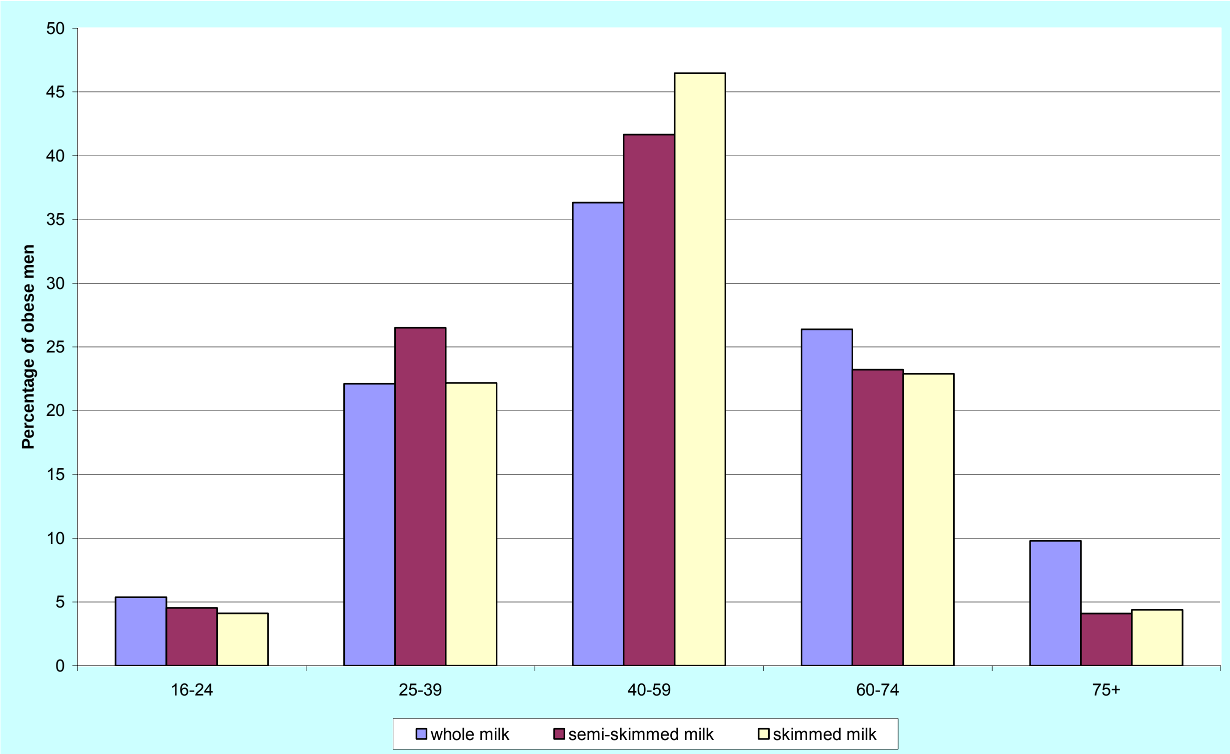


Figure 31: Interaction between age group and type of milk consumed type for obesity in women (HSE)

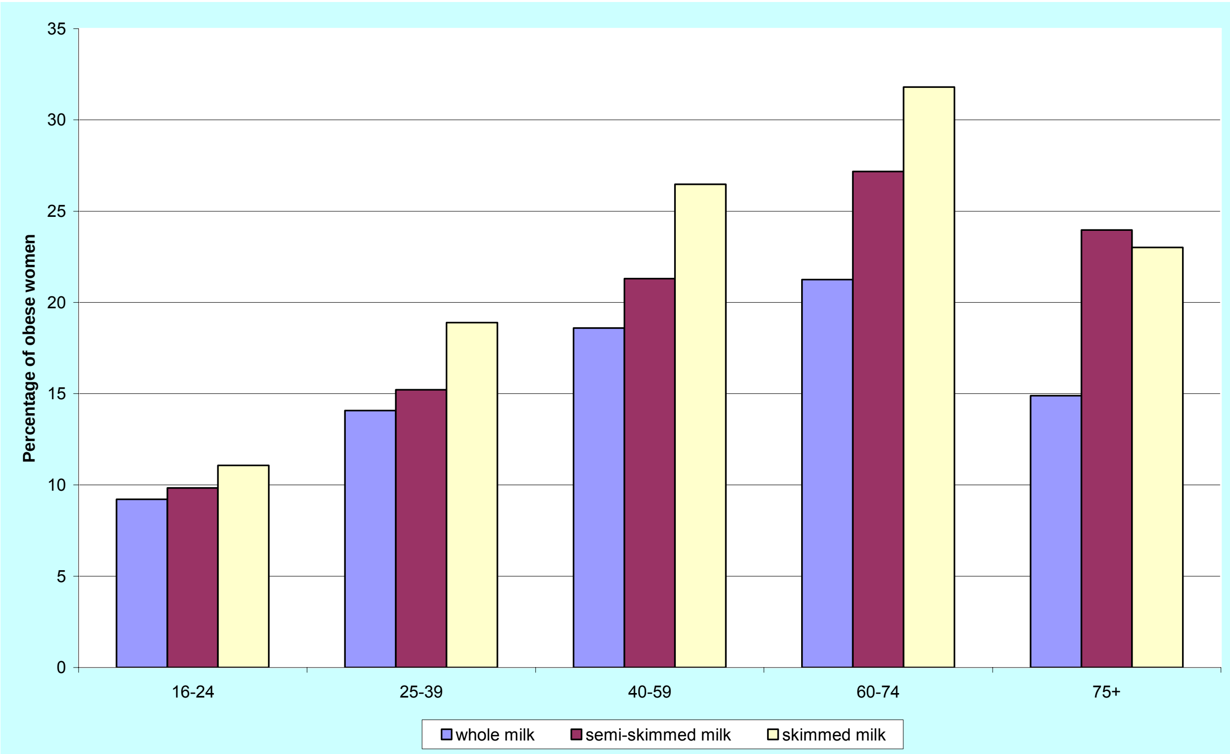


Figure 32: Interaction between age group and type of milk consumed for being overweight in women (HSE)

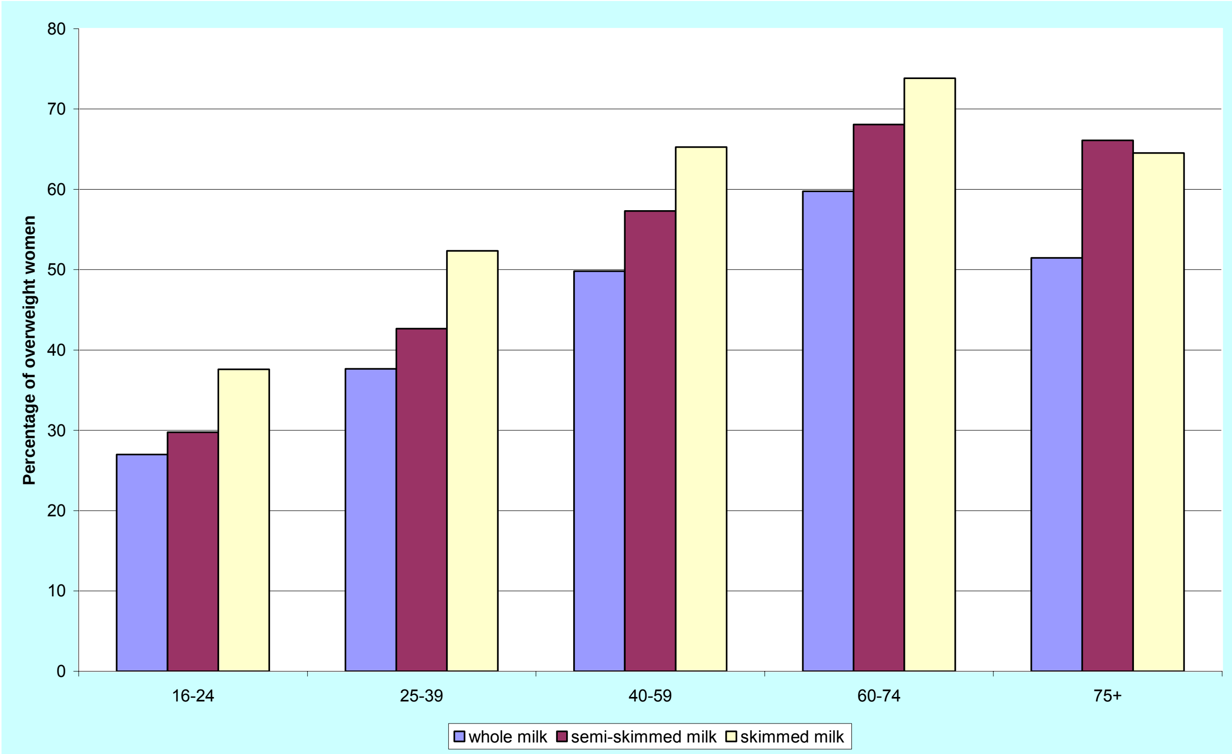


Table 40: Adjusted odds ratios for obesity, overweight and high waist-hip ratio among adult men and women by type of milk and fruit and vegetable consumption (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Obese		
Milk type	*[n=27869, P<0.001]* †	*[n=32136, P<0.001]* †
Whole	1	1
Semi-skimmed	1.27(1.18-1.37)	1.19 (1.11-1.28)
Skimmed	1.43 (1.29-1.59)	1.54 (1.41-1.68)
Fruit & vegetable portions	*[n=18782, P=0.9201]* †	*[n=22500, P<0.001]* †
Fewer than 2	1	1
2 or 3	0.99 (0.91-1.08)	0.94 (0.87-1.02)
4 or more	1.01 (0.92-1.10)	0.84 (0.78-0.91)
Overweight		
Milk type	*[n=27869, P<0.001]* †	*[n=32136, P<0.001]* †
Whole	1	1
Semi-skimmed	1.50 (1.42-1.59)	1.31 (1.24-1.38)
Skimmed	1.76 (1.61-1.92)	1.83 (1.71-1.97)
Fruit & vegetable portions	*[n=18782, P<0.001]* †	*[n=22500, P=0.6323]* †
Fewer than 2	1	1
2 or 3	1.13 (1.05-1.23)	0.98 (0.91-1.05)
4 or more	1.19 (1.10-1.29)	0.97 (0.90-1.04)
High Waist-hip ratio		
Milk type	*[n=26053, P=0.0347]* †	*[n=30003, P<0.001]* †
Whole	1	1
Semi-skimmed	1.02 (0.96-1.09)	0.77 (0.72-0.83)
Skimmed	1.13 (1.03-1.24)	0.83 (0.76-0.90)
Fruit & vegetable portions	*[n=14094, P<0.001]* †	*[n=16888, P<0.001]* †
Fewer than 2	1	1
2 or 3	0.88 (0.81-0.98)	0.77 (0.70-0.84)
4 or more	0.81 (0.73-0.89)	0.66 (0.61 -0.72)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group, firstly for milk choice and then for fruit and vegetable consumption

† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Table 41 shows the prevalence of obesity, overweight and high WHR among adult men and women by survey years, in those eating fewer than 2 portions, those eating 2-3 portions and those eating 4 or more of fruit and vegetables daily. The odds ratios from the logistic regressions are reported in Table 40 and the data are illustrated graphically in Figure 33.

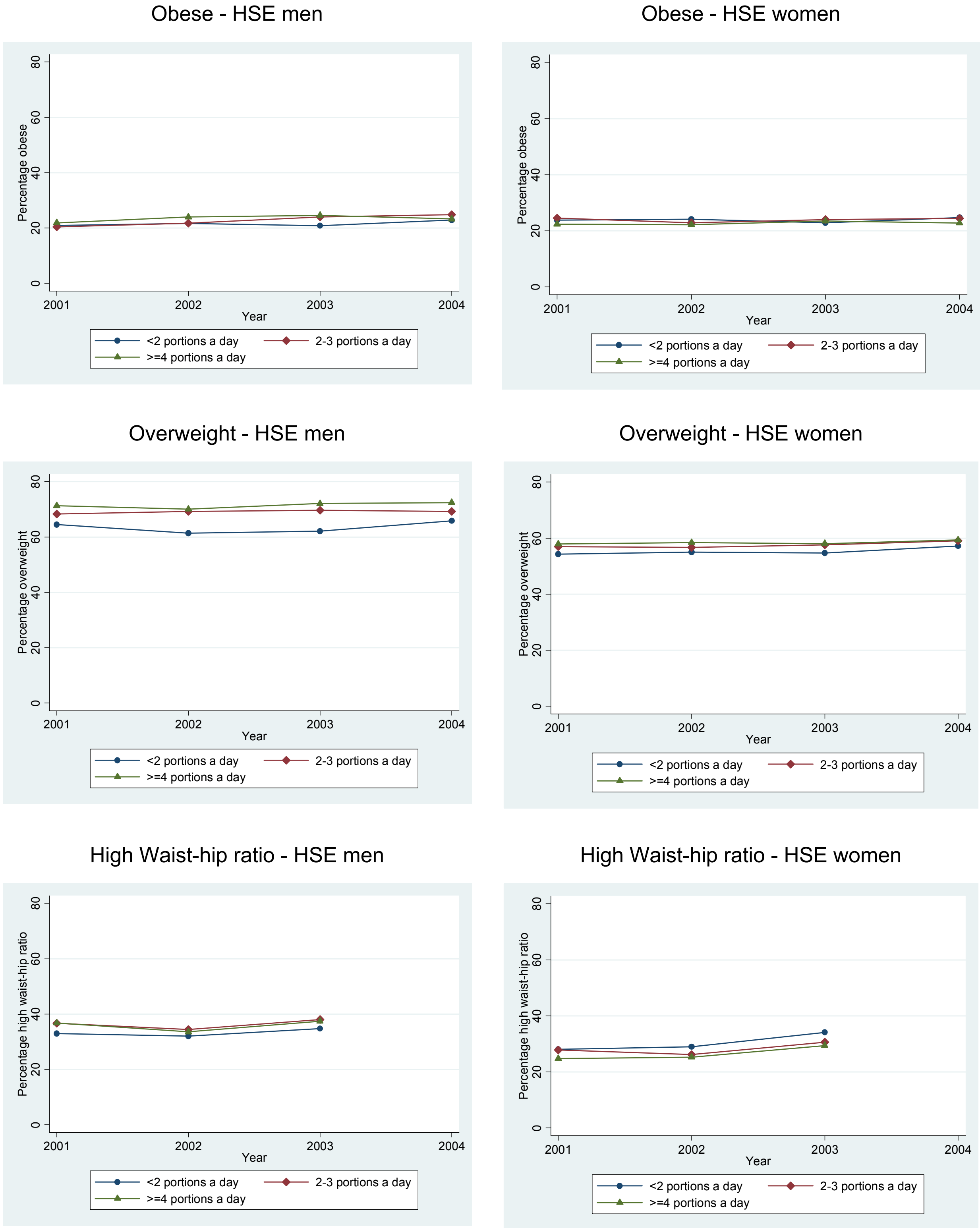
Table 41: Percentage (unweighted sample size) of adult men and women with obesity, overweight and high waist-hip ratio by fruit and vegetable consumption and survey year (HSE)

	Survey year			
	2001	2002	2003	2004*
Portions of fruit & vegetables				
Men				
Obese				
Fewer than 2	20.9 (2364)	21.7 (1773)	20.8 (2279)	22.9 (870)
2 or 3	20.4 (1867)	21.8 (1190)	24.0 (1819)	24.8 (757)
4 or more	21.9 (2036)	24.0 (1145)	24.6 (1868)	23.3 (817)
Overweight				
Fewer than 2	64.5 (2364)	61.4 (1773)	62.1 (2279)	65.8 (870)
2 or 3	68.3 (1867)	69.2 (1190)	69.7 (1819)	69.3 (757)
4 or more	71.3 (2036)	70.1 (1145)	72.1 (1868)	72.5 (817)
High waist-hip ratio*				
Fewer than 2	33.0 (2043)	32.1 (1460)	34.7 (1876)	
2 or 3	36.7 (1647)	34.4 (1009)	38.0 (1513)	
4 or more	36.8 (1835)	33.5 (978)	37.4 (1573)	
Women				
Obese				
Fewer than 2	23.8 (2359)	24.2 (1775)	22.9 (2268)	24.7 (976)
2 or 3	24.6 (2287)	22.9 (1607)	24.0 (2226)	24.4 (961)
4 or more	22.4 (2768)	22.2 (1635)	23.5 (2595)	22.8 (1197)
Overweight				
Fewer than 2	54.3 (2359)	55.1 (1775)	54.7 (2268)	57.2 (976)
2 or 3	57.0 (2287)	56.7 (1607)	57.6 (2226)	59.0 (961)
4 or more	57.9 (2768)	58.4 (1635)	58.0 (2595)	59.4 (1197)
High waist-hip ratio*				
Fewer than 2	28.0 (1990)	27.9 (1525)	24.7 (1890)	
2 or 3	26.2 (2034)	25.3 (1378)	34.1 (1898)	
4 or more	29.4 (2503)	43.1 (1447)	30.0 (2206)	

* High WHR data only available and reported for 2003

From Figure 33 and Table 41, it can be seen that the prevalence of all three outcomes varied little between those consuming different amounts of fruit and vegetables in both men and women, except for overweight men. However the adjusted odds ratios in Table 40 show that prevalence of being overweight in men was higher among those who consume more portions of fruit and vegetables per day, and high WHR was less common in men who ate fruit and vegetables more often. There were only negligible differences between the prevalence of overweight in women with different levels of fruit and vegetable consumption. However, the adjusted odds ratios show that obesity and high WHR was less common in those who consumed more portions of fruit and vegetables. All interactions between milk type and age and survey year, or fruit and vegetable consumption and age and survey year were tested for each outcome and found to be non-significant (p>0.01).

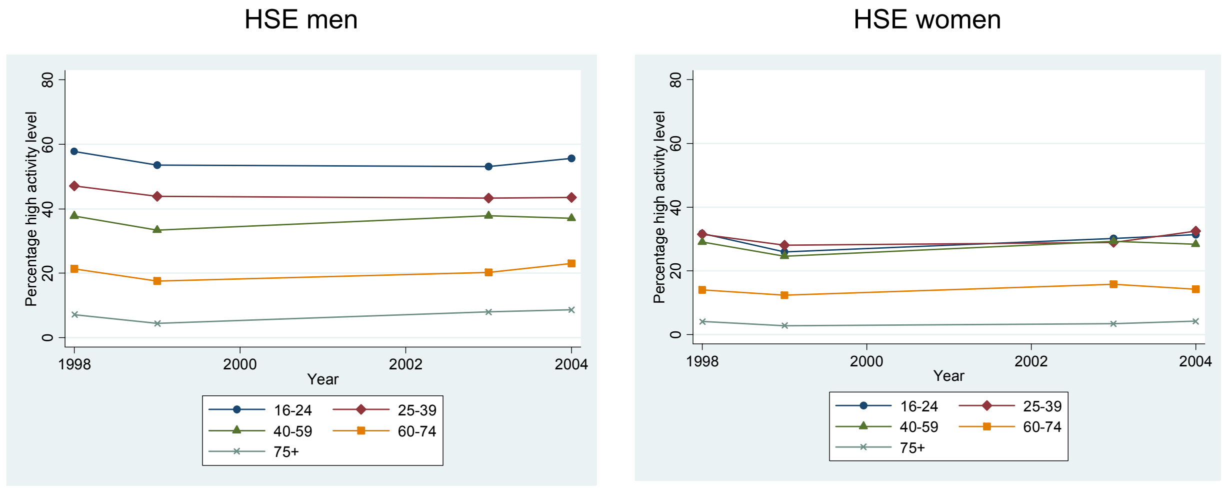
Figure 33: Prevalence of obesity, overweight and high waist-hip ratio among adults by portions of fruit and vegetables consumed and survey year (HSE)



Trends in physical activity

Logistic regression analyses with high activity level as the outcome variable were used to model trends over time, age-group and social class and the results are shown in Table 42. The trends by survey year and age group are illustrated graphically in Figure 34.

Figure 34: Prevalence of high activity level among adults by age group and survey year (HSE)



The percentages of men and women having a high level of activity decreased with age. There was a small but significant difference in the proportion with a high activity level across the survey years with the lowest value in 1999.

There was a significant association between social class group and activity level in men, with a greater proportion of manual workers having a high level of PA (Figure 35). Figure 35 and Table 42 show that there was little association between the social class and activity levels for women.

Figure 35: Prevalence of high activity by social class group among adults and survey year (HSE)

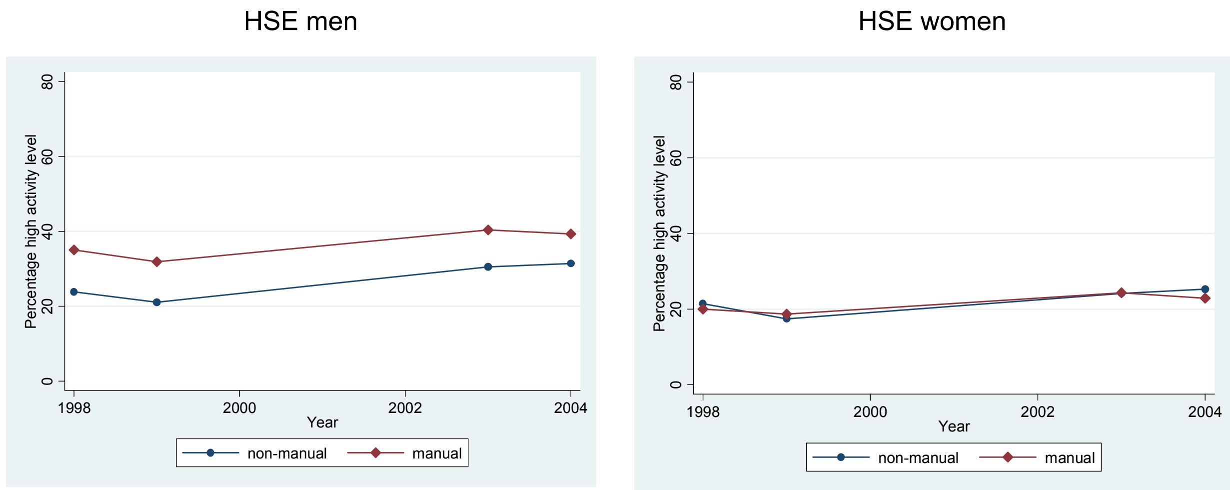


Table 42: Adjusted odds ratios for physical activity level by survey year, age group and social class group (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Period	*[n=19763, P=0.0005]* †	*[n=24135, P=0.0001]* †
1998	1	1
1999	0.83 (0.76-0.91)	0.81 (0.74-0.89)
2003	0.93 (0.86-0.99)	0.97 (0.90-1.04)
2004	0.96 (0.87-1.05)	1.00 (0.91-1.09)
Age group	*[n=19763, P<0.001]* †	*[n=24135, P<0.001]* †
16-24	1	1
25-39	0.66 (0.60-0.73)	1.00 (0.91-1.10)
40-59	0.47 (0.43-0.52)	0.91 (0.83-1.00)
60-74	0.21 (0.19-0.24)	0.39 (0.35-0.44)
75+	0.06 (0.05-0.08)	0.09 (0.07-0.11)
Social Class	*[n=19763, P<0.001]* †	*[n=24135, P=0.645]* †
Non-manual	1	1
Manual	1.85 (1.74-1.97)	1.01 (0.95-1.08)

* Separate logistic regressions by gender adjusting for other variables in the model
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Associations between obesity, overweight and high waist-hip ratio, and physical activity

The prevalence of overweight, obesity in adults and a high WHR among adult men and women by survey year and level of PA are shown in Table 43, and illustrated graphically in Figure 36.

Table 43: Percentage (unweighted sample size) of obese, overweight and with a high waist-hip ratio in adult men and women by survey year, and by level of physical activity (HSE)

	Survey years			
	1998	1999	2003	2004*
Physical activity				
Men				
Obese				
low	22.4 (2172)	24.5 (1106)	28.6 (1886)	28.0 (792)
moderate	17.1 (1890)	19.0 (989)	22.2 (1913)	24.2 (762)
high	13.2 (2528)	12.8 (1104)	18.6 (2157)	19.2 (889)
Overweight				
low	67.8 (2172)	70.1 (1106)	73.0 (1886)	74.3 (792)
moderate	64.7 (1890)	60.8 (989)	68.5 (1913)	70.9 (762)
high	57.6 (2528)	57.0 (1104)	61.9 (2157)	63.0 (889)
High waist-hip ratio*				
low	38.8 (2072)		49.7 (1642)	
moderate	25.3 (1767)		32.7 (1591)	
high	18.9 (2246)		27.8 (1722)	
Women				
Obese				
low	26.3 (2974)	26.6 (1507)	29.6 (2623)	29.6 (1162)
moderate	19.6 (2759)	19.1 (1373)	22.2 (2658)	22.4 (1173)
high	16.0 (1989)	14.4 (817)	16.2 (1797)	17.9 (795)
Overweight				
low	59.0 (974)	59.9 (1507)	64.2 (2623)	65.1 (1162)
moderate	53.3 (2759)	52.7 (1373)	55.1 (2658)	57.4 (1173)
high	45.3 (1989)	45.3 (817)	48.9 (1797)	50.9 (795)
High waist-hip ratio*				
low	28.0 (2829)		2295 (39.9)	
moderate	16.0 (2518)		2213 (27.0)	
high	12.5 (1786)		1477 (24.1)	

* High WHR data only available and reported for 2003

The highest prevalence of obesity, overweight and high WHR occurs in men and women with the lowest activity levels, whilst the group with high activity levels have the lowest prevalence of obesity.

The results of the logistic regression for obesity, overweight and high WHR with PA among adult men and women are shown in Table 44. The odds ratios with activity level show that there was a lower chance of being obese, overweight or having a high WHR at high and moderate activity levels compared to those of low activity. All interactions between activity level, age and year were tested for each outcome. There was a significant interaction between age group and activity level for being overweight in women (p=0.0088) which is illustrated in Figure 37. There were no significant interactions between survey year and activity level (i.e. the trend in each outcome with activity level did not change significantly over time).

Table 44: Adjusted odds ratios for obesity, overweight and high waist-hip ratio among adult men and women by physical activity level (HSE)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Obese		
Activity level	*[n=18150, P<0.001]* †	*[n=21578, P<0.001]* †
Low	1	1
Medium	0.75 (0.68-0.82)	0.70 (0.65-0.75)
High	0.59 (0.53-0.64)	0.52 (0.48-0.57)
Overweight		
Activity level	*[n=18150, P<0.001]* †	*[n=21578, P<0.001]* †
Low	1	1
Medium	0.92 (0.84-1.00)	0.83 (0.77-0.88)
High	0.79 (0.73-0.85)	0.65 (0.60-0.70)
High waist-hip ratio		
Activity level	*[n=11040, P<0.001]* †	*[n=13118, P<0.001]* †
Low	1	1
Medium	0.62 (0.56-0.70)	0.69 (0.62-0.76)
High	0.57 (0.51-0.64)	0.60 (0.54-0.68)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group.
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Figure 36: Prevalence of obesity, overweight and high waist-hip ratio by activity level and survey year (HSE)

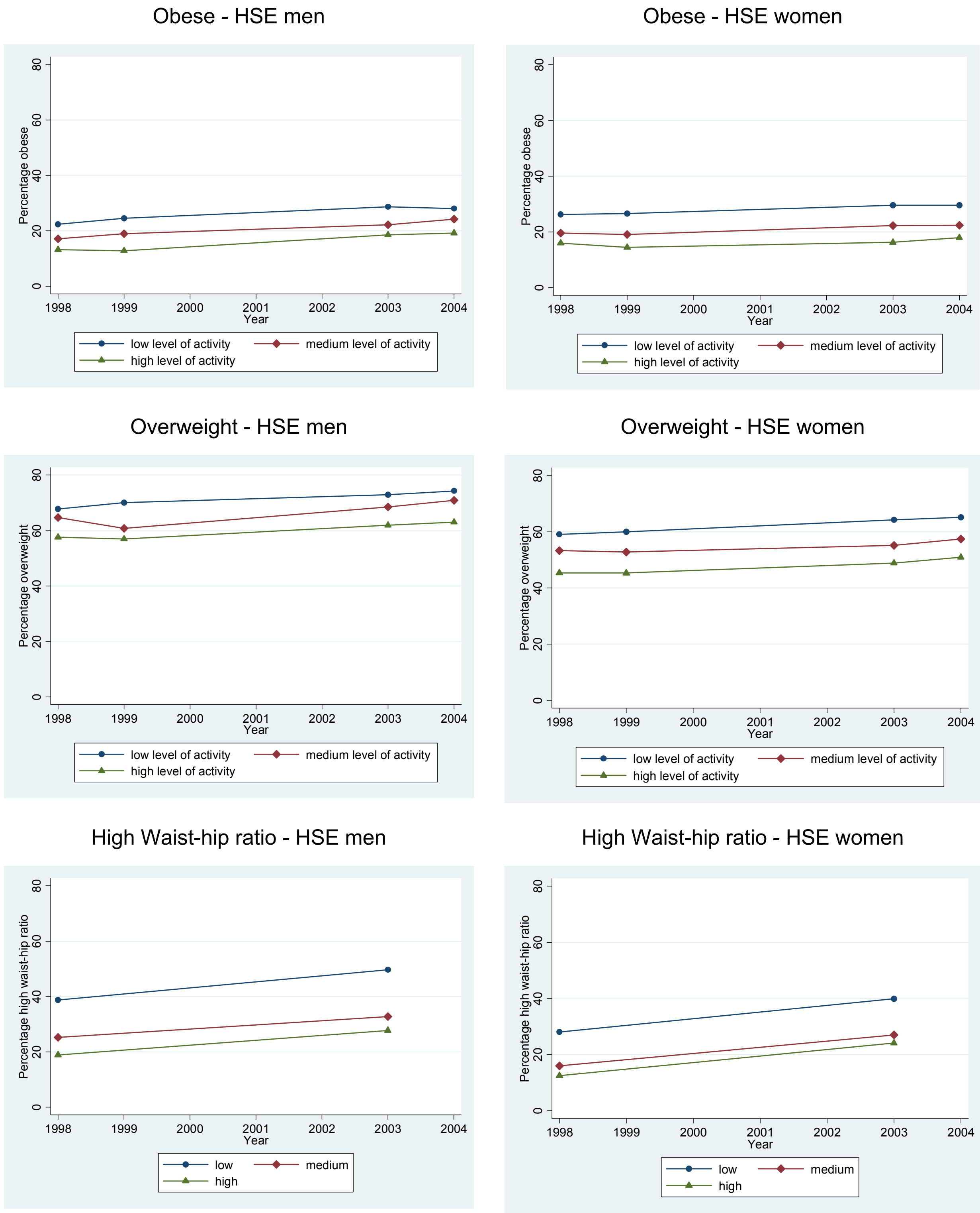
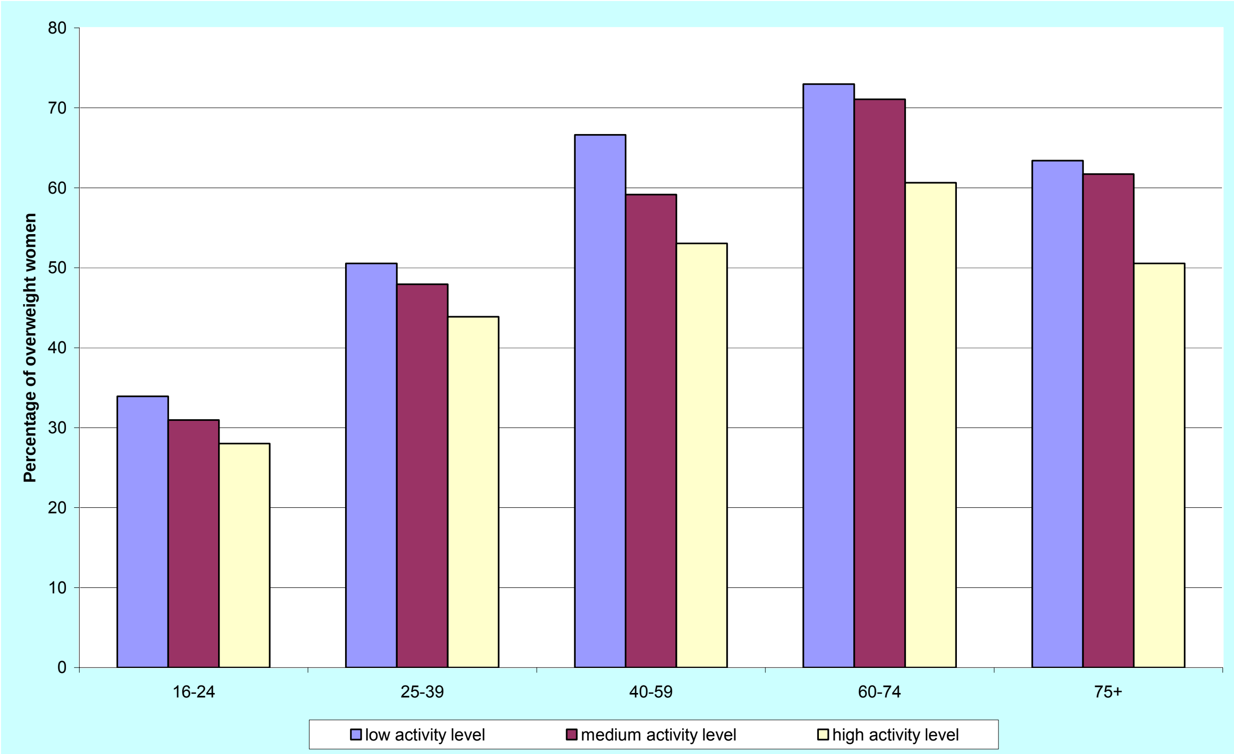


Figure 37: Interaction between age and activity level for being overweight in women (HSE)



Health Survey for England: children

Trends in obesity and overweight over time and by age group

The availability of data for children in the HSE is disappointing. Data were only collected from 1995-2004 and most of the variables that have been analysed for adults were only present in small numbers, and for fewer years, for children. The associations with obesity, overweight and high WHR are presented for survey period, age group, social class, fruit and vegetable consumption, and PA where available.

The prevalence of obese and overweight children are summarised by age group and survey period in Table 45 and illustrated graphically in Figure 38. Results of logistic regression analyses can be found in Table 46.

The prevalence of obesity and overweight in boys showed an increase over time, and this was statistically significant for both obesity and overweight. This was also the case in girls, but the association with obesity was weaker than for the boys. There was no significant association between obesity and age group for either boys or girls. However, there were significant associations between age and being overweight in both sexes. For boys, the prevalence of overweight was lower in the 5-10 year age group than in the younger and older groups, whereas for girls overweight was more common in the 11-15 age group.

All interactions between age and survey years were tested, and there was a statistically significant interaction between year and age group for being overweight in children ($p=0.0029$). This was illustrated in Figure 39: the increasing prevalence of being overweight over time seen in the 5-10 and 11-15 age groups was not present in those aged 2-4.

Table 45: Percentage (unweighted sample size) of obese and overweight boys and girls by survey year and age group (HSE)

	Survey years				
	1995/96	1997/98	1999/00	2001/02	2003/04
Age group					
Boys					
Obese					
2-4	4.4 (806)	3.5 (1046)	6.7 (342)	5.3 (855)	4.3 (350)
5-10	3.0 (1585)	3.1 (2298)	4.1 (803)	5.1 (2094)	6.9 (918)
11-15	3.0 (1229)	3.6 (1685)	5.2 (576)	5.9 (1791)	5.5 (784)
Overweight					
2-4	20.4 (806)	19.3(1046)	25.6 (342)	22.1 (855)	20.8 (350)
5-10	13.8 (1585)	15.3 (2298)	17.6 (803)	19.7 (2094)	21.9 (918)
11-15	18.5 (1229)	20.5 (1685)	22.1 (576)	23.9 (1791)	25.3 (784)
Girls					
Obese					
2-4	5.2 (769)	6.2 (1040)	4.4 (346)	5.4 (868)	4.2 (343)
5-10	5.8 (1565)	5.0 (2264)	7.0 (726)	7.5 (2060)	6.3 (864)
11-15	4.8 (1146)	5.0 (1641)	6.3 (563)	6.9 (1744)	7.3 (787)
Overweight					
2-4	20.7 (769)	26.5 (1040)	20.9 (346)	25.4 (868)	21.5 (343)
5-10	21.0 (1565)	19.7 (2264)	23.4 (726)	27.3 (2060)	25.2 (864)
11-15	23.5 (1146)	19.7 (1641)	24.0 (563)	28.3 (1744)	32.3 (787)

Figure 38: Prevalence of obesity and overweight among boys and girls by age group and survey year (HSE)

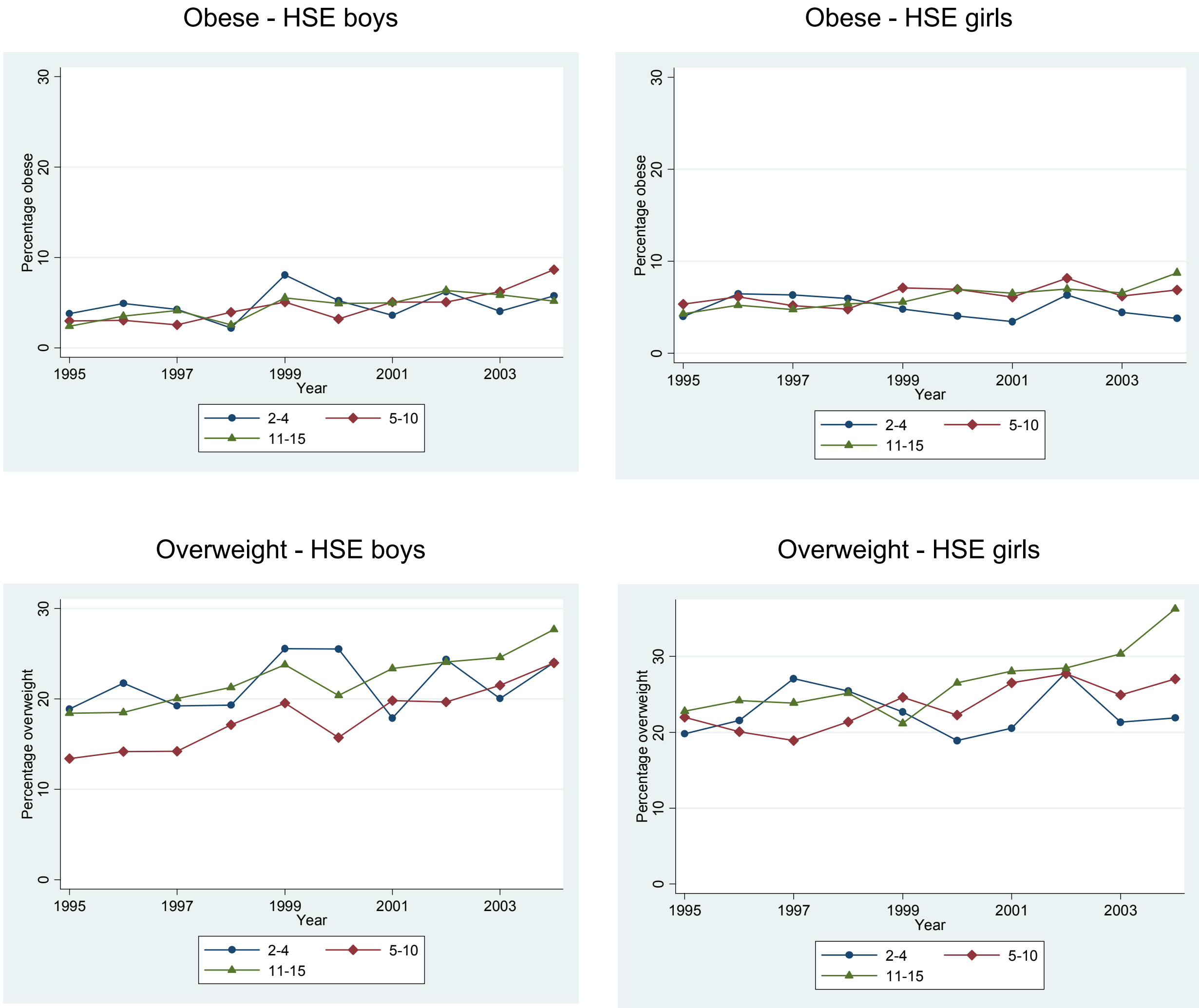
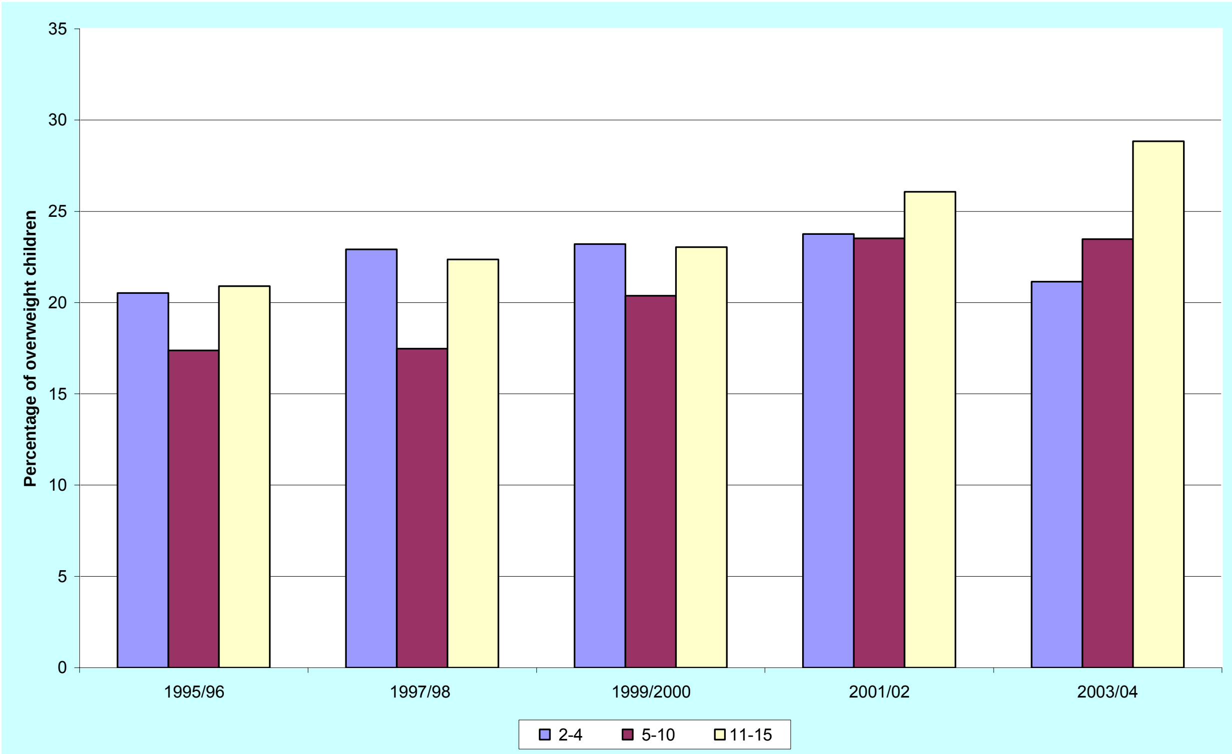


Table 46: Adjusted odds ratios for obese and overweight among boys and girls by survey year and age group (HSE)

	Boys	Girls
	OR* (95%CI)	OR* (95%CI)
Obese		
Period	*[n=17169, P<0.001]* †	*[n=16814, P=0.0093]* †
95/96	1	1
97/98	1.01 (0.79-1.29)	0.99 (0.81-1.21)
99/00	1.53 (1.15-2.05)	1.19 (0.91-1.55)
01/02	1.68 (1.34-2.11)	1.31 (1.08-1.59)
03/04	1.84 (1.42-2.39)	1.20 (0.95-1.52)
Age group	*[n=17169, P=0.4663]* †	*[n=16814, P=0.2778]* †
2-4	1	1
5-10	0.89 (0.73-1.09)	1.16 (0.97-1.39)
11-15	0.96 (0.78-1.19)	1.10 (0.91-1.33)
Overweight		
Period	*[n=17169, P<0.001]* †	*[n=16814, P<0.001]* †
95/96	1	1
97/98	1.08 (0.96-1.21)	1.05 (0.95-1.17)
99/00	1.29 (1.11-1.50)	1.08 (0.93-1.25)
01/02	1.37 (1.22-1.54)	1.35 (1.21-1.50)
03/04	1.48 (1.29-1.70)	1.35 (1.18-1.54)
Age group	*[n=17169, P<0.001]* †	*[n=16814, P=0.0002]* †
2-4	1	1
5-10	0.77 (0.69-0.86)	0.95 (0.86-1.05)
11-15	1.03 (0.93-1.14)	1.13 (1.02-1.25)

* Separate logistic regressions by gender adjusting for other factors in the model
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Figure 39: Interaction between survey year and age group for being overweight in children (HSE)



Associations between overweight and obesity, and socio-economic position

Table 47 shows prevalence of obesity and overweight in children by SEP and survey year; results of logistic regressions are given in Table 48. The prevalence of obesity was slightly higher for both boys and girls where the head of household was in the manual social class group. There was no significant association between being overweight and social class of head of household for boys, but there was for girls, with those where the head of household was in a manual social class being more likely to be overweight. This is a similar pattern to that seen in adults.

There were no significant interactions between any of the factors in the model: specifically there was no indication that the association between obesity or being overweight and social class groups has changed over time (i.e. no significant interaction between the health outcomes and year of survey and social class group ($p>0.01$)), although there is arguably a trend in the direction of an emerging social inequality among children (see Table 47 and Figure 40).

Table 47: Percentage (unweighted sample size) of obese and overweight boys and girls by social class group of head of household and survey year (HSE)

	Survey years				
	1995/96	1997/98	1999/00	2001/02	2003/04
Boys					
Obesity					
Non-Manual	3.1 (1693)	2.9 (2309)	5.2 (831)	4.5 (2513)	5.5 (1119)
Manual	3.5 (1694)	3.7 (2533)	4.7 (811)	6.4 (2040)	6.2 (846)
Overweight					
Non-Manual	16.7 (1693)	18.2 (2309)	21.3 (831)	20.9 (2513)	21.8 (1119)
Manual	16.7 (1694)	17.6 (2533)	20.0 (811)	22.6 (2040)	24.4 (846)
Girls					
Obesity					
Non-Manual	4.9 (1666)	4.8 (2337)	6.7 (840)	5.7 (2489)	4.9 (1105)
Manual	5.9 (1565)	5.7 (2420)	5.8 (718)	8.2 (1984)	8.0 (821)
Overweight					
Non-Manual	22.1 (1666)	22.3 (2337)	22.1 (840)	26.1 (2489)	24.3 (1105)
Manual	22.3 (1565)	23.2 (2420)	24.8 (718)	29.5 (1984)	30.7 (821)

Figure 40: Prevalence of obesity and overweight among boys and girls by social class group and survey year (HSE)

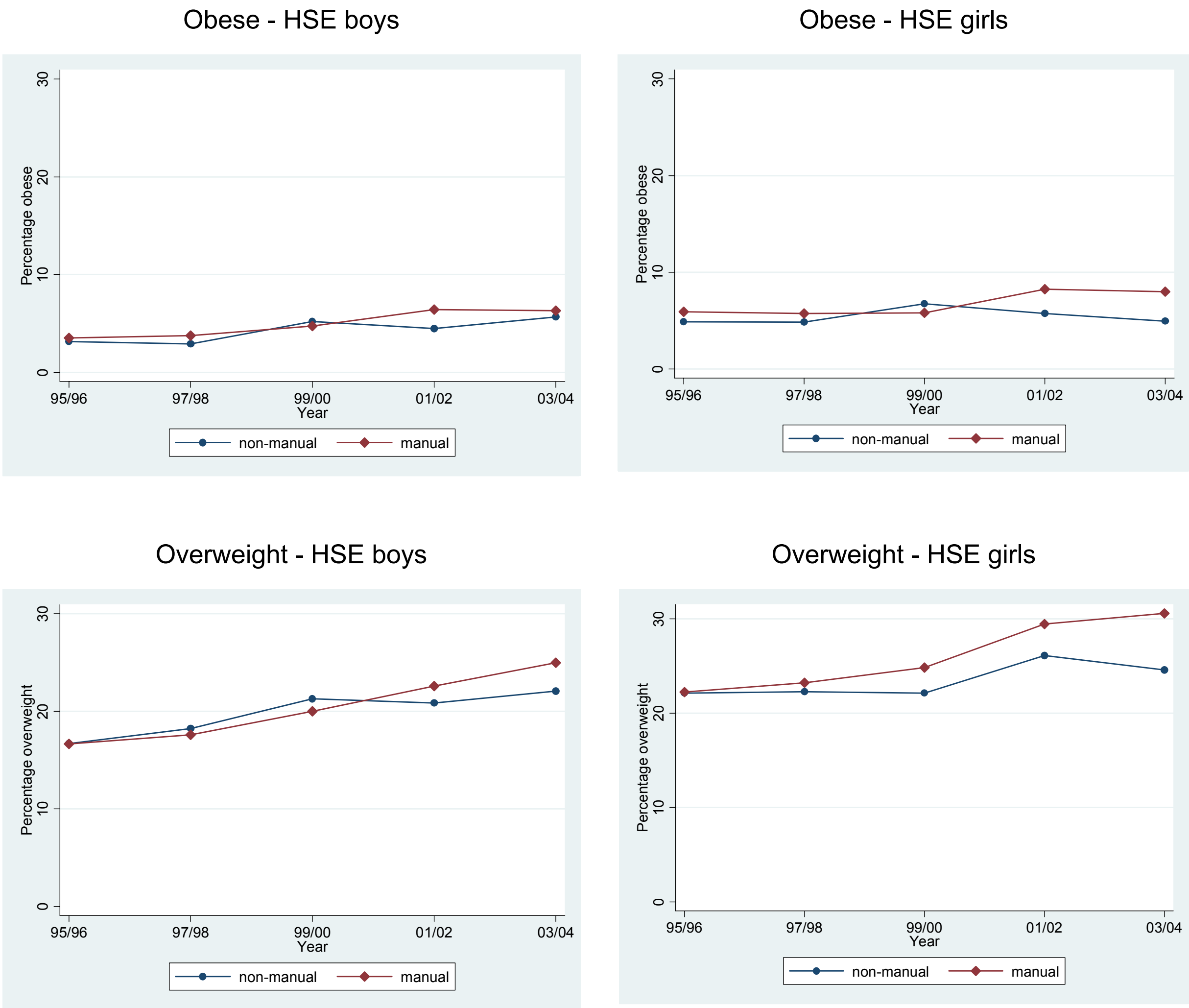


Table 48: Adjusted odds ratios for obesity and overweight among boys and girls by social class group (HSE)

	Boys	Girls
	OR* (95%CI)	OR* (95%CI)
Obese		
Social Class	*[n=16357, P=0.006]* †	*[n=15967, P<0.001]* †
Non-manual	1	1
Manual	1.24 (1.07-1.45)	1.30 (1.13-1.49)
Overweight		
Social Class	*[n=16357, P=0.494]* †	*[n=15967, P=0.001]* †
Non-manual	1	1
Manual	1.03 (0.95-1.11)	1.13 (1.05-1.22)

* Separate logistic regressions by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Associations between obesity and overweight, and dietary intake

Unfortunately, information on milk consumption was only available for children in one year of the HSE, so it was not included in this analysis. Data for number of portions of fruit and vegetables consumed was available consistently for children between 2001 and 2004, but only children aged 5 and over who were questioned about fruit consumption.

Table 49 shows the prevalence of obesity in children by the number of portions of fruit and vegetables consumed. These data are presented graphically in Figure 41, and odds ratios are reported in Table 50. There was little evidence of associations between fruit and vegetable consumption and obesity in either boys or girls. This was also true for overweight girls. However, there was a weak but significant association in overweight boys, such that those eating the most portions of fruit and vegetables were more likely to be overweight.

There were no significant interactions between any of the factors in the model: specifically there was no indication that the association between obesity or being overweight and levels of fruit and vegetable consumption changed over time.

Table 49: Percentage (unweighted sample size) of obese and overweight among boys and girls by fruit and vegetable consumption and by survey year (HSE)

	Survey years			
	2001	2002	2003	2004
Boys				
Obese				
<2 portions	5.7 (634)	5.5 (1366)	5.2 (625)	4.8 (247)
2-3 portions	4.4 (353)	5.6 (824)	6.8 (360)	8.5 (168)
4 or more portions	4.3 (209)	6.1 (499)	7.5 (186)	8.2 (116)
Overweight				
<2 portions	21.9 (634)	20.4 (1366)	22.4 (625)	20.1 (247)
2-3 portions	21.2 (353)	19.8 (824)	20.0 (360)	27.9 (168)
4 or more portions	21.0 (209)	28.2 (499)	30.3 (186)	29.1 (116)
Girls				
Obese				
<2 portions	5.7 (571)	7.7 (1196)	6.5 (575)	9.3 (211)
2-3 portions	6.3 (429)	6.8 (887)	7.5 (374)	8.5 (161)
4 or more portions	7.6 (243)	8.9 (478)	4.2 (229)	3.7 (101)
Overweight				
<2 portions	26.1 (571)	27.1 (1196)	25.5 (575)	30.8 (211)
2-3 portions	26.8 (429)	28.5 (887)	31.8 (374)	31.9 (161)
4 or more portions	30.5 (243)	29.9 (478)	25.1 (229)	31.2 (101)

Figure 41: Prevalence of obesity and overweight among boys and girls by portions of fruit and vegetables per day and survey year (HSE)

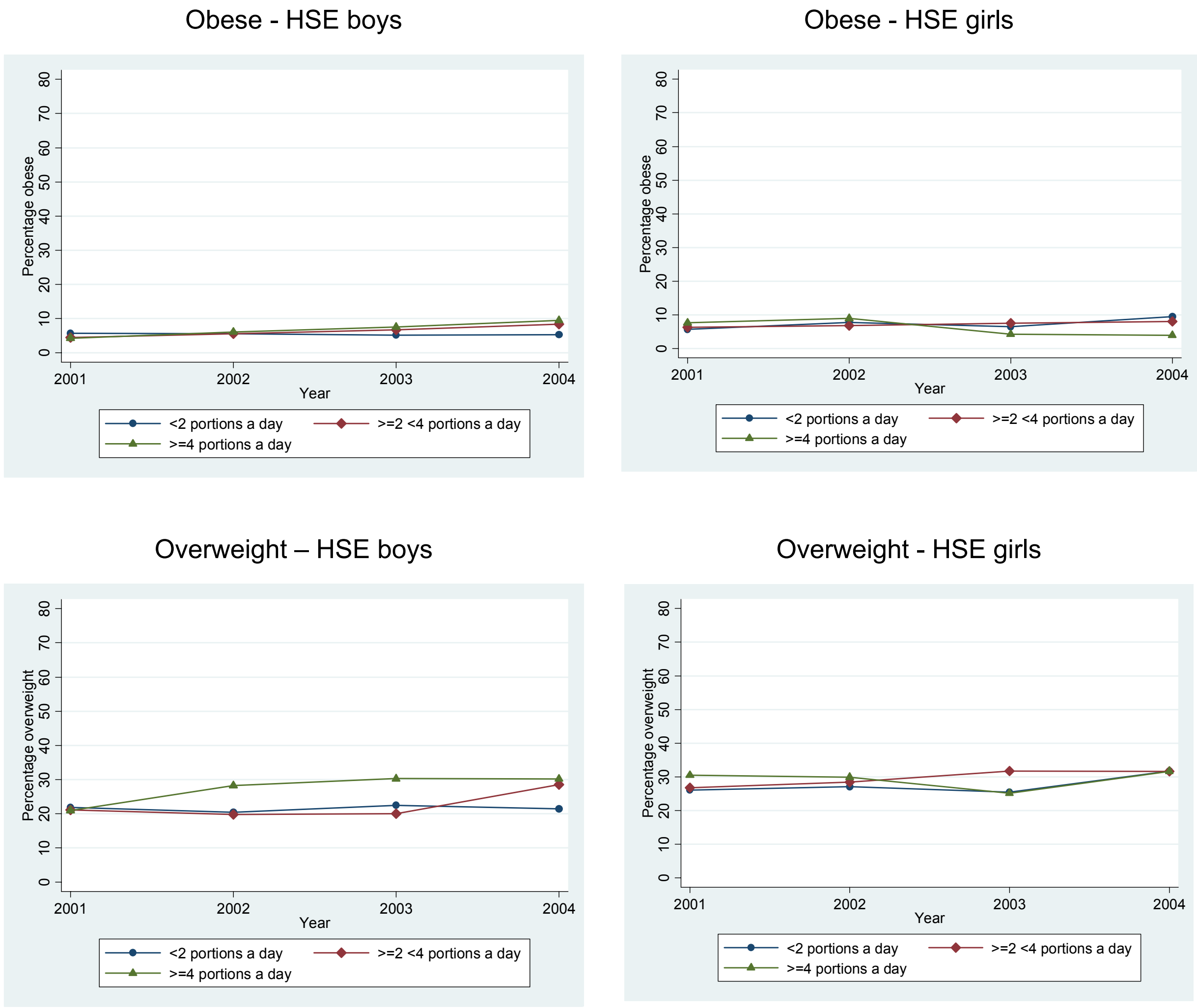


Table 50: Adjusted odds ratios for obesity and overweight among boys and girls by fruit and vegetable consumption (HSE)

	Boys	Girls
	OR* (95%CI)	OR* (95%CI)
Obese		
Fruit & vegetable portions	*[n=5606, P=0.6347]* †	*[n=5522, P=0.9795]* †
Less than 2	1	1
2 or 3	1.08 (0.83-1.41)	0.98 (0.77-1.24)
4 or more	1.15 (0.85-1.56)	0.99 (0.75-1.33)
Overweight		
Fruit & vegetable portions	*[n=5606, P=0.0003]* †	*[n=5522, P=0.2090]* †
Less than 2	1	1
2 or 3	0.99 (0.85-1.16)	1.12 (0.97-1.28)
4 or more	1.39 (1.17-1.64)	1.12 (0.95-1.31)

* Separate logistic regressions by gender adjusted for survey year and age-group

† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Trends in physical activity

Unfortunately, the data collected on PA in children changed in almost every year of the HSE. This made it very difficult to find a consistent variable, and the variable that was recommended by NatCen was only available for 2002 and 2004.

Figure 42 shows the trends over time in PA for all children. It shows that the number of children doing 60+ minutes of activity every day has decreased, whilst the number of children doing 30-59 minutes and those doing even less have increased.

Associations between obesity and overweight, and physical activity

Table 51 shows the prevalence of overweight and obesity among children by activity level (high = 60+ minutes every day, medium = 30-59 minutes every day, low = <30 minutes every day). The results are illustrated in Figure 43 and the odds ratios are reported in Table 52. None of the associations with activity level were significant and there were no significant interactions between any of these factors.

Figure 42: Levels of physical activity among children by survey year (HSE)

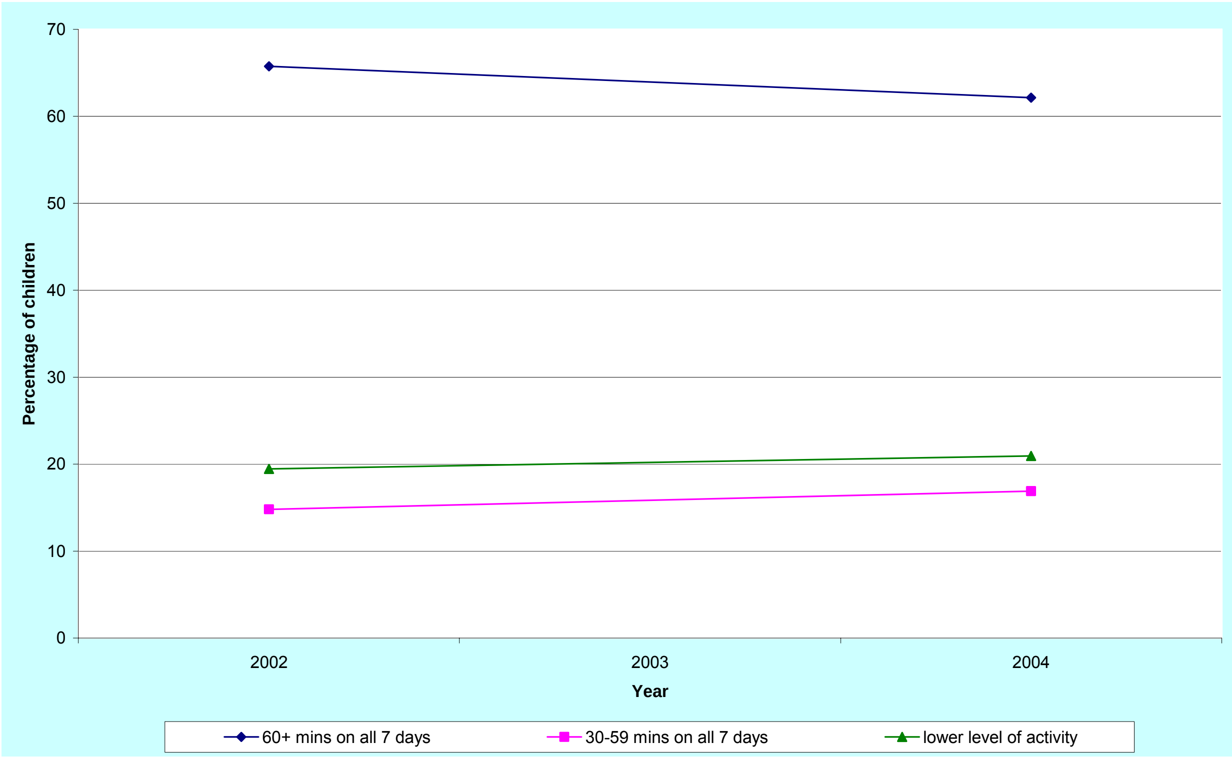


Table 51: Percentage (unweighted sample size) of obese and overweight boys and girls by activity level and survey year (HSE)

	Survey years			
	Boys		Girls	
	2002	2004	2002	2004
Obese				
Low	5.8 (518)	4.2 (93)	8.2 (704)	7.4 (149)
moderate	7.9 (435)	6.3 (104)	7.8 (502)	8.5 (100)
high	5.3 (2264)	6.7 (434)	7.0 (1897)	6.7 (314)
Overweight				
Low	24.5 (518)	21.9 (93)	29.8 (704)	30.7 (149)
moderate	21.4 (435)	21.6 (104)	29.2 (502)	23.0 (100)
high	21.6 (2264)	25.3 (434)	26.9 (1897)	30.4 (314)

Figure 43: Prevalence of obesity and overweight among boys and girls by activity level and survey year (HSE)

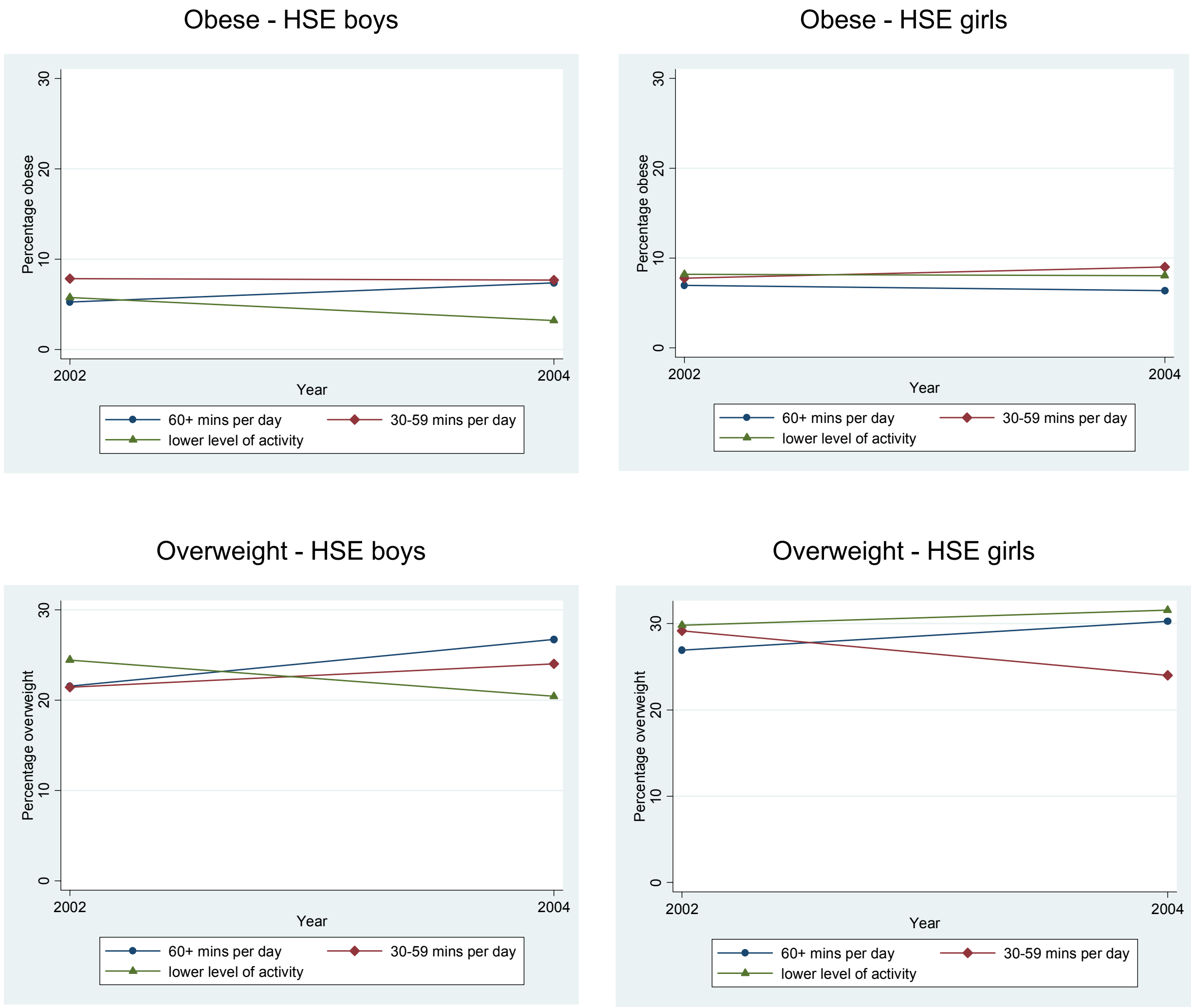


Table 52: Adjusted odds ratios for obesity and overweight among boys and girls by activity level (HSE)

	Boys	Girls
	OR* (95%CI)	OR* (95%CI)
Obese		
Activity level	*[n=3866, P=0.1890]* †	*[n=3689, P=0.4156]* †
Low	1	1
Medium	1.40 (0.97-2.02)	1.15 (0.80-1.64)
High	1.00 (0.67-1.49)	1.17 (0.87-1.59)
Overweight		
Activity level	*[n=3866, P=0.5499]* †	*[n=3689, P=0.5022]* †
Low	1	1
Medium	0.96 (0.76-1.21)	1.02 (0.83-1.26)
High	1.11 (0.90-1.38)	1.11 (0.93-1.33)

* Separate logistic regressions by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Scottish Health Survey and regional comparisons

We repeated the above HSE analyses for Scotland, where possible, and then made comparisons between Scotland and England, as well as regional comparisons, including Scotland. The results, which largely confirm the trends shown in England, can be found in Appendix 2.

Summary of main findings

Health Survey for England

Trends in overweight, obesity and waist hip ratio among adults

The prevalence of overweight and obesity and high WHR in adult men and women increased between 1991 and 2004. In all survey years, the prevalence of being overweight and obese increased with age to the 60-74 age-group and then decreased in the 75+ age group in both men and women. The prevalence of high WHR in men followed the same pattern as obesity and overweight with age. However, in women the increase continued into the 75+ age group, which may be an indicator of an overall later development of central obesity in women post-menopause. The prevalence of obesity and overweight increased more rapidly with age in men than in women.

Prevalence of obesity, overweight and high WHR was higher among adults in manual compared with non manual social class group and adults who had left school aged 16 or younger compared with those who left school after 16. These associations were statistically significant except for the association between social class and being overweight in men. There was no evidence of a widening gap over time between the either indicator of socioeconomic position for either men or women for any outcome (obesity, overweight or high WHR).

Role of diet and physical activity in adults

The highest prevalence of obesity and overweight occurred in men and women who consumed skimmed milk, whilst the lowest occurred among those who drink whole milk. High WHRs were more likely among men drinking skimmed milk, and least likely among the group drinking whole milk, whereas this trend was reversed for women. The association between fruit and vegetable consumption and obesity, overweight or a high WHR was weaker and less consistent than for milk consumption. Prevalence of obesity, overweight and high WHR were greater among adults with lower activity levels. There was a significant association between lower social class and higher activity level in men, but not in women.

Trends in obesity and overweight in children

Prevalence of obesity and overweight has increased over time between 1995 and 2004 in both boys and girls. Children where the head of household was in the manual social class group were more likely to be obese. This was also true for overweight girls, but not for overweight boys. There was a suggestion that the association between obesity or being overweight and social class is changing over time among children, but this was not statistically significant.

Role of diet and physical activity in children

Boys eating 4 or more portions of fruit and vegetables daily were more slightly more likely to be overweight than those eating fewer than 2 portions. There were no significant associations between obesity or overweight and PA among children.

Scottish Health Survey and regional comparisons

Trends in overweight, obesity and high WHR over time, by age group and SEP in Scotland mirrored those in England, for both adults and children. Overall, markers of adiposity were greater in Scotland than England, but there was no evidence of a widening gap over time. Similarly, relationships between, for example, SEP, milk consumption or PA and measures of adiposity in adults were the same as in England, although the Scots were generally less active and more likely to drink whole milk, though the gap narrowed between 1998 and 2003. Importantly, there was no evidence of a widening gap over time between the indicators of socioeconomic position or lifestyle for obesity overweight or high WHR in males or females, adults or children in Scotland.

There were significant variations in obesity, overweight and high WHR between the English regions and Scotland and differences by sex, but no obvious evidence of a 'north-south' gradient, after adjustment for survey year and age group. Prevalence of obesity was greatest in the West Midlands in men and women, overweight greatest in Yorkshire and Humber in men and the West Midlands in women, and high WHR greatest in Scotland in women and the East and West Midlands in men.

Methodological considerations

The HSE and SHS are the largest representative population health surveys undertaken regularly in the UK and provide a rich source of data. However, they are not without limitations. Although the annual national health surveys were developed, in part, in order to enable tracking of trends over time, the inconsistency with which specific variables have been collected, and the variation in the definitions of variables from year to year significantly limits the utility of these data sets for this purpose. In particular we found deficiencies in the diet and PA data, both in terms of annual availability and changing definitions over time. There were also significant proportions of missing data for some variables, notably WHR, in some years. The overall impact of these deficiencies was that we were forced to exclude some years from some analyses altogether.

Whilst the data on BMI and WHR were collected by direct measurement and is considered robust, the behavioural data were collected using self-report questionnaires which are less reliable, for example, being subject to recall bias. The behavioural variables were also limited in their scope and we were, for example, only able to chose marker variables for a healthy diet (milk and fruit and vegetable consumption), rather than a measure of energy intake or any other indicator of quality or quantity of dietary intake. Likewise the PA questions varied from year to year and we had to rely on a relatively crude summary measure, which only crudely approximates to energy expenditure.

Another limitation was the necessity for complex weighting procedures for each year's survey data in order to make them comparable with other years and representative of sampling frames. Whilst we were able to devise strategies for weighting the general and children's samples in individual years to enable comparisons across time and analysis of pooled data across years, we were not able to do this for the ethnic minority samples in 1999 or 2004, or the elderly care home sample in 2000, and these data were therefore excluded from our analyses.

Discussion of combined findings of the three studies

In this report we have presented the findings of three separate studies using data from two British cohort studies (one historical birth cohort, started in 1958, and one contemporary cohort, started in 2000) and from the annual cross-sectional national health surveys. We have used these analyses to investigate age, sex and socioeconomic trends in overweight and obesity; weight gain among parents and its influence on weight gain in children; and indicators of the changing epidemiology of diet and PA.

Main findings

Age, sex and socioeconomic trends in overweight and obesity

Our findings support and extend those of the published research literature, which suggests that the obesity epidemic continues to grow unabated. Offspring in the 1958 birth cohort have on average greater BMIs than their parents at similar adult ages, and year on year increases in age-group specific prevalence of overweight obesity and high WHR were observed in the national health surveys. Woman have higher levels of obesity overall, but men are more likely to be overweight at all ages. Among children, girls were more likely to be overweight and obese at most ages. However, the increases in obesity and overweight have been proportionately greater since the early 1990s in men than women, indicating a convergence of these trends. Cross-sectionally, prevalence of obesity, overweight and high WHR increases up to age 75 years, but thereafter declines somewhat.

Although socio-economic differentials in body mass were not present in children in the 1958 Birth Cohort, there is evidence that they are emerging at age 3 years in the MCS (born in 2000/2), with some differences between the ‘never worked and long term unemployed’ group and higher social groups. The socio-economic gap seems to be wider for females than males at all ages and across time in the national health surveys. We have clearly demonstrated marked socio-economic patterning of obesity and markers of behavioural risk in adults and children, males and females. However, our analyses have not shown that the gap between rich and poor has widened, or narrowed, since the early 1990s.

Weight gain among parents and its influence on weight gain in children

We found considerable evidence for longitudinal and intergenerational influences on obesity. In the MCS, greater gestational age at birth and higher birth weight were associated with greater weight gain up to 3 years of age. In the 1958 Birth Cohort, adiposity tracked from childhood into adulthood. Moreover, we found that parental BMI independently predicted offspring BMI and, if both parents were overweight or obese, then the chances of offspring being overweight or obese were even greater than if one parent had excess body weight. In the MCS, there was evidence that socioeconomic patterning of weight gain to 3 years was linked to parental weight gain. In families where the household socio-economic classification was ‘never worked or long term unemployed’, weight gain from 9 months to 3 years was predicted by maternal weight gain over the same period. Socioeconomic patterning of weight gain between 9 months and 3 years for the whole cohort was abolished once parental weight gain was taken into account. In the 1958 Birth Cohort, BMI in adulthood was better predicted by social class of origin than concurrent social class, although both had an independent effect.

The changing epidemiology of diet and physical activity

When we looked at behavioural risk markers for excess body weight, we found some inconsistency in results from the three analyses. Whole milk consumption has decreased over time since 1993 in the national health surveys and consumption of lower fat (semi-skimmed and skimmed) milks increased. Milk consumption was patterned socio-economically, with the manual social class group more likely to drink whole milk. However, paradoxically, obesity and overweight were greater among those drinking lower fat milks than whole milk, which may be a consequence of people switching to lower fats milks in order to control weight or may be a result of response bias. Our inability to determine the direction of causality is an obvious limitation of cross-sectional analyses using the national health surveys.

Although fruit and vegetable consumption did not change over time between 2001 and 2004 in adults or children in the national health surveys, it was consistently higher among older adult age groups and the higher social class group in adults. Greater fruit and vegetable consumption was associated with greater prevalence of overweight and lower prevalence of a high WHR in men, but a lower prevalence of obesity and lower prevalence of high WHR in women. Among boys, as in men, those eating more fruit and vegetables were more likely to be overweight, but there were no similar associations in girls. Overall, these findings suggest greater fruit and vegetable consumption is associated with a lesser tendency to central obesity in men and women. The association with greater levels of overweight in men may be explained by the finding that greater levels of physical fitness are associated with greater body mass due to muscle.[2] In other words, men who eat more fruit and vegetables may also be more likely to be physically fitter, a question that could be explored further using these data sets.

In the 1958 Birth Cohort, social class differences in diet tended to be greater for concurrent social class than social class of origin, suggesting a more important effect of present environment on behaviour.

Physical activity declined with age in all years of the national health surveys and was lower among women than men. However, trends over time were less clear and a social patterning was only observed in men, with manual social class men being more physically active. Nevertheless, lower levels of activity were associated with greater prevalence of obesity, overweight and high WHR, and this relationship was consistent over time. Among children there was some indication that levels of activity have declined over time, but activity was not associated with levels of overweight or obesity. There was no evidence of social patterning in PA observed in either boys or girls.

In contrast, data from the 1958 Birth Cohort showed an association between lower social class and lower levels of PA and, over time, social differentials in physical were better predicted by concurrent socio-economic position than social class of origin, again suggesting a more important role for environmental factors in adulthood. The conflicting findings on PA and body mass in the cross-sectional and cohort studies may be due to the different methods used to assess PA, both of which were based on self-report.

Strengths and weaknesses of the studies

There were a number of limitations of the measurement methods used and data available in all three studies (in particular on health related behaviours), but we were able to rely on higher quality, although much of the anthropometric data from MCS relied upon self-report, which is less reliable. The wide range of data gave us the opportunity to explore trends across time and generations, drawing on all three studies.

Where available, markers of diet and PA only provided indicators of these behaviours, relying on self-reported behavioural recall questionnaires covering a limited range of foods and activities. The results of these analyses therefore need to be interpreted with caution, as more comprehensive assessments of dietary intake and total PA might have yielded different relationships with SEP. For example, questions on PA did not include occupational activity, which is known to vary by SEP.

Although the annual national health surveys were developed, in part, in order to enable tracking of trends over time, the inconsistency with which specific variables have been collected, and the variation in the definitions of variables from year to year significantly limits the utility of these data sets for this purpose. We found particular deficiencies in the diet and PA data, both in terms of annual availability and changing definitions over time. There were also significant proportions of missing data for some variables, notably WHR, in some years. The overall impact of these deficiencies was that we were forced to exclude some years from some analyses altogether.

Our choice of data sets to analyses was largely pragmatic. We were commissioned to conduct a secondary analysis study within a relatively short time frame. Thus, although we could have, for example, conducted analyses on a number of other cohort studies (e.g. the 1970 British Birth Cohort or the Avon Longitudinal Study (ALSPAC)), in practice gaining access to these would have delayed the work. The datasets we have used provide results that are, nevertheless, relevant to the present obesity epidemic. Obesity was relatively uncommon during childhood for the generation born in 1958 (1.4-2.8%) compared to today's children (4.6% boys and 6.8% girls ages 5-10y in 2002-3).[28] Lifestyles and living conditions would also have differed from those experienced by children nowadays. Given these temporal changes not all of our findings are necessarily generalisable. Nonetheless, the 1958 cohort represents the contemporary generation in which influences on obesity and associated chronic disease in today's middle-aged adults can be understood. Similarly, the MCS provides an ideal data set for understanding the emergence of obesity in today's children.

Overall conclusions and implications

Analyses of these three datasets have largely confirmed reported trends in obesity in the British population, including its strong social gradient.[2 4] However, within this broad conclusion, there are a number of more detailed findings which have implications for future policy, practice and research.

Age, sex and socioeconomic trends in overweight and obesity

Obesity and overweight have increased over time in the national health surveys. Levels of excess body weight are greater among women than among men, although there is some evidence that men are catching up. Levels of overweight and obesity increase with age from childhood up to age 75 years. This finding also supports the conclusion that efforts to prevent or reduce obesity and overweight need to start early in life and continue at least until retirement age.[8 20 22 23 46 48 59 92]

Socioeconomic inequalities in body mass are marked but evidence from the HSE survey suggests they do not appear to have widened over the last 15 years. There is a clear need to focus on this inequality and reduce the gap between rich and poor. Implementation of the recently published NICE guidance on prevention and management of obesity[64], as well as relevant NSFs[70-72 74] and implementation plans arising from the governments health strategy 'Choosing Health'[66-68] will need to take account of this social patterning and ensure that the interventions proposed do not inadvertently further widen inequalities in obesity and overweight. Socio-economic trends, particularly among children, will need to be monitored in the future to see whether this pattern remains static, as it may have important implications for intervention strategies.

Levels of obesity are worse in some regions of the UK than others, after controlling for demographic factors. These regions, which include Scotland, the North East, Yorkshire and Humber, and the East and West Midlands, will need to make greater efforts to reduce levels of obesity than those regions with relatively lower levels of obesity.

Weight gain among parents and its influence on weight gain in children

The presence of intergenerational effects in both cohort studies was striking and suggests an important priority for public health interventions. Intergenerational effects may presently be amplifying the growth of the obesity epidemic through the generation of a repeating cycle, with obese parents having obese children, who become obese parents, and so on. Breaking this cycle will require a range of interventions including attention to preventing excessive weight gain in early childhood including infancy, among young parents and during pregnancy.[8 20 22 23 46 48 59 92 93]

BMI was associated with social class in both early life and adulthood in the 1958 Birth Cohort, although there was a tendency for social differences to be greater for class of origin than concurrent social class. In contrast social differences in dietary factors, and for men PA, tended to be greater for concurrent social class. This suggests that the origins of social inequalities may be different for BMI, activity and dietary habits and that interventions aimed at modifying behaviour in mid-life may be only partly successful in reducing inequalities in obesity. Given this, we would not necessarily expect social inequalities in activity and diet to mirror those for BMI over time. This may also provide another argument for initiating efforts to prevent obesity early, preferably in childhood. However, efforts to change diet and PA behaviour will need to continue among adults, since it is likely to be beneficial to help parents to adopt lifestyle changes that can provide role models for their children and shape the environment for their children.[8 22 48 53]

The MCS found socioeconomic gradients in weight gain in a contemporary cohort of young children and their parents, contributing to the social patterning of obesity in children and adults.

Although parental weight gain was not found to be strongly associated with faster weight gain in children from 9 months to 3 years overall, such an association was present within 'never worked or long-term unemployed' households, suggesting an 'at risk' group. These households may benefit from targeted help with an emphasis on a family-based approach to weight management.

The changing epidemiology of diet and physical activity

Physical activity and diet are known to be important determinants of energy balance and thus body mass. Despite some inconsistent findings from these analyses, efforts to reduce energy intake and increase energy expenditure should continue to play an important role in reducing obesity and overweight[14 94] and, for diet in particular, focus on lower social groups.

Implications for research

Overall, inconsistencies in the data collected and available for analysis from the national health surveys hinder their usefulness as a tool for research and policy analysis at national levels. Better data are needed on energy intake from the whole diet and energy expenditure from all types of PA across age and social groupings. Further research is needed to understand better the relation ship between diet and PA, and SEP.

An assessment of the data consistently needed to monitor trends relevant to Choosing Health,[66-69] NSFs,[70-72 74] NICE guidance[64] and strategies to reduce health inequalities[95] would be of value.

Clearly, there is already a significant body of information, policies and action plans relating to obesity much at national level. Some of this, such as the children's NSF,[72] makes specific reference to the social patterning of obesity, but more direct guidance on interventions, such as from NICE,[64] does not acknowledge the potential importance of the social patterning in delivering interventions effectively and efficiently.

Dissemination of findings

As well as this report, a summary of this research will be placed on the PHRC web site (www.york.ac.uk/phrc). The further dissemination of this report will be subject to discussion with the Department of Health.

We would anticipate giving a number of conference presentations on this work at national and international conferences (e.g. ISBNPA).

There is potential for peer-reviewed journal articles, although many of the findings will be seen as confirmatory, rather than novel. A paper is in preparation on the intergenerational transmission of obesity. The formal presentation of socio-economic trends over time in adulthood in the UK has not previously been published and we will seek to publish these findings in a paper also. We are exploring the potential for further work, including analyses of ethnic inequalities and the creation of a 'synthetic cohort', bringing together data from the HSE and 1958 birth cohort.

Appendix 1: Details of data weighting

Data weighting proved necessary in the HSE and SHS surveys in order to correct for the fact that, in some cases, the achieved samples did not accurately reflect the population distribution. The weighting strategy in the analyses reported here was informed by the technical reports on the HSE and SHS, and also from detailed correspondence with NatCen undertaken to clarify details of the weighting, and to ensure that the variables used matched our objectives in the analysis of trends across all the survey years.

For the HSE it was felt that the adult sample had provided a good match to the population structure in the majority of survey years. However, a non-response weight was introduced in 2003 and 2004 to adjust for possible biases introduced by participants failing to respond to certain portions of the survey such as the nurse visit where waist hip measurements were taken. However if this weight was included in our analyses, the 2003 and 2004 data would be weighted differently to other years, so it was not used. So, all adult HSE data were unweighted with the exception of 2002, when there was a deliberate over sampling of 16-24 year olds, and 2004 when an adult selection weight was introduced. Where data were not weighted in the original dataset, the generated weight variable takes the value 1. In keeping with this, to preserve the original sample size, all weight variables taken from the original data were scaled to have mean 1 (by dividing the weight variable by its mean). It was unfortunately not possible to combine the extra care home sample in 2000 or ethnic boost samples in 1999 and 2004 into the main survey sample, as despite considerable correspondence on the topic with NatCen, a suitable weight did not exist to correct the distributions.

Child data required weighting in all survey years, as the number of children selected from a household was limited to a maximum (the sampled fraction of children therefore being smaller in households with more than this number of children). An inverse probability (of selection) child weight was used, which may be thought of as the total number of children in a household divided by the number of selected children from that household. In some years further small changes were made to this weight to further correct age and sex distributions.

We now consider how the weights were built up by year for the HSE:

- 1991 to 1994: children were not present in the sample and all data remained unweighted.
- 1995, 1996, 1998 & 2001: the child weight was created from a single child selection weight variable.
- 1997: a number of possible child weights were created by NatCen for different analysis purposes and the selected weight was the weight that maintained the effective sample size.
- 1999: data were divided into a general population sample, which merely had a child weight, and a separate ethnic minority boosted sample which collected data from the various ethnic minorities within the UK. All the data from this second sample was weighted (including children) in order to correct for non-equal chances of selection in the ethnic sub-population. However NatCen advised that there was no weight available which would allow an analysis combining these two sub-samples so here only the general population sample was retained.
- 2000: only the general population sample has been retained as there was no weight available to combine the care home sample data with the general population; again this general population was weighted only for children.
- 2002: a selection weight was applied to both adults and children, correcting for the over sampling of adults under 25 and mothers with a child of age less than 1 year, and the usual child selection weight.
- 2003: There were selection weights available for children but not adults. Non-response weights were introduced for adults and children for the interview and nurse visit stages, but in order to combine the data with that from the previous years, they were not used in the

analysis. The analysis in this report therefore used unweighted adult data and only the child selection weights

- 2004: HSE had derived weights for both adults and children that combined selection weights and non-response weights for nurse visits. It was desirable to only utilise the component which corresponded to selection weights, for comparability with previous surveys. NatCen were able to provide us with a selection weight for adults, but although requested, did not do so for children. The child data were therefore analysed using the combined weights.

The SHS followed a slightly different weighting approach, in that, in both 1995 and 1998 all available data (no children were sampled in 1995) was been given a selection weight in order to correct for non-equal probabilities of inclusion in the survey depending on factors such as postcode. In 2003 the approach largely mirrors that of the HSE with the use of a combined weight which encompassed selection and non-response weights in both adults and children. It was desirable to only utilise the component which corresponded to selection weights, for comparability with previous surveys. However although the calculation of selection weights only was requested from NatCen, they were not provided and the analysis used the combined weights.

Appendix 2: Results of the Scottish Health Survey and regional comparisons

Scottish Health Survey: adults

Trends in obesity, overweight and high waist-hip ratio over time and by age group

Table 53 shows the prevalence of obesity, overweight and high WHR by gender, survey year and age groups. Figure 44 illustrates these results graphically. Table 54 shows the results of the logistic regression models fitted to these data. There were significant interactions among adults between gender and both year of survey and age group for all three outcomes, so the results have been reported separately by gender.

There was a significant upward trend in obesity, overweight and high WHR over time in men and women. There was also a significant increase in all three outcomes with age in both men and women. Since data were not collected consistently for higher ages in all survey years, the results are only presented up to the age of 59, and the possibility of a decrease in any outcome at higher ages than this, as was seen in the HSE results, has not been explored.

The increase in high WHRs was particularly high in women at all ages (e.g. from 6%-21% between 1995 and 2003 in those aged 16-24).

Table 53: Percentage (unweighted sample size) of men and women with obesity, overweight and high WHR by survey year and age-group – (SHS)

	Survey years		
	1995	1998	2003
Men			
Obesity			
16-24	5.0 (424)	6.7 (373)	8.4 (286)
25-39	16.1 (1269)	15.2 (1110)	18.7 (695)
40-59	22.0 (1415)	25.1 (1327)	29.0 (1129)
Overweight			
16-24	24.5 (474)	29.5 (373)	30.3 (286)
25-39	55.4 (1269)	58.3 (1110)	62.3 (695)
40-59	70.4 (1415)	72.9 (1327)	77.2 (1129)
High waist-hip ratio			
16-24	1.7 (405)	2.3 (308)	2.9 (175)
25-39	12.2 (1119)	12.6 (951)	16.1 (501)
40-59	27.8 (1259)	33.9 (1214)	35.9 (889)
Women			
Obesity			
16-24	9.4 (515)	10.2 (470)	13.4 (336)
25-39	15.2 (1630)	19.8 (1356)	20.7 (861)
40-59	21.7 (1668)	24.0 (1588)	28.3 (1394)
Overweight			
16-24	31.1 (515)	32.6 (470)	40.3 (336)
25-39	40.9 (1630)	46.7 (1356)	51.4 (861)
40-59	57.9 (1668)	60.0 (1588)	64.8 (1394)
High waist-hip ratio			
16-24	6.4 (446)	5.7 (389)	20.8 (204)
25-39	8.7 (1415)	12.9 (1178)	27.1 (627)
40-59	19.0 (1472)	23.2 (1431)	36.8 (1102)

Figure 44: Prevalence of obesity, overweight and high waist-hip ratio by year and by age groups (SHS)

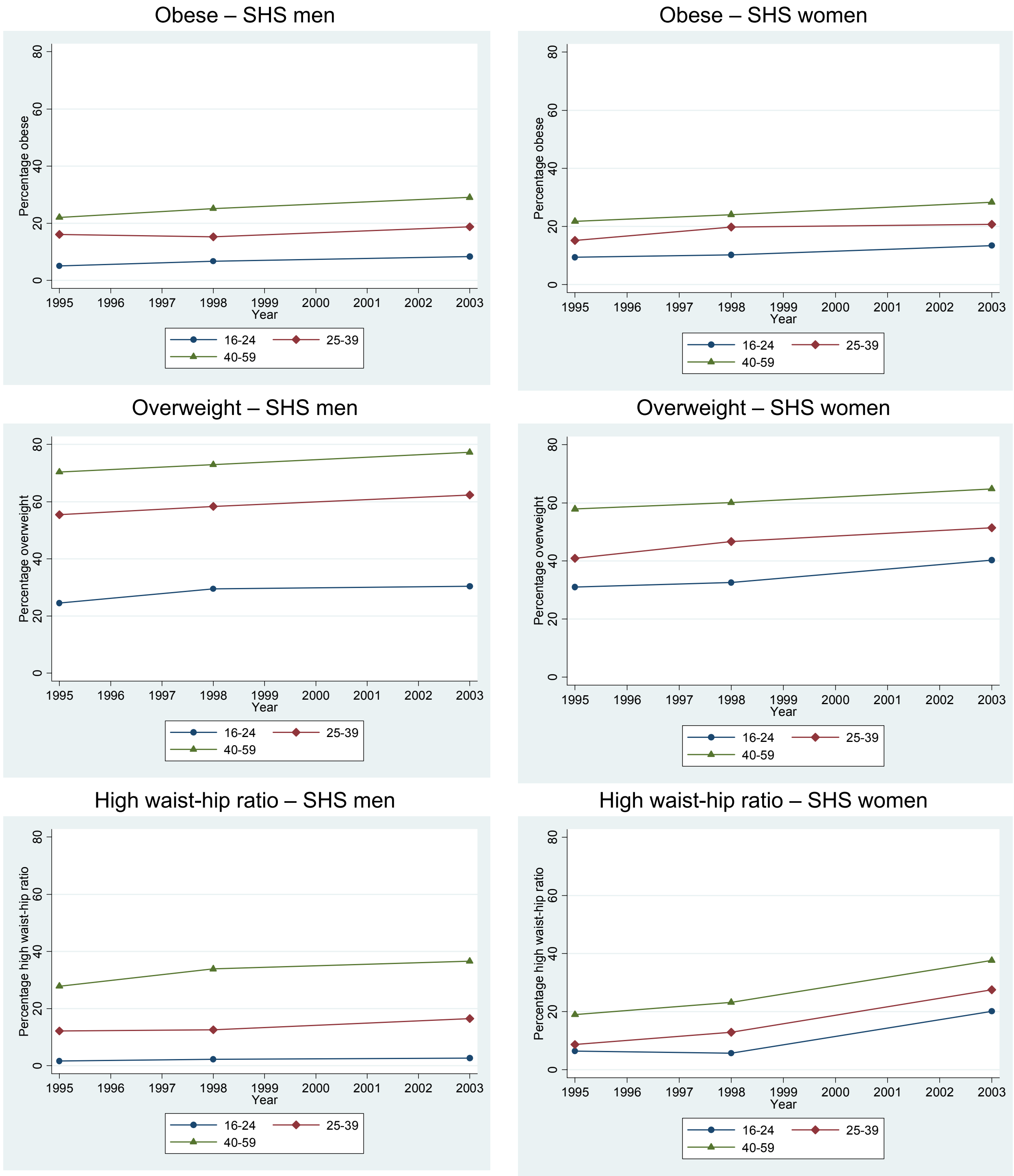


Table 54: Adjusted odds ratios for obesity, overweight and high WHR among men and women by survey year and age group (SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Obese		
Year	*[n=8894, P=0.0003]* †	*[n=9533, P<0.0001]* †
1995	1	1
1998	1.10 (0.95-1.27)	1.22 (1.08-1.38)
2003	1.37 (1.17-1.60)	1.45 (1.26-1.66)
Age group	*[n=8894, P<0.0001]* †	*[n=9533, P<0.0001]* †
16-24	1	1
25-39	2.89 (2.20-3.79)	1.85 (1.50-2.28)
40-59	4.86 (3.73-6.32)	2.65 (2.16-3.25)
Overweight		
Year	*[n=8894, P<0.0001]* †	*[n=9533, P<0.0001]* †
1995	1	1
1998	1.15 (1.02-1.29)	1.16 (1.04-1.28)
2003	1.37 (1.20-1.57)	1.44 (1.28-1.61)
Age group	*[n=8894, P<0.0001]* †	*[n=9533, P<0.0001]* †
16-24	1	1
25-39	3.69 (3.14-4.35)	1.63 (1.41-1.88)
40-59	7.21 (6.13-8.48)	2.96 (2.57-3.41)
High waist-hip ratio		
Year	*[n=8580, P=0.0008]* †	*[n=8993, P<0.0001]* †
1995	1	1
1998	1.24 (1.07-1.44)	1.34 (1.15-1.55)
2003	1.48 (1.24-1.76)	3.08 (2.63-3.60)
Age group	*[n=8580, P<0.0001]* †	*[n=8993, P<0.0001]* †
16-24	1	1
25-39	7.11 (4.23-11.97)	1.60 (1.22-2.10)
40-59	21.64 (12.99-36.04)	3.07 (2.38-3.97)

* Separate logistic regressions for each outcome by gender
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Associations between obesity, overweight and high waist-hip ratio and socioeconomic position

Table 55 shows the prevalence of obesity, overweight and high WHR across social class and educational groups, gender and survey year. Figure 45 illustrates these results graphically and Table 56 shows the results of the logistic regression models fitted to the data.

In general, the prevalence of obesity, overweight and high WHR was higher in the manual Social Class subgroup, and in those who left school aged less than 16. There was a statistically significant association between both of the indicators of socioeconomic position for most of outcomes in men and women: the exceptions were the lack of significant association between obesity or overweight with social class in men. The models included terms for the interactions between the SEP variables and either survey year or age-group, but few were significant. In particular, there was no evidence that the gap between the SEP groups has changed significantly over the years. However, there was a significant interaction between age left school and both obesity and being overweight in men (P=0.006 and 0.001). As with the results from the HSE, there was a higher prevalence of obese and overweight men who stayed in education after 16 in the lowest age group, whereas in all other age groups those leaving school early had a higher prevalence of overweight individuals.

Table 55: Percentage (unweighted sample size) obese, overweight and with high waist-hip ratio by gender, survey year and socioeconomic position (SHS)

	Survey years		
	1995	1998	2003
Men			
Obesity			
Social class			
Non-manual	16.0 (1487)	19.9 (1579)	21.1 (1524)
Manual	17.8 (1830)	20.9 (1923)	24.3 (1431)
Left school			
16+ years	11.6 (1053)	16.7 (1105)	19.4 (977)
<16 years	20.2 (2281)	22.9 (2309)	26.1 (1812)
Overweight			
Social class			
Non-manual	58.2 (1487)	65.4 (1579)	66.9 (1524)
Manual	57.4 (1830)	63.5 (1923)	64.5 (1431)
Left school			
16+ years	52.3 (1053)	61.7 (1105)	65.8 (977)
<16 years	62.6 (2281)	66.9 (2309)	68.6 (1812)
High waist-hip ratio			
Social class			
Non-manual	15.4 (1330)	25.3 (1424)	25.3 (1217)
Manual	21.5 (1606)	30.4 (1731)	32.4 (1098)
Left school			
16+ years	12.1 (924)	19.5 (984)	22.5 (786)
<16 years	23.2 (2012)	33.0 (2089)	35.6 (1405)
Women			
Obesity			
Social class			
Non-manual	15.1 (2086)	20.0 (2331)	21.8 (1977)
Manual	21.1 (1895)	26.7 (2052)	31.3 (1599)
Left school			
16+ years	13.0 (1354)	16.1 (1451)	21.3 (1300)
<16 years	21.6 (2720)	27.4 (2878)	30.7 (2150)
Overweight			
Social class			
Non-manual	45.3 (2086)	53.0 (2331)	58.0 (1977)
Manual	53.2 (1895)	59.0 (2052)	63.2 (1599)
Left school			
16+ years	42.5 (13548)	47.5 (1451)	54.4 (1300)
<16 years	51.1 (2720)	56.0 (2878)	63.5 (2150)
High waist-hip ratio			
Social class			
Non-manual	11.4 (1843)	19.8 (2102)	33.4 (1569)
Manual	17.1 (1650)	26.1 (1800)	41.7 (1201)
Left school			
16+ years	9.1 (1201)	11.4 (1140)	238 (859)
<16 years	16.9 (2358)	28.01 (2542)	43.9 (1642)

Figure 45: Prevalence of obesity, overweight and high waist-hip ratio by year and SEP (SHS)

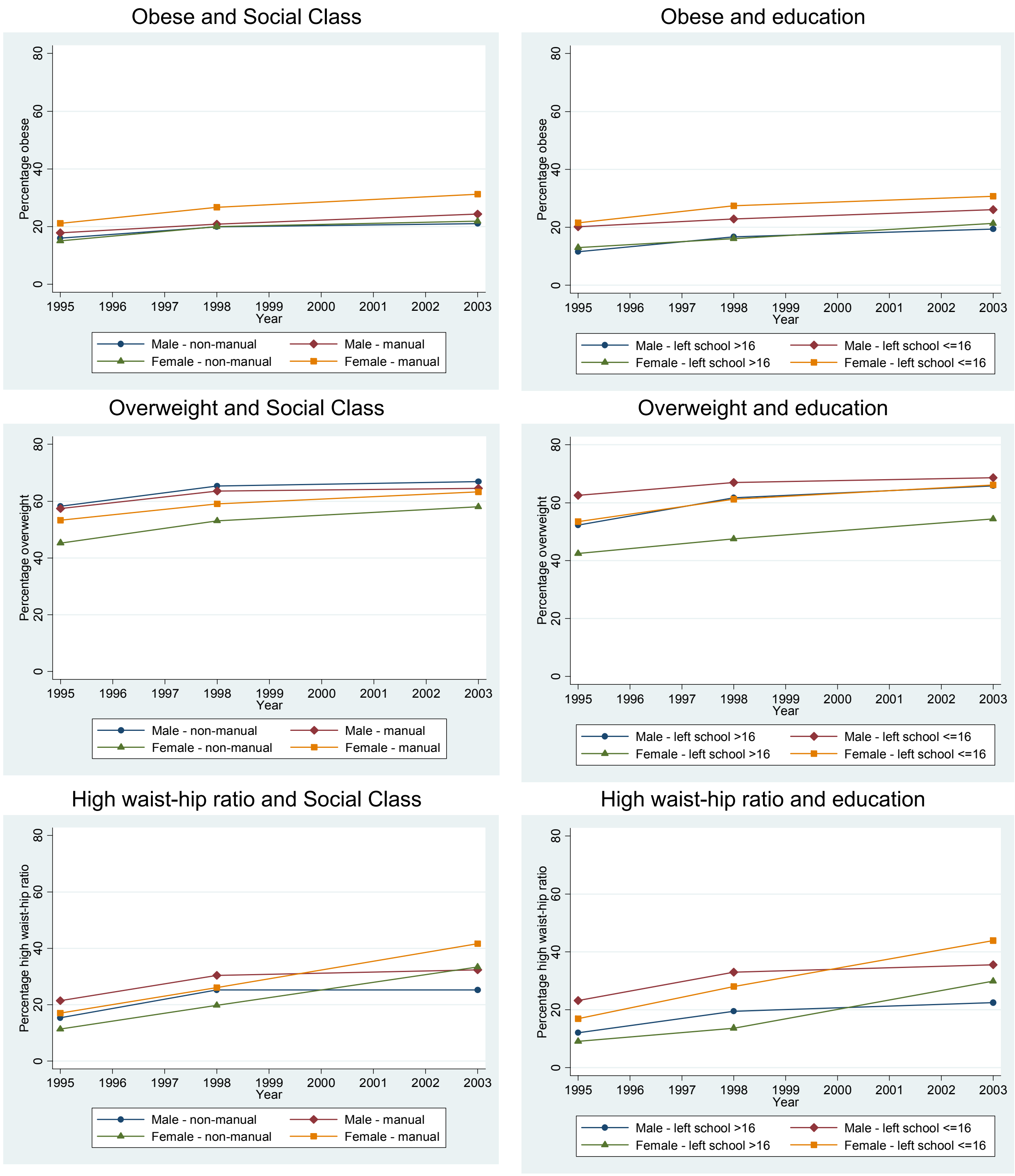


Table 56: Adjusted odds ratios for obesity, overweight and high waist-hip ratio with indicators of socioeconomic position (SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Obese		
Social Class	*[n=8527, P=0.094]* †	*[n=9090, P<0.001]* †
Non-manual	1	1
Manual	1.11 (0.98-1.26)	1.56 (1.39-1.74)
Left school	*[n=8151, P<0.001]* †	*[n=7662, P<0.001]* †
16+	1	1
<16	1.45 (1.27-1.66)	1.48 (1.32-1.66)
Overweight		
Social Class	*[n=8527, P=0.138]* †	*[n=9090, P<0.001]* †
Non-manual	1	1
Manual	0.92 (0.83-1.03)	1.34 (1.23-1.47)
Left school	*[n=8151, P=0.035]* †	*[n=7662, P<0.001]* †
16+	1	1
<16	1.13 (1.01-1.26)	1.33 (1.22-1.47)
High waist-hip ratio		
Social Class	*[n=8270, P<0.001]* †	*[n=8625, P<0.001]* †
Non-manual	1	1
Manual	1.40 (1.22-1.61)	1.53 (1.34-1.74)
Left school	*[n=7828, P<0.001]* †	*[n=8237, P<0.001]* †
16+	1	1
<16	1.61 (1.38-1.88)	1.66 (1.45-1.91)

* Separate logistic regressions for each outcome by gender adjusting for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Trends in dietary intake

The only indicator of diet available in the SHS was the type of the milk usually consumed: the consumption of fruit and vegetables was only available in 2003 and therefore gave no information on trends over time. Table 57 shows the prevalence of obesity, overweight and high WHR across the milk consumption groups, gender and survey year. Figure 46 illustrates these results graphically and Table 58 shows the results of the logistic regression models fitted to the data.

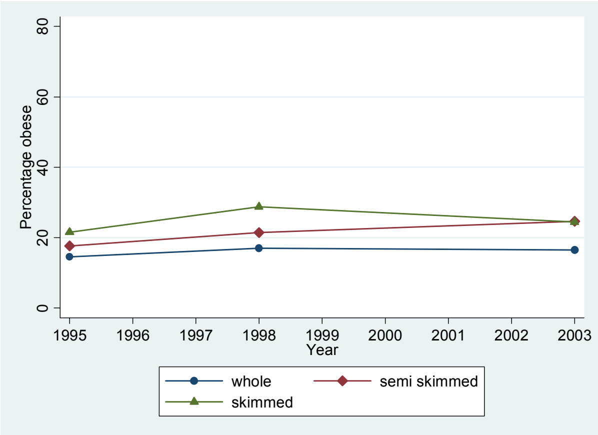
There were significant associations between the milk type consumed and measures of general and central obesity in both men and women. However, the patterns varied with the outcome. Those adults drinking skimmed or semi-skimmed milk were more likely to be obese or overweight than those drinking whole milk. Whereas those women drinking skimmed or semi-skimmed milk were slightly less likely to have a high WHR than those drinking whole milk, there was no significant association with waist hip ratio for men. The models included terms for the interaction between the milk type and either survey year or age-group with each outcome, but none were significant. In particular, there was no evidence that the gap between the milk consumption groups in each outcome has changed significantly over time.

Table 57: Percentage (unweighted sample size) of obesity, overweight and high WHR by gender, survey year and milk consumption (SHS)

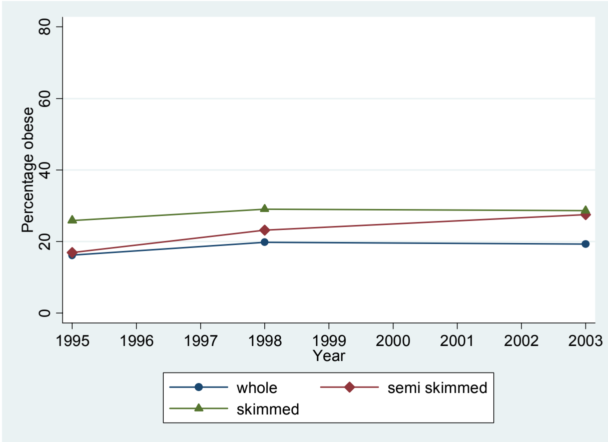
	Survey years		
	1995	1998	2003
Men			
Obesity			
Whole	14.5 (1279)	17.0 (1242)	16.6 (883)
Semi skimmed	17.6 (1822)	21.5 (1957)	24.6 (1819)
Skimmed	21.6 (223)	28.7 (226)	24.5 (191)
Overweight			
Whole	50.9 (1149)	55.4 (947)	56.3 (584)
Semi skimmed	60.4 (1653)	64.3 (1561)	69.7 (1296)
Skimmed	68.1 (188)	73.8 (160)	80.5 (133)
High waist hip ratio			
Whole	18.7 (1121)	27.1 (1101)	29.7 (664)
Semi skimmed	17.5 (1606)	27.8 (1770)	29.0 (1428)
Skimmed	21.0 (200)	31.5 (216)	23.4 (160)
Women			
Obesity			
Whole	16.2 (1248)	19.8 (1212)	19.3 (825)
Semi skimmed	16.9 (2320)	23.2 (2602)	27.5 (2279)
Skimmed	25.9 (454)	29.0 (489)	28.6 (374)
Overweight			
Whole	40.6 (1115)	43.0 (877)	48.7 (550)
Semi skimmed	47.4 (2084)	51.9 (1976)	58.5 (1622)
Skimmed	60.1 (398)	60.4 (371)	67.7 (272)
High waist hip ratio			
Whole	15.7 (1065)	23.2 (1077)	42.7 (606)
Semi skimmed	12.2 (2045)	22.0 (2328)	36.1 (1786)
Skimmed	18.1 (412)	24.6 (431)	31.2 (295)

Figure 46: Prevalence of obesity, overweight and high waist-hip ratio by year and type of milk consumed (SHS)

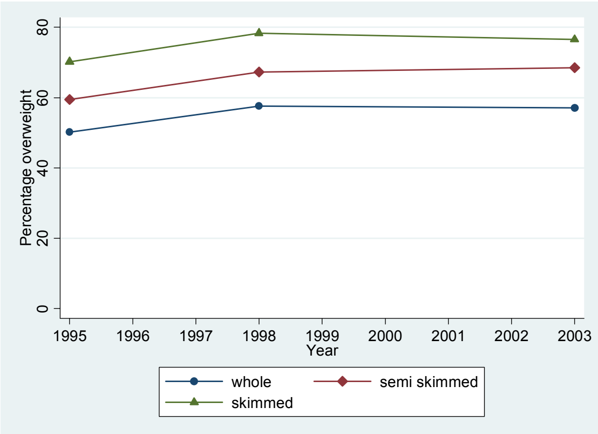
Obese – SHS men



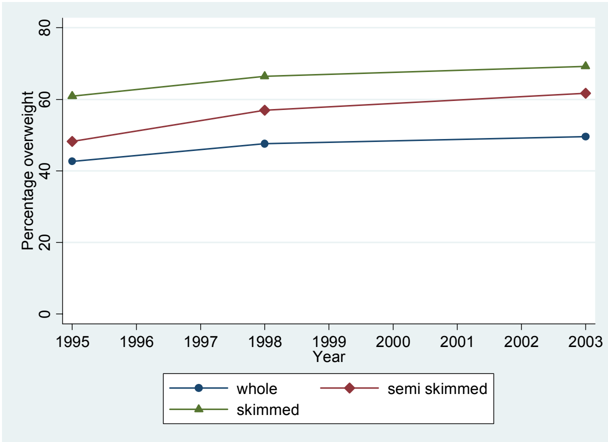
Obese– SHS women



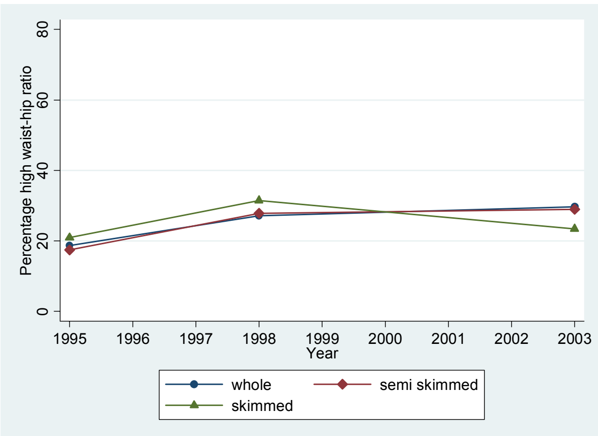
Overweight – SHS men



Overweight – SHS women



High waist-hip ratio – SHS men



High waist-hip ratio - SHS women

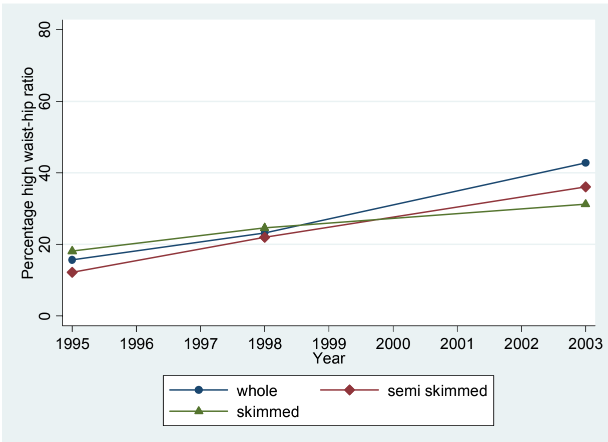


Table 58: Adjusted odds ratios for obesity, overweight and high waist-hip ratio and indicator of diet (SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Obese		
Milk type	*[n=8464, P<0.001]* †	*[n=9005, P<0.001]* †
Whole	1	1
Semi-skimmed	1.38 (1.20-1.59)	1.27 (1.08-1.41)
Skimmed	1.53 (1.19-1.97)	1.49 (1.23-1.80)
Overweight		
Milk type	*[n=8464, P<0.001]* †	*[n=9005, P<0.001]* †
Whole	1	1
Semi-skimmed	1.55 (1.39-1.73)	1.39 (1.25-1.54)
Skimmed	2.29 (1.78-2.94)	2.00 (1.71-2.35)
High Waist-hip ratio		
Milk type	*[n=8160, P=0.731]* †	*[n=5541, P=0.0015]* †
Whole	1	1
Semi-skimmed	0.97 (0.83-1.13)	0.77 (0.67-0.90)
Skimmed	0.89 (0.67-1.19)	0.74 (0.59-0.93)

* Separate logistic regressions for each outcome by gender
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Trends in physical activity

Figure 47 and Table 59 illustrate the patterns in prevalence of measures of obesity by activity level groups: the highest prevalence of general and central obesity occurred in the men and women with the lowest activity level, whilst the groups with highest activity levels had the lowest prevalence of obesity.

The results of the logistic regression for obesity, overweight and high WHR among adults by PA are shown in Table 60. The odds ratios for activity level show that those reporting higher activity levels had a lower level of overall and central obesity, but that this association was not always statistically significant. The associations with activity level were statistically significant except in overweight men. All interactions between activity level, age and year were tested and none were significant: specifically, there was no significant interaction between survey year and activity level (i.e. the trend in activity level did not change significantly over time).

Table 59: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by gender, survey year and activity variable (SHS)

	Survey years	
	1998	2003
Men		
Obesity		
Inactive	28.8 (728)	29.5 (581)
Light activity	21.2 (1781)	24.5 (1516)
Moderate	13.2 (1100)	16.1 (919)
Overweight		
Inactive	70.3 (728)	68.5 (581)
Light activity	66.4 (1781)	70.2 (1516)
Moderate	56.0 (1100)	57.2 (919)
High waist-hip ratio		
Inactive	46.0 (700)	46.9 (477)
Light activity	29.5 (1581)	32.9 (1193)
Moderate	12.2 (967)	13.5 (686)
Women		
Obesity		
Inactive	34.9 (847)	34.7 (711)
Light activity	20.2 (2671)	24.0 (2097)
Moderate	16.2 (1025)	18.4 (876)
Overweight		
Inactive	65.2 (847)	63.5 (711)
Light activity	56.0 (2671)	62.4 (2097)
Moderate	47.6 (1025)	51.8 (876)
High waist-hip ratio		
Inactive	36.7 (793)	47.7 (577)
Light activity	21.8 (2343)	38.7 (1596)
Moderate	12.9 (899)	24.6 (677)

Figure 47: Prevalence of obesity, overweight and high waist-hip ratio by year and activity level (SHS)

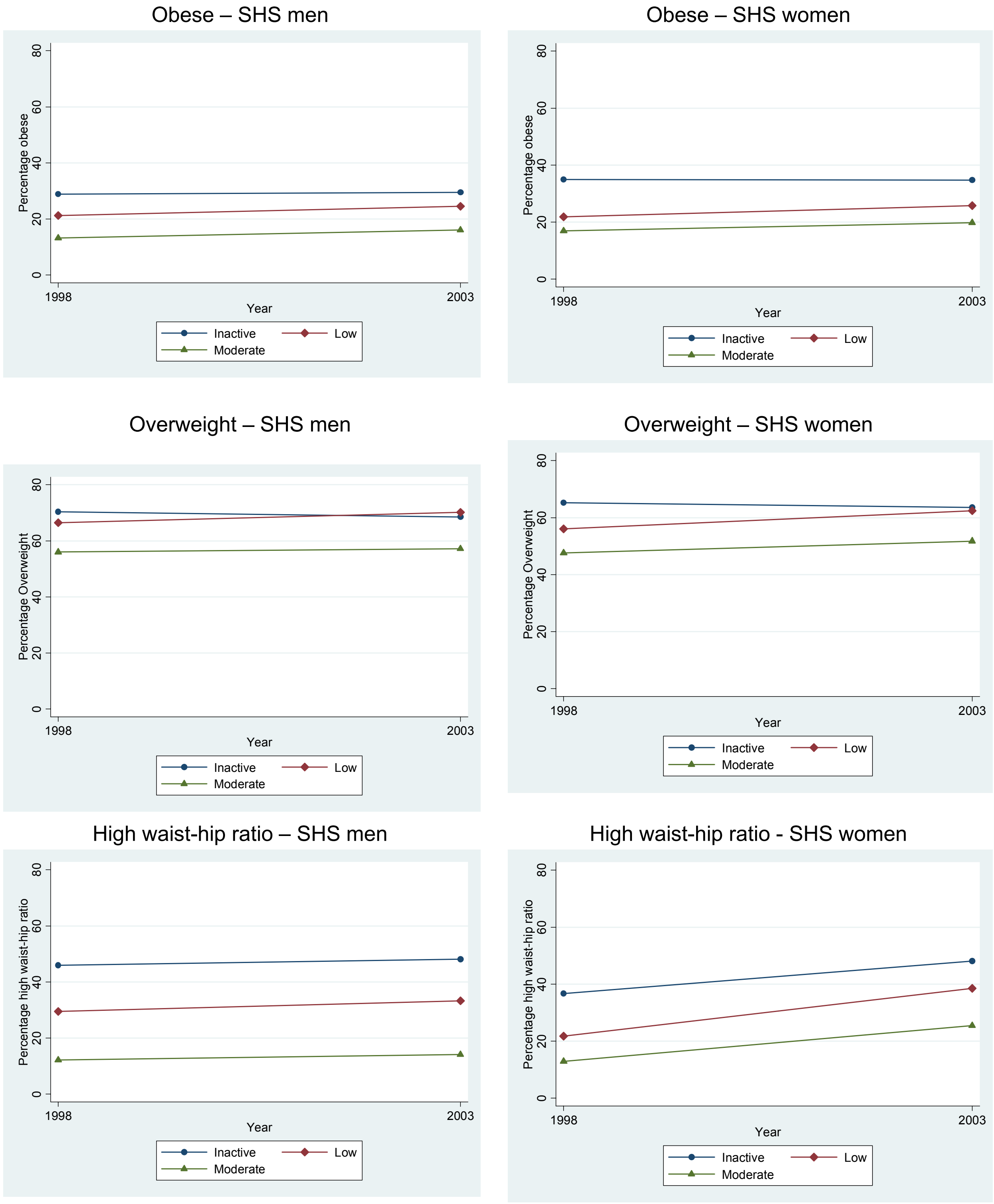


Table 60: Adjusted odds ratios for obesity, overweight and high waist-hip ratio and activity level (SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Obese		
Activity	*[n=5284, P<0.001]* †	*[n=5956, P<0.001]* †
Inactive	1	1
Light activity	0.76 (0.62-0.93)	0.58 (0.49-0.70)
Moderate	0.57 (0.45-0.72)	0.50 (0.40-0.61)
Overweight		
Activity	*[n=5284, P=0.645]* †	*[n=5956, P<0.001]* †
Inactive	1	1
Light activity	0.93 (0.76-1.14)	0.86 (0.73-1.02)
Moderate	0.90 (0.72-1.12)	0.72 (0.60-0.87)
High waist-hip ratio		
Activity	*[n=5365, P<0.001]* †	*[n=5851, P<0.001]* †
Inactive	1	1
Light activity	0.50 (0.40-0.62)	0.75 (0.61-0.93)
Moderate	0.28 (0.21-0.36)	0.48 (0.37-0.61)

* Separate logistic regressions for each outcome by gender
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Scottish Health Survey: children

Trends in overweight and obesity

Data were only available for children in 1998 and 2003 and a number of variables were not available in those years. The results therefore concentrate on variations by survey year, age group and a measure of socioeconomic position – the social class of the head of household. Table 61 shows the prevalence of obesity and overweight by gender, age-group, survey year and social class groups. Table 62 shows the results of the logistic regression models fitted to the data. The prevalence of obesity was low in children (around 5%), but overweight was more common (around 20%). The prevalence of obesity and overweight increased slightly between 1998 and 2003 in both boys and girls, but this was not statistically significant, except for overweight boys. There were no consistent patterns of obesity or overweight by age group.

Table 61: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by gender, survey year, age group and socioeconomic position (SHS)

	Survey years	
	1998	2003
Boys		
Obesity		
Age group		
2-4	6.7 (340)	5.8 (233)
5-10	4.3 (773)	6.2 (519)
11-15	3.7 (668)	4.5 (458)
Social Class		
Non-manual	3.5 (868)	5.1 (649)
Manual	5.1 (828)	6.0 (524)
Overweight		
Age group		
2-4	25.3 (340)	16.5 (233)
5-10	16.5 (773)	24.4 (519)
11-15	21.0 (668)	26.2 (458)
Social Class		
Non-manual	18.9 (868)	20.2 (649)
Manual	20.7 (828)	28.0 (524)
Girls		
Obesity		
Age group		
2-4	7.4 (337)	4.8 (211)
5-10	6.7 (731)	8.9 (539)
11-15	2.2 (637)	4.7 (465)
Social Class		
Non-manual	5.0 (825)	6.7 (638)
Manual	5.8 (787)	6.5 (528)
Overweight		
Age group		
2-4	30.2 (337)	26.6 (211)
5-10	25.5 (731)	28.2 (539)
11-15	24.3 (637)	23.3 (465)
Social Class		
Non-manual	23.9 (825)	24.9 (638)
Manual	28.3 (787)	26.4 (528)

Associations between overweight and obesity, and socioeconomic position

Table 61 shows that the prevalence of obesity and overweight was slightly higher in those boys where the head of household was in a manual social class group. Table 62 shows the association between social class and obesity and overweight. Although the odds ratios for social class were all slightly above 1, there was no significant association between social class group and either obesity or overweight in boys and girls with one exception: there was a significant association between being overweight and social class group in boys. The models included terms for the interaction between social class and either survey year or age-group for each outcome, but none were significant. In particular, there was no evidence that the gap between the social class groups had changed significantly between 1998 and 2003.

Table 62: Adjusted odds ratios for obesity and overweight with gender, survey year, age and father's social class (SHS)

	Boys	Girls
	OR* (95% CI)	OR* (95% CI)
Obese		
Year	*[n=3035, P=0.227]* †	*[n=2874, P=0.115]* †
1998	1	1
2003	1.23 (0.88-1.73)	1.30 (0.94-1.80)
Age group	*[n=3035, P=0.124]* †	*[n=2874, P<0.0001]* †
2-5	1	1
5-9	0.78 (0.51-1.20)	1.20 (0.78-1.84)
10-15	0.62 (0.39-0.98)	0.48 (0.29-0.81)
Social class	*[n=2898, P=0.088]* †	*[n=2731, P=0.725]* †
Non manual	1	1
Manual	1.35 (0.96-1.92)	1.06 (0.76-1.49)
Overweight		
Year	*[n=3035, P=0.016]* †	*[n=2874, P=0.928]* †
1998	1	1
2003	1.25 (1.04-1.51)	1.01 (0.84-1.20)
Age group	*[n=3035, P=0.151]* †	*[n=2874, P=0.107]* †
2-5	1	1
5-9	0.88 (0.68-1.13)	0.90 (0.71-1.14)
10-15	1.07 (0.83-1.38)	0.77 (0.60-0.99)
Social class	*[n=2898, P=0.008]* †	*[n=2731, P=0.089]* †
Non manual	1	1
Manual	1.29 (1.07-1.56)	1.17 (0.98-1.41)

* Separate logistic regressions for each outcome by gender. Models including social class adjusted for age group and survey year
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

England and Scotland Comparisons: Adults

Trends in obesity and overweight over time and by age group

The advantage of the availability of both the HSE and SHS data sets is that it enables a direct comparison of the outcomes between England and Scotland. This section will outline any differences between the two countries in the main outcome measures and then examine interactions between the variable for country and lifestyle factors across the outcomes.

Since SHS is only available in 1995, 1998 and 2003 all comparisons are restricted to these years. In some cases, where data are not available analysis has been restricted to only two survey years, in particular this is the case for WHR measurements. Due to inconsistencies in data collection among the higher age groups, results have only been analysed up to the age of 59 among adults.

Table 63: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by gender, survey year and age group for England and Scotland (HSE & SHS)

	England	Scotland	England	Scotland	England	Scotland
	1995*		1998		2003	
Men						
Obese						
16-24	6.0 (872)	5.0 (474)	5.6 (825)	6.7 (373)	8.7 (686)	8.4 (286)
25-39	12.6 (2017)	16.1 (1269)	15.9 (1929)	15.2 (1110)	20.1 (1550)	18.8 (695)
40-59	19.2 (2162)	22.0 (1415)	20.9 (2200)	25.2 (1327)	27.3 (2150)	29.0 (1129)
Overweight						
16-24	30.5 (872)	24.5 (474)	28.7 (825)	29.5 (373)	33.1 (686)	30.4 (286)
25-39	54.6 (2017)	55.4 (1269)	58.8 (1929)	58.3 (1110)	63.1 (1550)	62.4 (695)
40-59	68.4 (2162)	70.4 (1415)	72.3 (2200)	72.9 (1327)	75.9 (2150)	77.2 (1129)
High waist-hip ratio*						
16-24			2.3 (693)	2.3 (308)	4.0 (475)	2.7 (175)
25-39			12.6 (1715)	12.6 (951)	18.8 (1223)	16.5 (501)
40-59			33.3 (2062)	33.9 (1214)	42.3 (1845)	36.6 (889)
Women						
Obese						
16-24	8.0 (2488)	9.4 (515)	10.7 (2551)	10.2 (470)	13.6 (2528)	13.4 (336)
25-39	14.5 (2253)	15.2 (1630)	18.0 (2217)	19.8 (1356)	19.4 (1833)	20.7 (861)
40-59	20.1 (983)	21.8 (1668)	23.0 (903)	24.1 (1588)	25.3 (788)	28.3 (1394)
Overweight						
16-24	27.2 (983)	31.1 (515)	28.1 (903)	32.6 (470)	32.7 (788)	40.3 (336)
25-39	41.1 (2253)	40.9 (1630)	45.6 (2217)	46.7 (1356)	49.2 (1833)	51.4 (861)
40-59	56.5 (2488)	57.9 (1668)	58.8 (2551)	60.1 (1588)	60.5 (2528)	64.8 (1394)
High waist-hip ratio*						
16-24			5.9 (781)	5.7 (389)	11.6 (605)	20.1 (204)
25-39			9.9 (1997)	12.9 (1178)	20.3 (1489)	27.6 (627)
40-59			19.5 (2394)	23.2 (1431)	31.2 (2186)	37.6 (1102)

* High WHR data not available for 1995

Figure 48: Prevalence of obesity, overweight and high waist-hip ratio by survey year and age groups for England and Scotland (HSE & SHS)

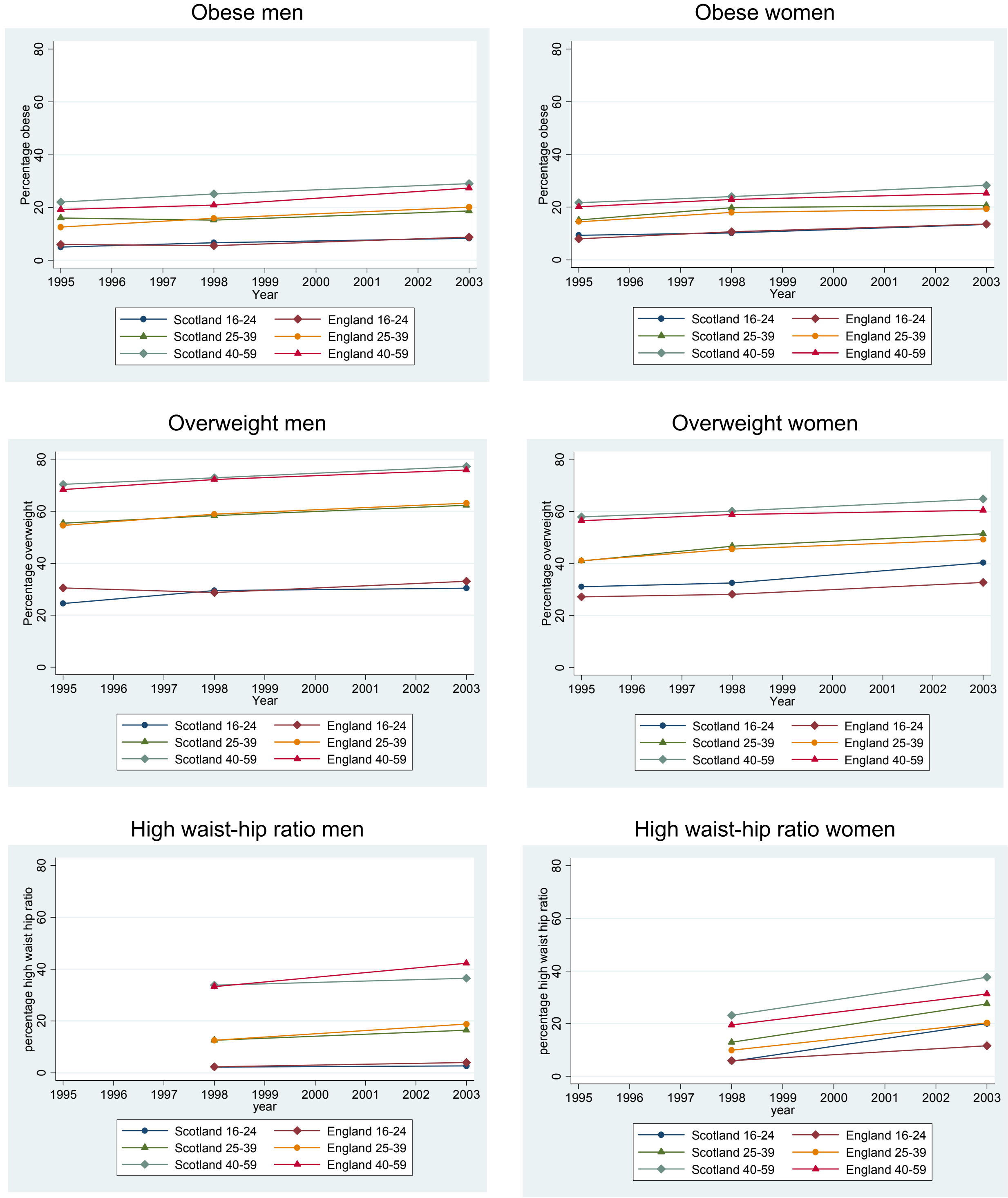


Table 63 shows the prevalence of obesity, overweight and high WHR by gender, survey year and age group. Figure 48 illustrates these results graphically. Table 64 shows the results of the logistic regression models fitted to these data. Results have been reported separately by gender as there were significant interactions between gender and year of survey and gender and age group for all three outcomes. The prevalence of obesity and overweight was slightly lower in England than Scotland for both men and women and this was statistically significant for all outcomes except being overweight in men. There were no statistically significant interactions between overweight or obesity and survey year, so there is little evidence to suggest that there are any differences in trends over time between England and Scotland. There were also no significant interactions for obesity or overweight between country and age, so, again, there is little evidence to suggest that any difference between countries varied across the age groups.

In men, a high WHR was significantly more prevalent in England than Scotland, whereas in women it was more prevalent in Scotland. The large increase over time in the prevalence of a high WHR among Scottish women was reported in the SHS analysis, and there appeared to be a widening gap between England and Scotland from 1998 to 2003. However, the interaction term between the country and year was not statistically significant for WHR (P=0.137), and so this apparent difference in trend between England and Scotland may be explained by random variation.

Table 64: Adjusted odds ratios for obesity, overweight and high waist-hip ratio with country (HSE & SHS)

	Men	Women
	OR* (95%CI)	OR* (95%CI)
Obese		
Country	*[n=23285, P=0.003]* †	*[n=26078, P=0.008]* †
Scotland	1	1
England	0.89 (0.83-0.96)	0.91 (0.86-0.98)
Overweight		
Country	*[n=23285, P=0.937]* †	*[n=26078, P=0.001]* †
Scotland	1	1
England	1.00 (0.94-1.06)	0.91 (0.86-0.96)
High waist-hip ratio		
Country	*[n=13378, P=0.035]* †	*[n=15304, P<0.001]* †
Scotland	1	1
England	1.11 (1.01-1.23)	0.73 (0.67-0.80)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group.
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Trends in measures of socioeconomic position across England and Scotland

Trends were considered first for whether or not the head of household was in a manual social class. Figure 49 shows the percentage of the population in the manual social class over time, by age group and country. Table 65 shows the odds ratios for the related regression model. From Figure 49 it can be seen that there was a slightly higher percentage of men in the manual social class in Scotland across all age groups and this was significant. However, from Table 65 it can be seen that there was very little difference between England and Scotland for women.

I think the labelling in the following graph would be better if all Scottish ages were in one column and all the English in the other

Figure 49: Percentage of population in manual social class (HSE & SHS)

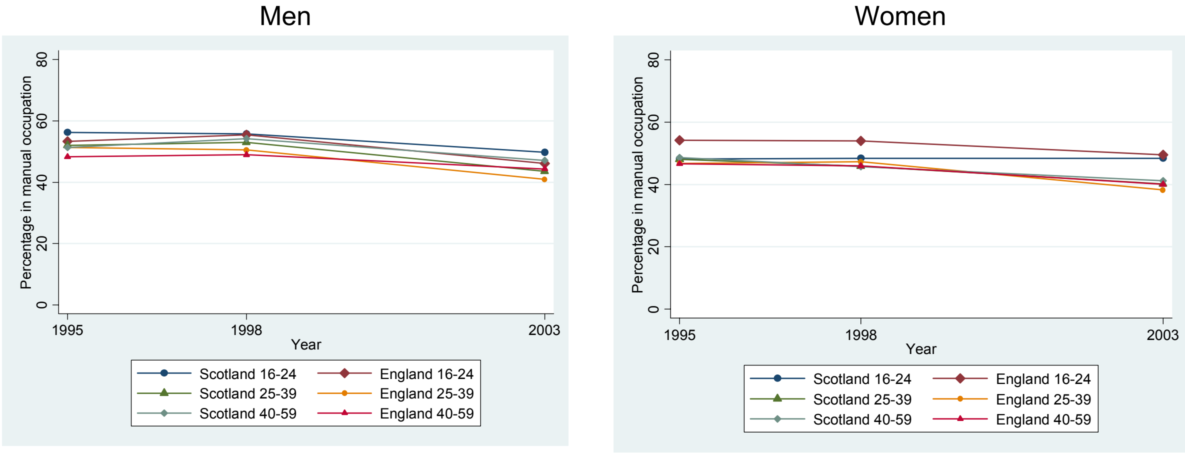


Table 65: Adjusted odds ratios for manual social class with country (HSE & SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Country	*[n=24039, P<0.001]* †	*[n=27607, P=0.961]* †
Scotland	1	1
England	0.89 (0.84-0.95)	1.00 (0.95-1.05)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group.
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Associations between overweight and obesity, and socioeconomic position

Looking at general and central obesity as the outcome measures, Table 66 shows the prevalence of obesity, overweight and high WHR across social class and educational attainment groups, gender, survey year and country. Figure 50 and Figure 51 illustrate the results graphically.

Table 66: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by country, gender, survey year and socioeconomic position (HSE & SHS)

	England	Scotland	England	Scotland	England	Scotland
	1995*		1998		2003	
Men						
Obese						
Social class group						
Non Manual	14.3 (3174)	16.0 (1487)	15.9 (3154)	19.9 (1579)	21.9 (3218)	21.1 (1524)
Manual	17.2 (3349)	17.8 (1830)	19.0 (3311)	20.9 (1923)	24.4 (2639)	24.3 (1431)
Age Left School						
16+ years	12.8 (2094)	11.6 (1053)	14.0 (2048)	16.7 (1105)	19.3 (2124)	19.4 (977)
≤16	17.5 (4382)	20.2 (2281)	19.5 (4158)	22.9 (2309)	26.1 (3464)	26.1 (1812)
Overweight						
Social class group						
Non Manual	60.3 (3174)	58.2 (1487)	60.6 (3154)	65.4 (1579)	63.3 (3218)	66.9 (1524)
Manual	63.3 (3349)	57.4 (1830)	68.0 (3311)	63.5 (1923)	67.1 (2639)	64.5 (1431)
Age Left School						
16+ years	56.6 (2094)	52.3 (1053)	59.4 (2048)	61.7 (1105)	65.6 (2124)	65.8 (977)
≤16	63.6 (4382)	62.6 (2281)	67.3 (4158)	66.9 (2309)	71.1 (3464)	68.6 (1812)
High waist-hip ratio*						
Social class group						
Non Manual			23.7 (2915)	25.3 (1424)	32.8 (2695)	25.3 (1217)
Manual			31.6 (3062)	30.4 (1731)	41.7 (2189)	32.4 (1098)
Age Left School						
16+ years			19.6 (1838)	19.5 (984)	28.0 (1742)	22.5 (786)
≤16			32.8 (3909)	33.0 (2089)	43.7 (2923)	35.6 (1405)
Women						
Obese						
Social class group						
Non Manual	13.9 (3785)	15.1 (2086)	18.1 (3895)	20.0 (2331)	19.7 (3977)	21.8 (1977)
Manual	22.2 (3570)	21.1 (1895)	24.9 (3613)	26.7 (2052)	28.7 (2902)	31.3 (1599)
Age Left School						
16+ years	13.4 (2418)	13.0 (1354)	17.2 (2436)	16.1 (1451)	18.1 (2555)	21.3 (1300)
≤16	20.7 (5096)	21.6 (2720)	23.8 (4851)	27.4 (2878)	28.0 (4061)	30.7 (2150)
Overweight						
Social class group						
Non Manual	47.7 (3785)	45.3 (2086)	50.4 (3895)	53.0 (2331)	52.7 (3977)	58.0 (1977)
Manual	55.0 (3570)	53.2 (1895)	57.4 (3613)	59.0 (2052)	62.7 (2902)	63.2 (1599)
Age Left School						
16+ years	42.5 (2418)	42.5 (1354)	45.9 (2436)	47.5 (1451)	48.2 (2555)	54.4 (1300)
≤16	56.6 (5096)	53.5 (2720)	58.9 (4851)	61.2 (2878)	64.3 (4061)	66.1 (2150)
High waist-hip ratio*						
Social class group						
Non Manual			17.5 (3592)	19.8 (2102)	27.0 (3396)	33.4 (1569)
Manual			22.3 (3343)	26.1 (1800)	37.2 (2436)	41.7 (1201)
Age Left School						
16+ years			12.9 (2245)	13.7 (1302)	22.2 (2187)	29.9 (103)0
≤16			24.3 (4505)	28.0 (2542)	38.0 (3419)	43.9 (1642)

* High WHR data not available for 1995

Figure 50: Prevalence of obesity, overweight and high waist-hip ratio by year and social class (HSE & SHS)

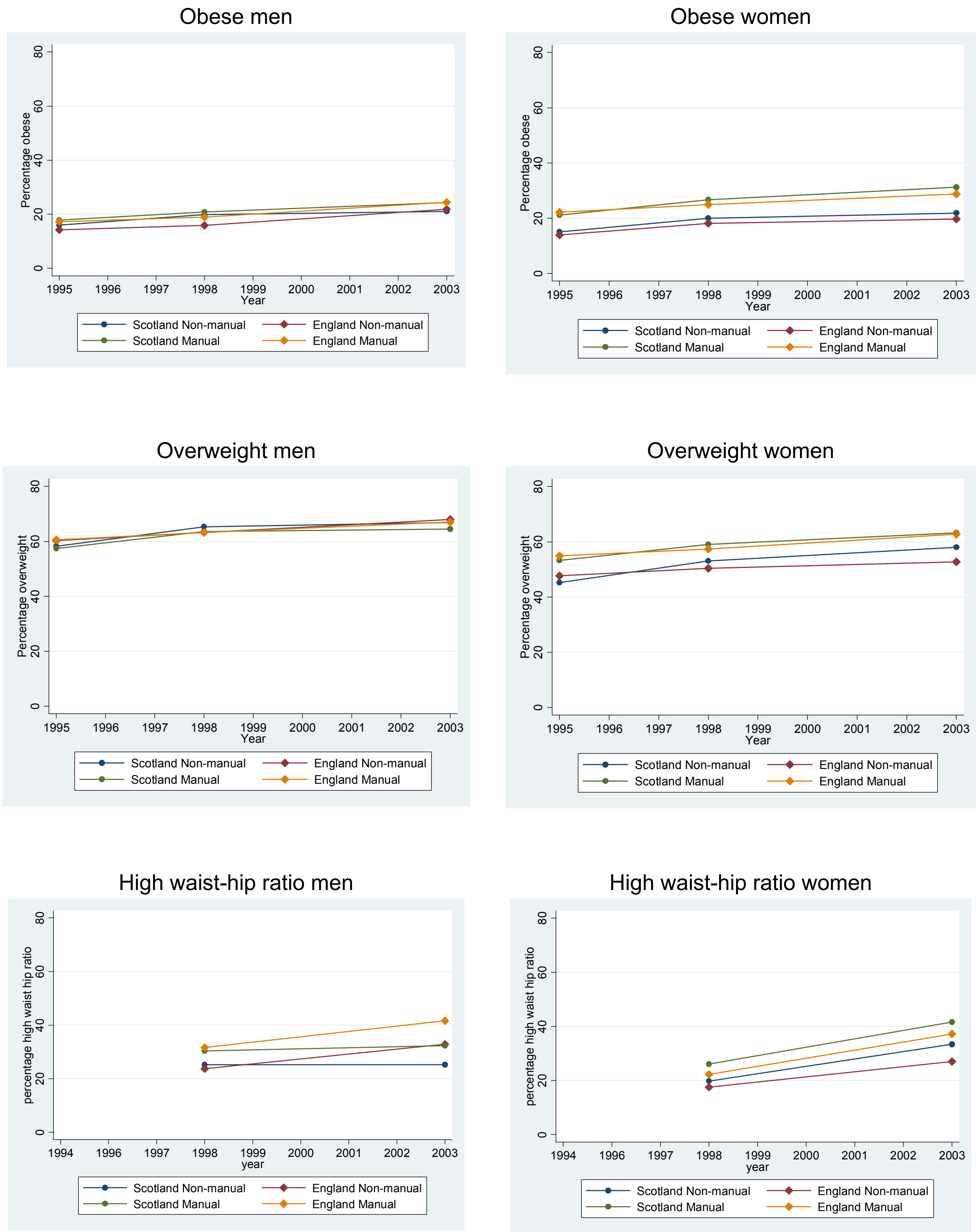
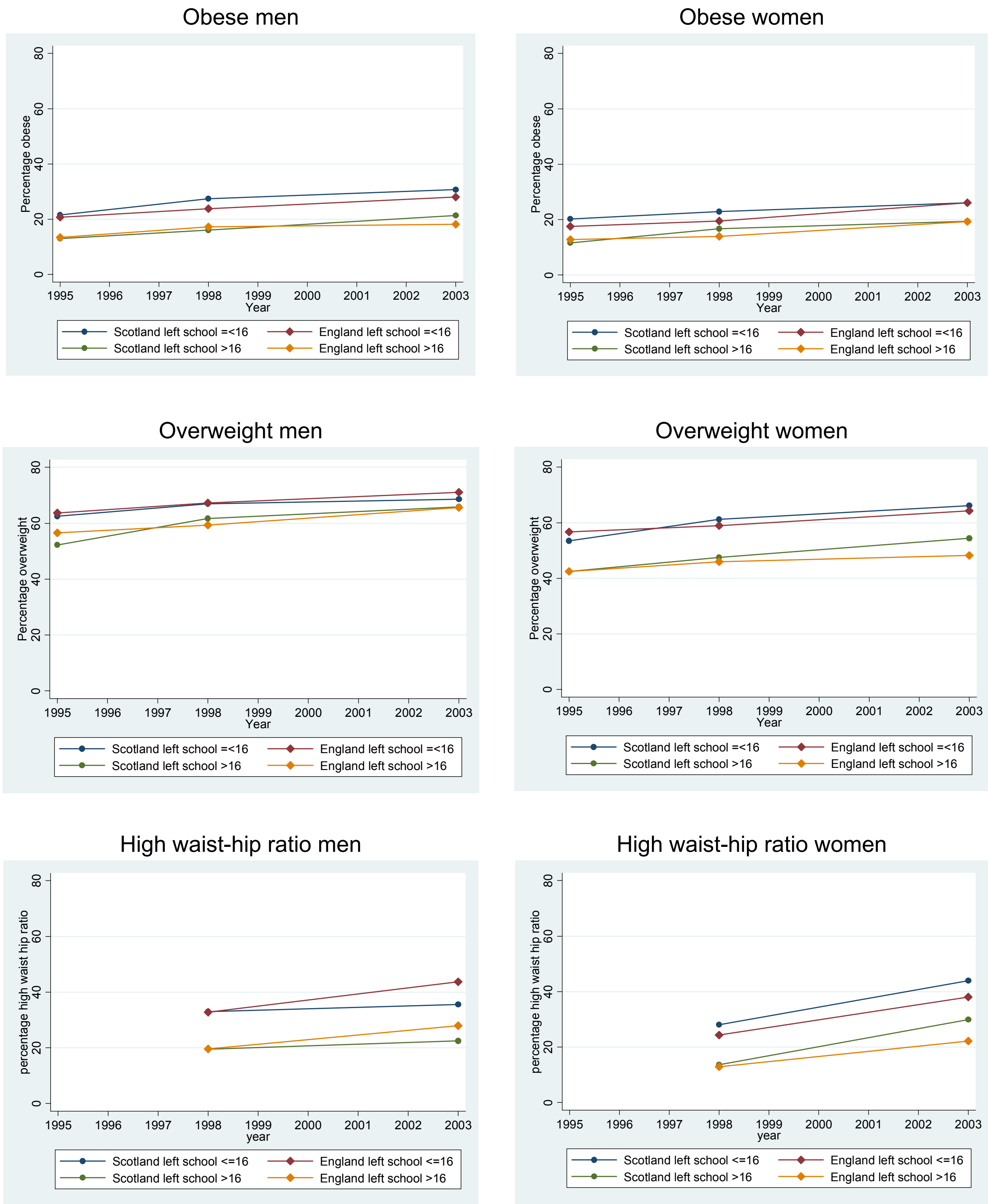


Figure 51: Prevalence of obesity, overweight and high waist-hip ratio by year and educational attainment (HSE & SHS)



There were no significant interactions between country and social class, and country and education in the analyses of each outcome, so there was no evidence to suggest that the association between socioeconomic position and outcomes differed in England and Scotland.

Trends in dietary intake

The variable for milk consumption was the only dietary measure available for both countries. This was only available in 1998 and 2003. A regression model using whether or not an individual consumed whole milk as the outcome measure illustrated the trend for whole milk consumption in the whole population.

Figure 52: Percentage of population drinking whole milk (HSE & SHS)

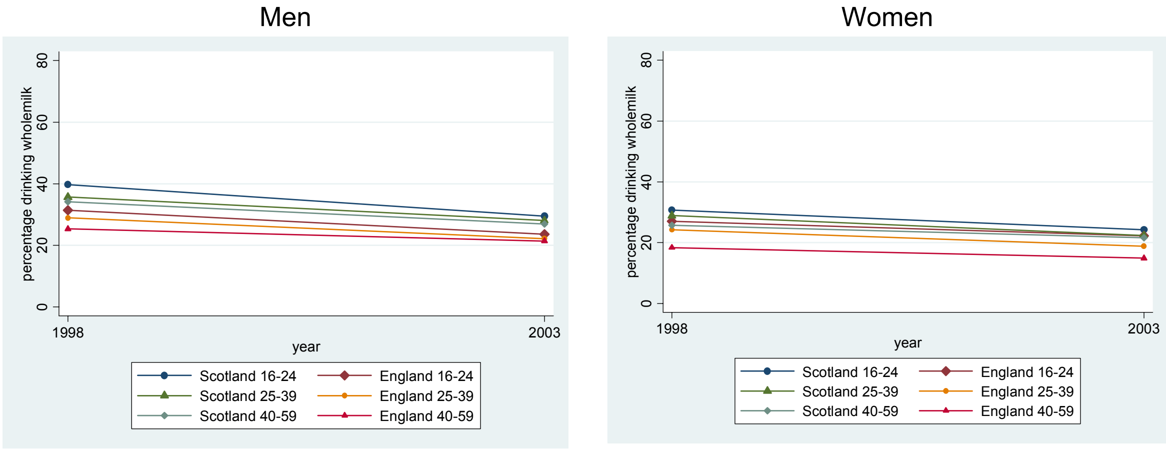


Figure 52 shows the percentage of men and women consuming whole milk in England and Scotland by age and survey year. Table 67 shows the results of the logistic regression for this model. The graphs show that a higher proportion of the population drank whole milk in Scotland across all age groups, although consumption of whole milk decreased over time in both countries. The difference in milk consumption in England and Scotland was significant, as can be seen by the odds ratios in Table 68. There were no significant interactions between country and year, or country and age group for the consumption of whole milk: so there is no evidence to suggest that the pattern of whole milk consumption is different in England and Scotland either by time or age group.

Table 67: Adjusted odds ratios for consumption of whole milk with country (HSE & SHS)

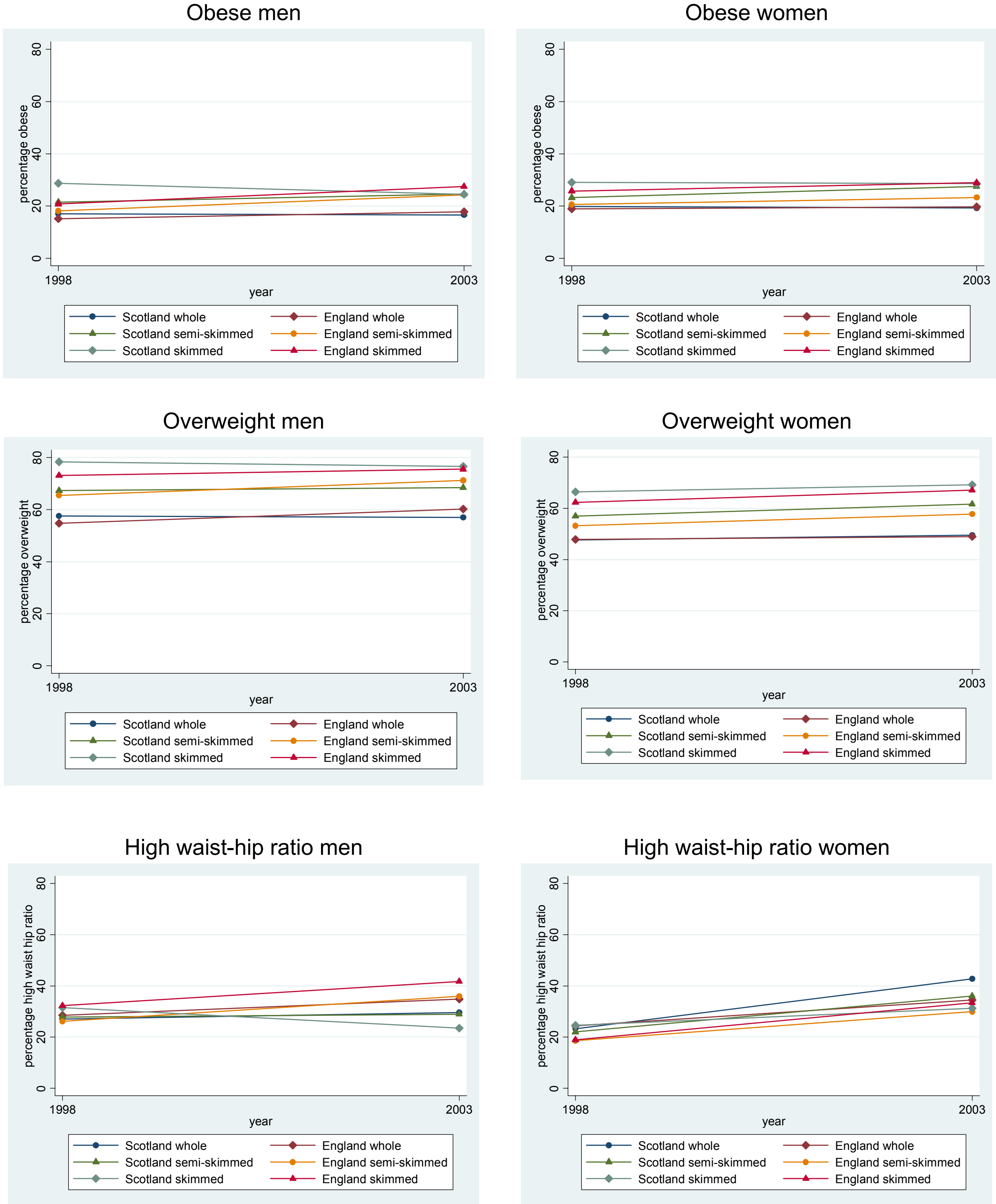
	Men	Women
	OR* (95% CI)	OR* (95% CI)
Country	*[n=14047, P<0.0001]*†	*[n=16559, P<0.0001]*†
Scotland	1	1
England	0.71 (0.66-0.77)	0.73 (0.67-0.81)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

Table 68: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by country, gender, survey year and dietary variables (HSE & SHS)

	England	Scotland	England	Scotland
	1998		2003	
Men				
Obese				
Whole	15.1 (1823)	17.0 (1242)	17.8 (990)	16.6 (883)
Semi skimmed	18.1 (3716)	21.5 (1957)	24.2 (2907)	24.6 (1819)
skimmed	20.8 (756)	28.8 (226)	27.5 (560)	24.5 (191)
Overweight				
Whole	54.8 (1823)	57.6 (1242)	60.2 (990)	57.0 (883)
Semi skimmed	65.4 (3716)	67.3 (1957)	71.2 (2907)	68.5 (1819)
skimmed	73.1 (756)	78.3 (226)	75.5 (560)	76.6 (191)
High waist-hip ratio				
Whole	28.5 (1670)	27.1 (1101)	34.9 (1041)	29.7 (664)
Semi skimmed	26.1 (3461)	27.8 (1770)	35.9 (3010)	29.0 (1428)
skimmed	32.3 (691)	31.5 (216)	41.8 (594)	23.4 (160)
Women				
Obese				
Whole	18.9 (1731)	19.8 (1212)	19.7 (904)	19.3 (825)
Semi skimmed	20.6 (4353)	23.2 (2602)	23.2 (3437)	27.5 (2279)
skimmed	25.8 (1231)	29.0 (489)	28.9 (962)	28.7 (374)
Overweight				
Whole	47.8 (1731)	47.6 (1212)	49.0 (904)	49.6 (825)
Semi skimmed	53.2 (4353)	57.0 (2602)	57.8 (3437)	61.7 (2279)
skimmed	62.3 (1231)	66.5 (489)	67.2 (962)	69.2 (374)
High waist-hip ratio				
Whole	24.4 (1593)	23.2 (1077)	34.5 (961)	42.7 (606)
Semi skimmed	18.6 (4013)	22.0 (2328)	30.0 (3587)	36.1 (1786)
skimmed	19.0 (1166)	24.6 (431)	33.4 (1026)	31.2 (295)

Figure 53: Prevalence of obesity, overweight and high waist-hip ratio by year and type of milk consumed (HSE & SHS)



Looking at central and general obesity as the outcome measures, Table 68 and Figure 53 illustrate the patterns in milk consumption for each of the outcomes by survey year, country and type of milk consumed. The logistic regression models showed that there were no significant interactions between the country and the type of milk consumed for each outcome, so there was little or no evidence that the association between central or general obesity and milk consumption differed between England and Scotland.

Trends in physical activity

Population trends for England and Scotland were investigated first. In this model the binary outcome variable was whether or not an individual had a high activity level. The activity variable was only available in 1998 and 2003.

Figure 54: Percentage of population with high activity level (HSE & SHS)

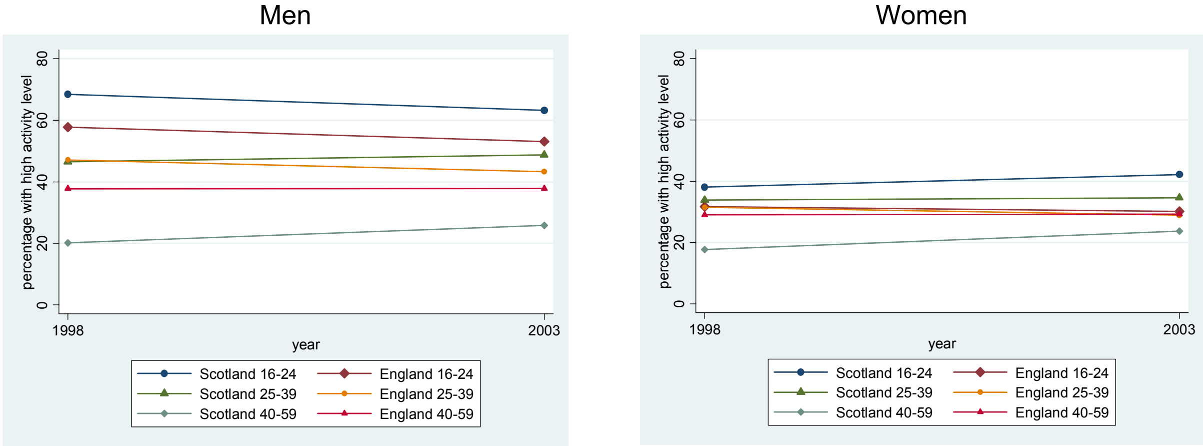


Figure 54 shows the percentage of the population with high activity levels in England and Scotland by age group and survey period. The odds ratios for the regression model are shown in Table 69. In general, the percentage of individuals with high activity levels was greater in England than Scotland, although there is some variation between the age groups. This association was statistically significant for men, but not for women.

Table 69: Adjusted odds ratios for high activity levels by country (HSE & SHS adults)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Country	*[n=15967, P<0.0001]*†	*[n=18919, P=0.11]*†
Scotland	1	1
England	1.22 (1.14-1.31)	1.06 (0.99-1.13)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test of set of model terms immediately below

There was a significant interaction between country and year for high activity levels among both men and women (P<0.001) and this is illustrated in Figure 55. For both men and women there was an increase in the percentage of individuals with high activity levels in Scotland between 1998 and 2003, whilst there was a decrease in England: so the gap between England and Scotland has narrowed.

Figure 55: Interaction between country and survey year for high activity level (HSE & SHS)

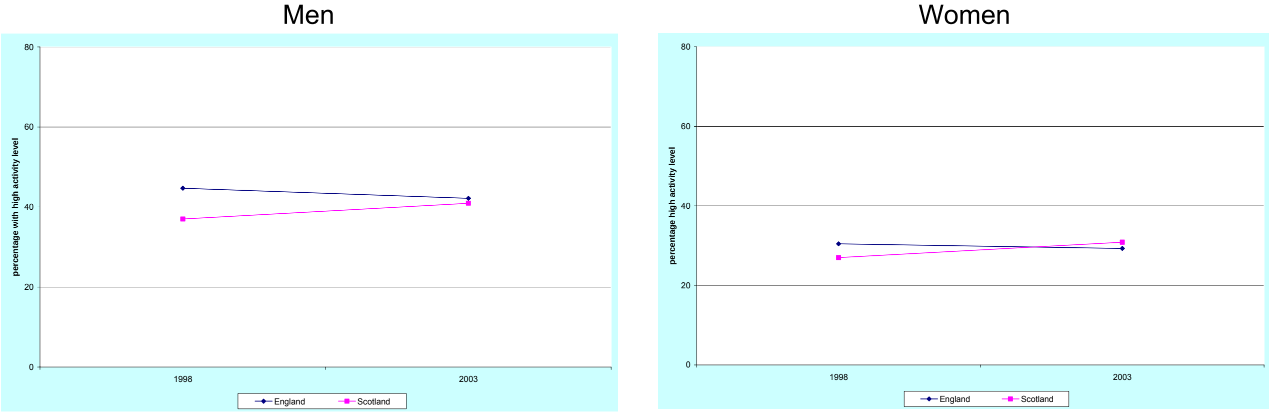


Table 70: Percentage (unweighted sample size) of obesity, overweight and high waist-hip ratio by country, gender, survey year and activity variable (HSE & SHS)

	England	Scotland	England	Scotland
	1998		2003	
Men				
Obese				
Low	22.4 *(2172)*	28.8 *(728)*	28.6 *(1886)*	29.5 *(581)*
Moderate	17.1 *(1890)*	21.2 *(1781)*	22.2 *(1913)*	24.5 *(1516)*
High	13.2 *(2528)*	13.2 *(1100)*	18.6 *(2157)*	16.1 *(919)*
Overweight				
Low	67.8 *(2172)*	70.3 *(728)*	73.0 *(1886)*	68.5 *(581)*
Moderate	64.7 *(1890)*	66.4 *(1781)*	68.5 *(1913)*	70.2 *(1516)*
High	57.6 *(2528)*	56.0 *(1100)*	61.9 *(2157)*	57.2 *(919)*
High waist-hip ratio				
Low	38.8 *(2072)*	46.0 *(700)*	49.7 *(1642)*	46.9 *(477)*
Moderate	25.3 *(1767)*	29.5 *(1581)*	32.7 *(1591)*	32.9 *(1193)*
High	18.9 *(2246)*	12.2 *(967)*	27.8 *(1722)*	13.5 *(686)*
Women				
Obese				
Low	26.3 *(2974)*	34.9 *(847)*	29.6 *(2623)*	34.7 *(711)*
Moderate	19.6 *(2759)*	21.8 *(2671)*	22.2 *(2658)*	25.8 *(2097)*
High	16.0 *(1989)*	16.9 *(1025)*	16.2 *(1797)*	19.8 *(876)*
Overweight				
Low	59.0 *(2974)*	65.2 *(847)*	64.2 *(2623)*	63.5 *(711)*
Moderate	53.3 *(2759)*	56.0 *(2671)*	55.1 *(2658)*	62.4 *(2097)*
High	45.3 *(1989)*	47.6 *(1025)*	48.9 *(1797)*	51.8 *(876)*
High waist-hip ratio				
Low	28.0 *(2829)*	36.7 *(793)*	39.9 *(2295)*	47.7 *(577)*
Moderate	16.0 *(2518)*	21.8 *(2343)*	27.0 *(2213)*	38.7 *(1596)*
High	12.5 *(1786)*	12.9 *(899)*	24.1 *(1477)*	24.6 *(677)*

Figure 56: Prevalence of obesity, overweight and high waist-hip ratio by year and activity levels(HSE& SHS)

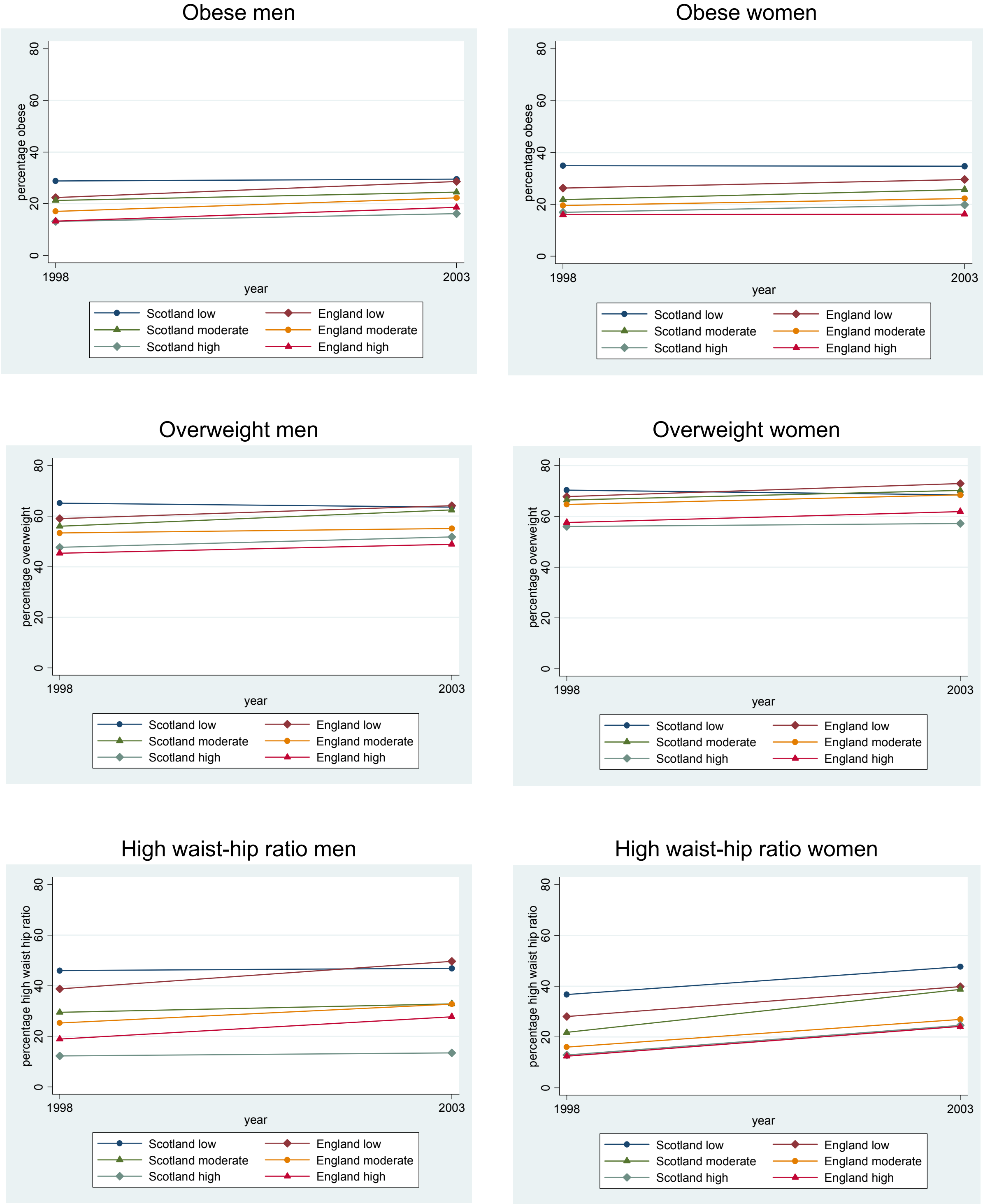


Table 70 shows the prevalence of obesity, overweight and high WHR by gender, year and activity level. The results are illustrated graphically in Figure 56. The logistic regression models showed there were no significant interactions between activity level and country for obesity and overweight. However, when high WHRs were modelled, there were significant interactions between country and PA men and women ($P<0.001$) which are illustrated in Figure 57.

'England high' is miss labelled in these graphs

Figure 57: Interactions between country and physical activity levels for having high waist hip ratio (HSE & SHS)

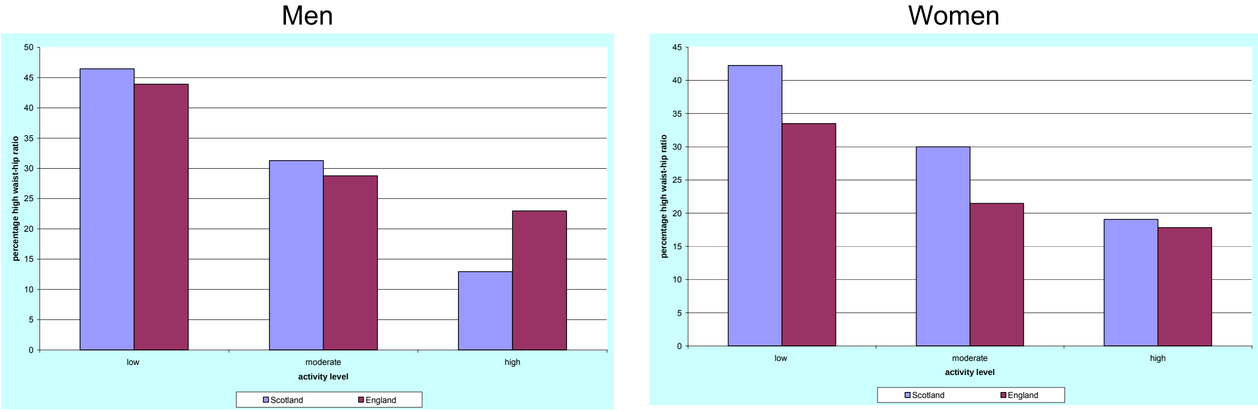


Figure 57 shows that, for men, the percentage with a high WHR was higher in Scotland for low and moderate levels of activity, but higher in England for high levels of activity. In women the percentage with high WHRs was higher in Scotland for all activity levels, although the gap between England and Scotland narrows as activity levels increase.

England and Scotland Comparisons: Children

Trends in obesity and overweight over time and by age group

Data were only available for children in 1998 and 2003 and several lifestyle variables were not available in those years. It has therefore only been possible to produce results for variation by survey year, age group and social class of head of household. Measures of WHR were also not available for children and so only obesity and overweight are reported.

Table 71: Percentage (unweighted sample size) of obesity and overweight by country, gender, survey year and age group (HSE & SHS)

	England	Scotland	England	Scotland
	1998		2003	
Boys				
Obese				
2-4	2.2 (371)	6.7 (340)	4.1 (246)	5.8 (233)
5-10	4.0 (814)	4.3 (773)	6.2 (618)	6.2 (519)
11-15	2.6 (569)	3.7 (668)	5.9 (553)	4.5 (458)
Overweight				
2-4	19.3 (2.2)	25.3 (6.7)	20.0 (4.1)	16.5 (5.8)
5-10	17.1 (4.0)	16.6 (4.3)	21.5 (6.2)	24.4 (6.2)
11-15	21.3 (2.6)	21.0 (3.7)	24.6 (5.9)	26.2 (4.5)
Girls				
Obese				
2-4	6.0 (339)	7.4 (337)	4.5 (238)	4.8 (211)
5-10	4.8 (743)	6.7 (731)	6.2 (631)	8.9 (539)
11-15	5.4 (575)	2.2 (637)	6.6 (547)	4.7 (465)
Overweight				
2-4	25.4 (339)	30.2 (337)	21.3 (238)	26.6 (211)
5-10	21.4 (743)	25.5 (731)	24.9 (631)	28.2 (539)
11-15	25.2 (575)	24.3 (637)	30.4 (547)	23.3 (465)

Figure 58: Prevalence of obesity and overweight by year and age group (HSE & SHS)

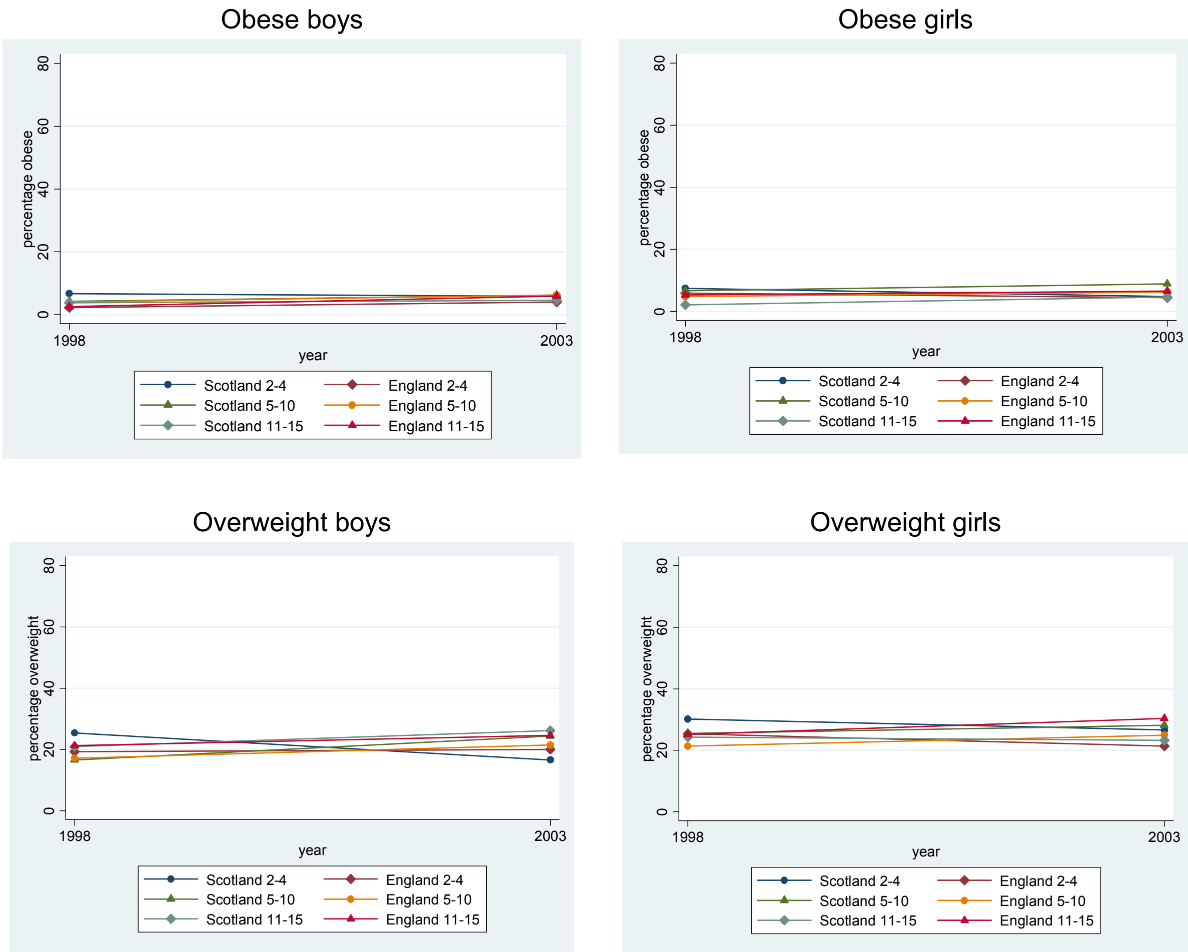


Table 71 shows the prevalence of obesity and overweight for boys and girls in England and Scotland across age group and survey year. The results are illustrated graphically in Figure 58 and the results of the logistic regression model are reported in Table 72. From the graphs Figure 58 and the results in Table 71, it is clear that although there was a tendency for obesity and overweight to be slightly less common in English rather than Scottish children. The odds ratios in Table 72 show that there were no significant associations between obesity or overweight and country.

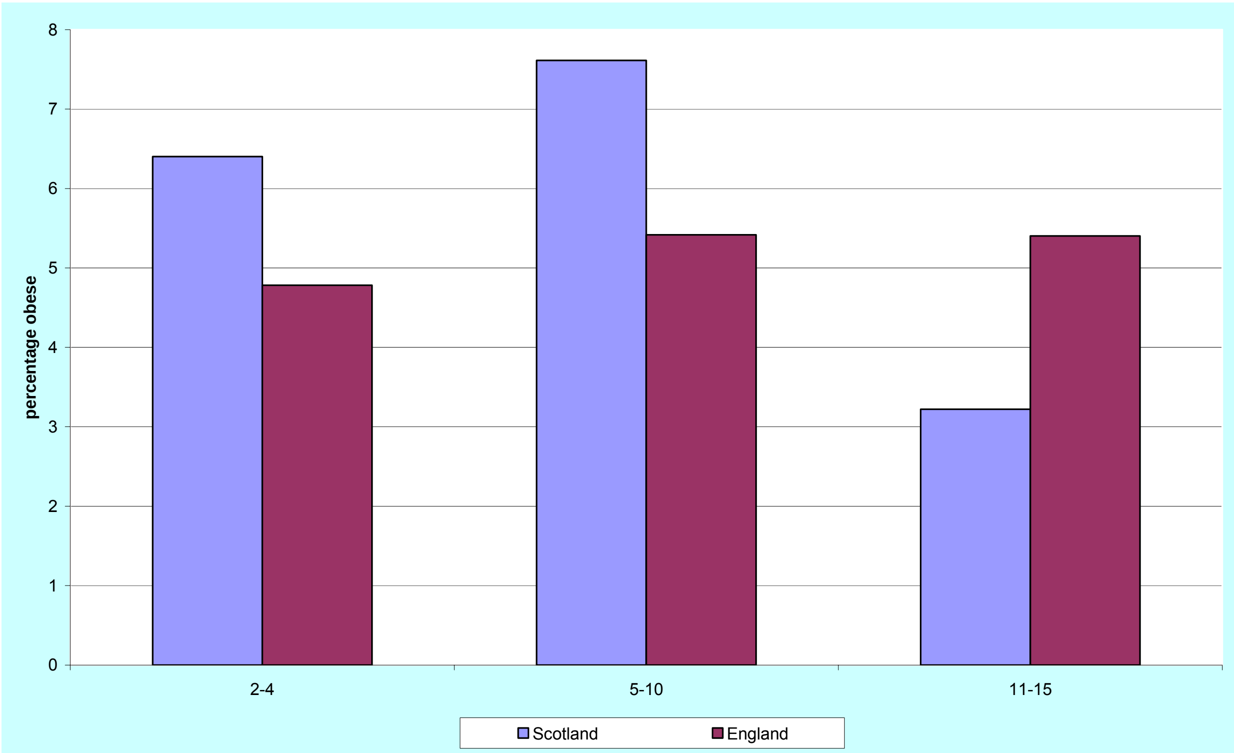
Table 72: Adjusted odds ratios for obesity and overweight by country (HSE & SHS)

	Boys	Girls
	OR* (95% CI)	OR* (95% CI)
Obese		
Country	*[n=6203, P=0.183]* †	*[n=5979, P=0.733]* †
Scotland	1	1
England	0.85 (0.67-1.08)	0.96 (0.77-1.21)
Overweight		
Country	*[n=6203, P=0.362]* †	*[n=5979, P=0.309]* †
Scotland	1	1
England	0.94 (0.83-1.07)	0.94 (0.83-1.06)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

However, there was a significant interaction between country and age group for obesity in girls (P=0.0011) which is illustrated in Figure 59: obesity was less common in English than Scottish girls in the 2-4 and 5-10 years age-groups , but more common in the 11-15 age group. There were no further significant interactions for the other outcomes between country and either survey year or age group.

Figure 59: Interaction between country and age for being obese in girls (HSE & SHS)



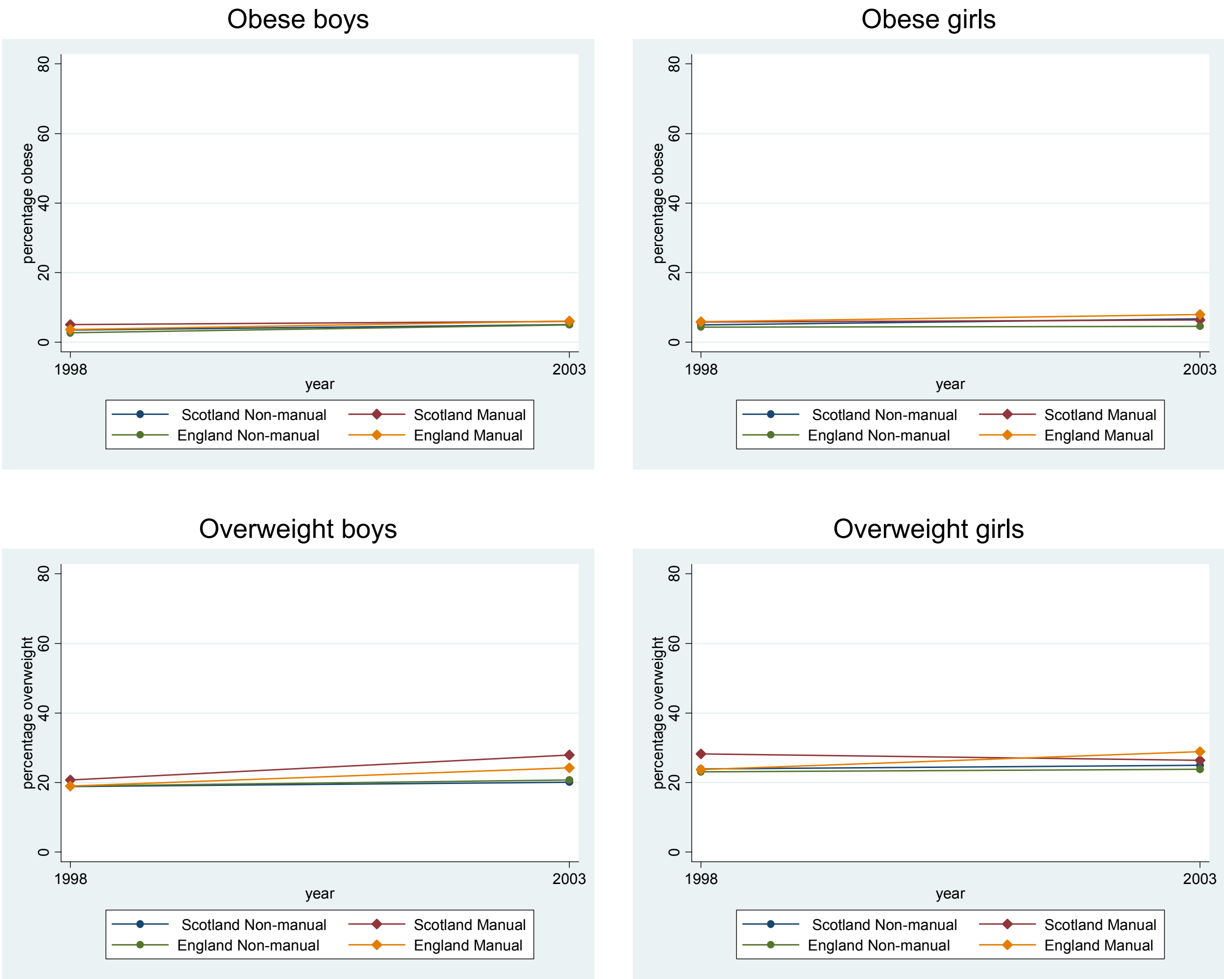
Associations between overweight and obesity, and socioeconomic position

Table 73 shows the prevalence of obesity and overweight in England and Scotland by gender, survey year and social class. The results are illustrated in Figure 60 which shows that there were only small differences between England and Scotland for each outcome; none were significant. Specifically, for each outcome there were no significant interactions between country and the social class of head of household, so there is no evidence to suggest that the association between obesity or overweight and social class differs between England and Scotland.

Table 73: Percentage (unweighted sample size) of for obesity and overweight by country, gender, survey year and age group (HSE & SHS)

	England	Scotland	England	Scotland
	1998		2003	
Boys				
Obese				
Non manual	2.7 (870)	3.5 (868)	5.0 (747)	5.1 (649)
Manual	3.6 (828)	5.1 (828)	6.1 (600)	6.0 (524)
Overweight				
Non manual	19.0 (870)	18.9 (868)	19.0 (747)	20.7 (649)
Manual	19.0 (828)	20.7 (828)	24.3 (600)	28.0 (524)
Girls				
Obese				
Non manual	4.3 (784)	4.9 (825)	4.5 (788)	6.7 (638)
Manual	6.0 (825)	5.8 (787)	7.9 (577)	6.5 (528)
Overweight				
Non manual	23.1 (784)	23.9 (825)	23.8 (788)	24.9 (638)
Manual	23.7 (825)	28.3 (787)	28.9 (577)	26.4 (528)

Figure 60: Prevalence of for obesity and overweight by year and social class of head of household (HSE & SHS)



Regional comparisons, including Scotland: adults

This section aims to highlight differences between regions for the outcome measures and consider any interactions between the variable for region and lifestyle factors across the outcomes.

Since SHS is only available in 1995, 1998 and 2003 all comparisons are restricted to these years. In some cases, where data are not available, analysis has been restricted to only two survey years: this is the case for WHR measurements. Due to differences in data collection among the higher age groups between surveys, results have only been analysed up to the age of 59 among adults.

Figure 61 to Figure 66 shows the prevalence among adults of each outcome measure by region, with odds ratios reported in Table 74.

Figure 61: Prevalence of obese men by region (HSE & SHS)

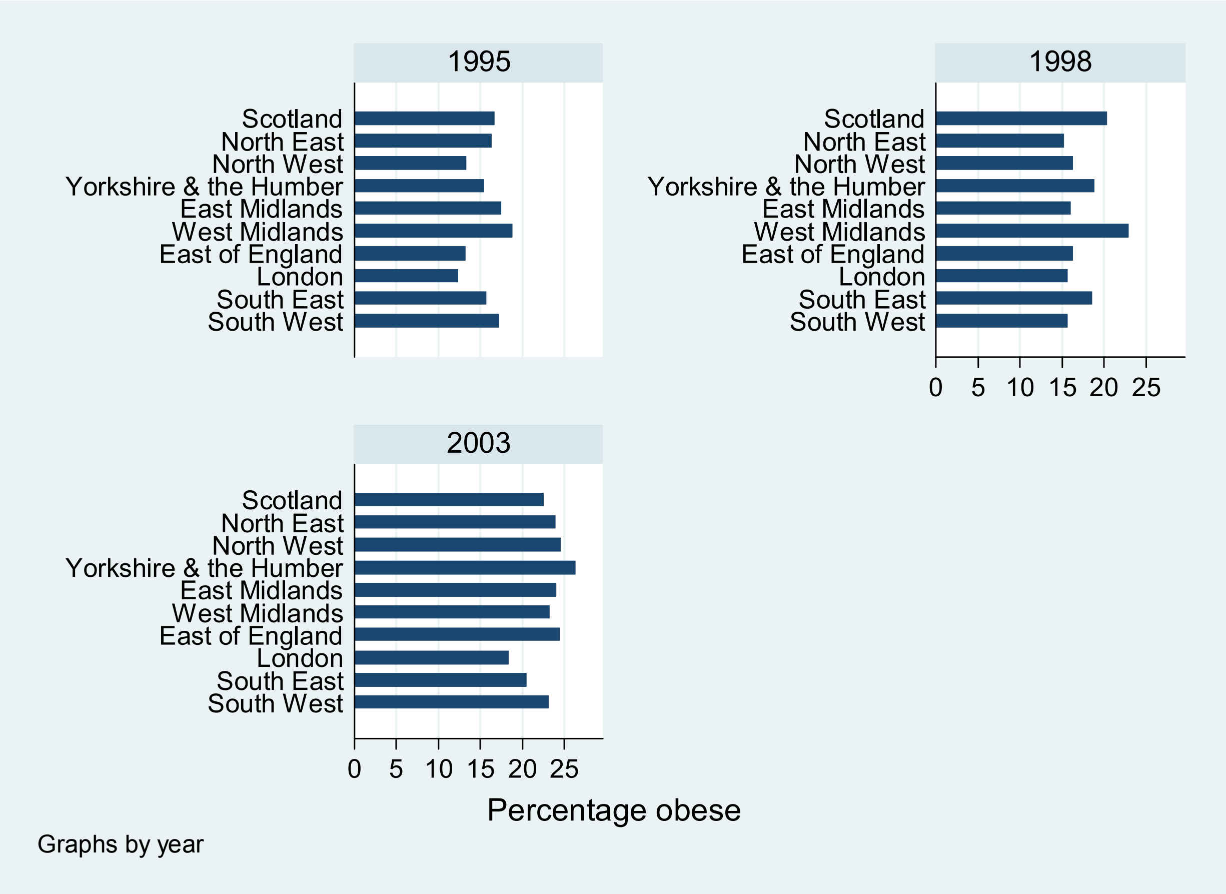


Figure 62: Prevalence of obese women by region (HSE & SHS)

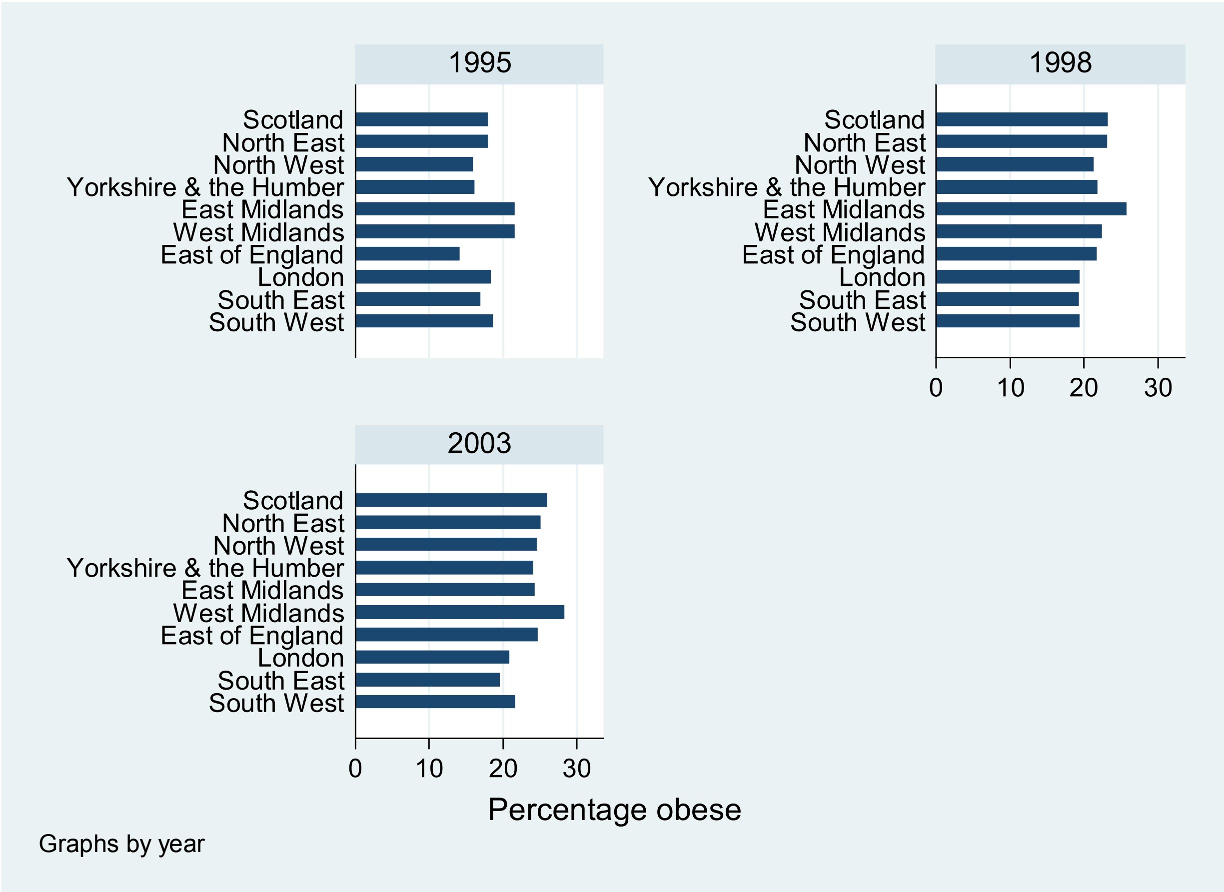


Figure 63: Prevalence of overweight men by region (HSE & SHS)

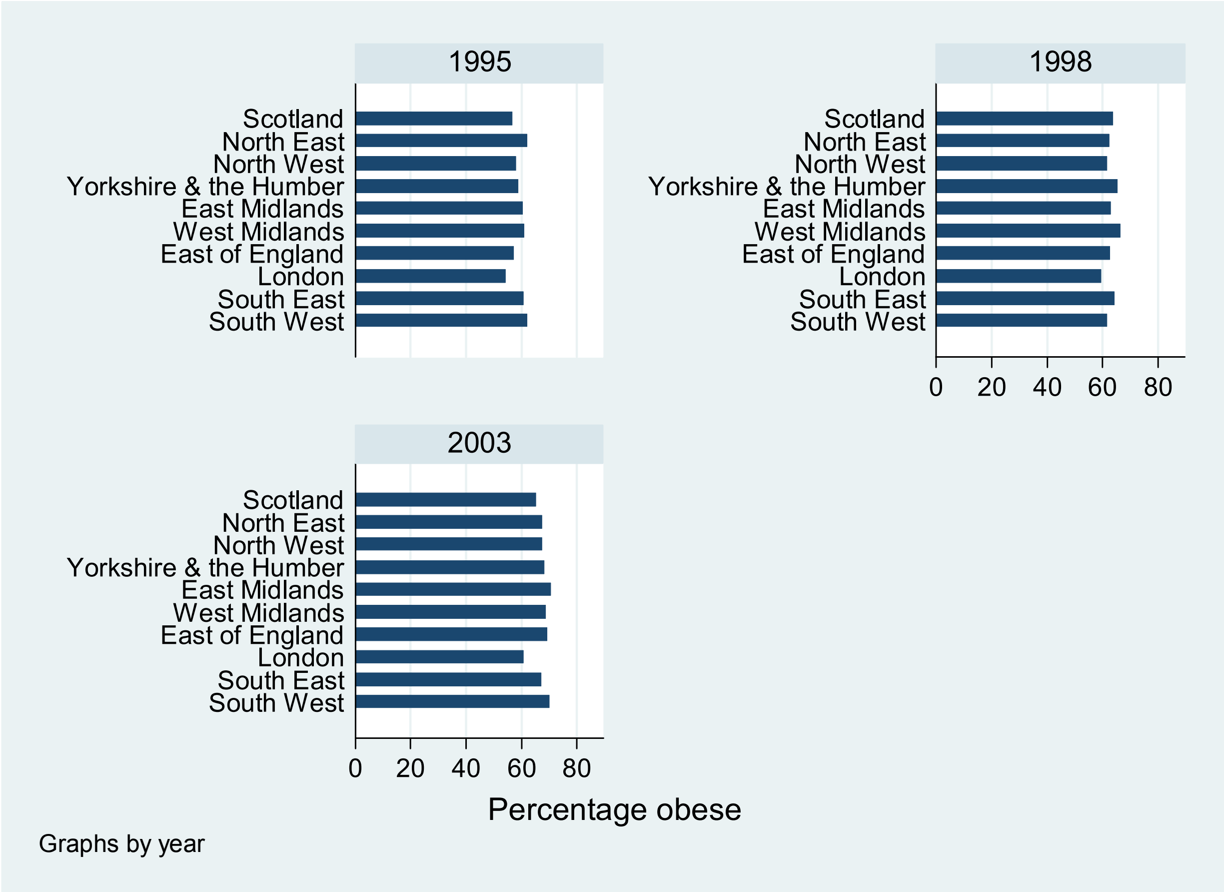


Figure 64: Prevalence of overweight women by region (HSE & SHS)

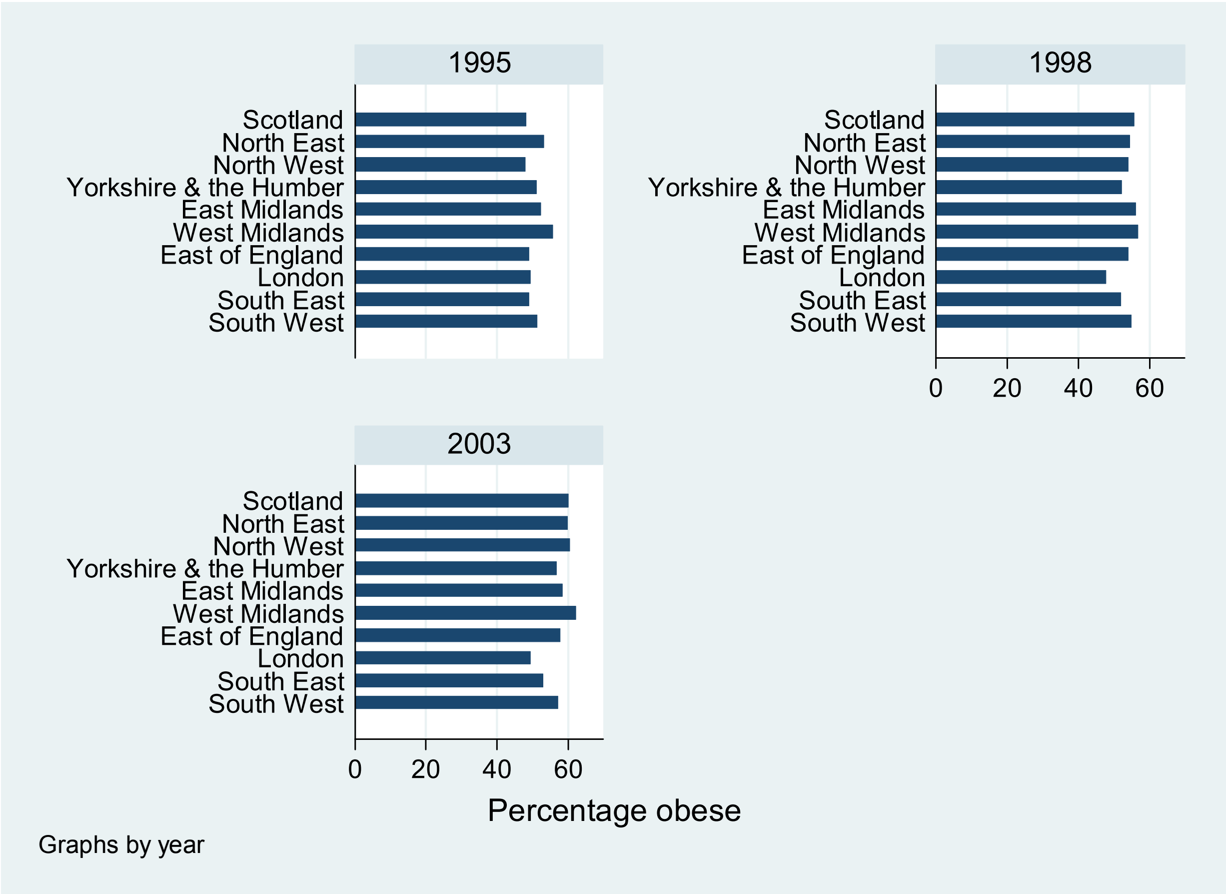


Figure 65: Prevalence of high waist-hip ratio men by region (HSE & SHS)

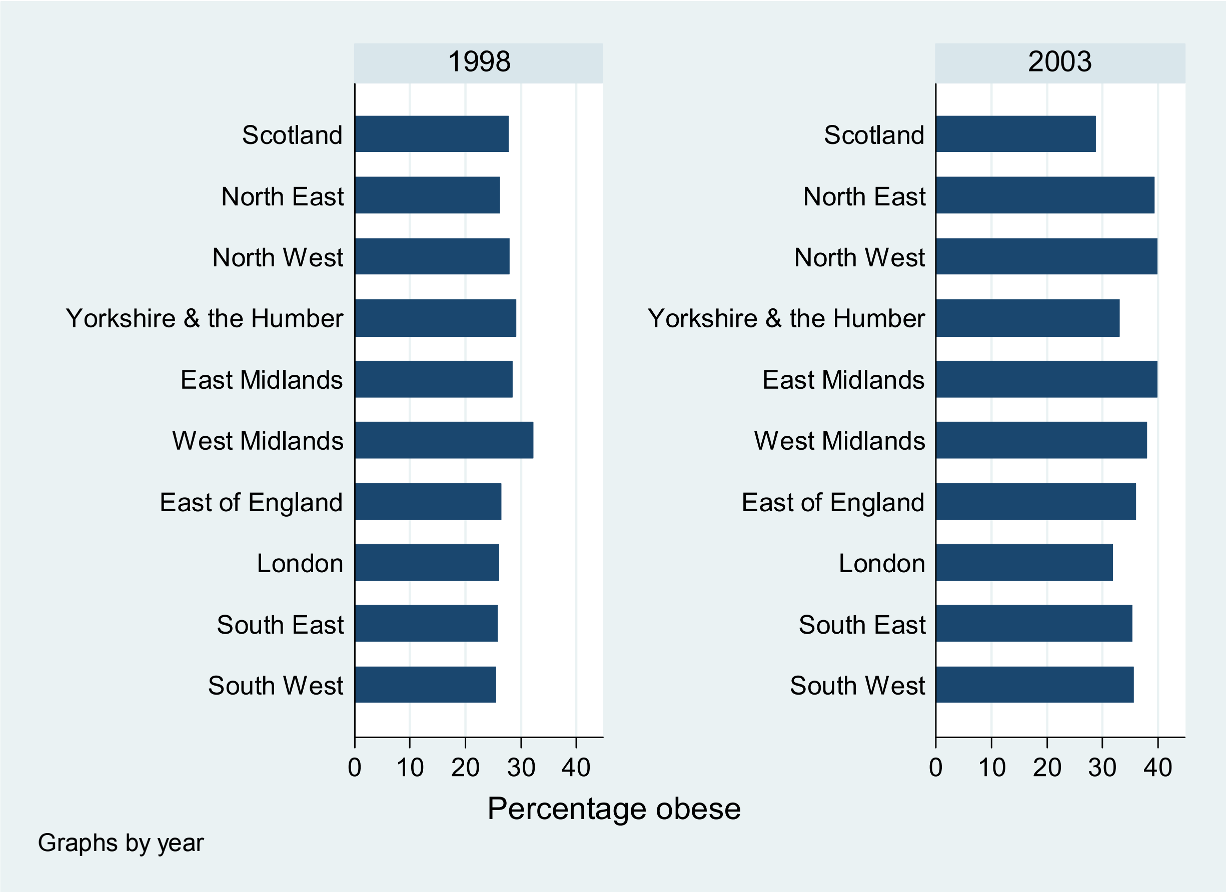


Figure 66: Prevalence of high waist-hip ratio women by region (HSE & SHS)

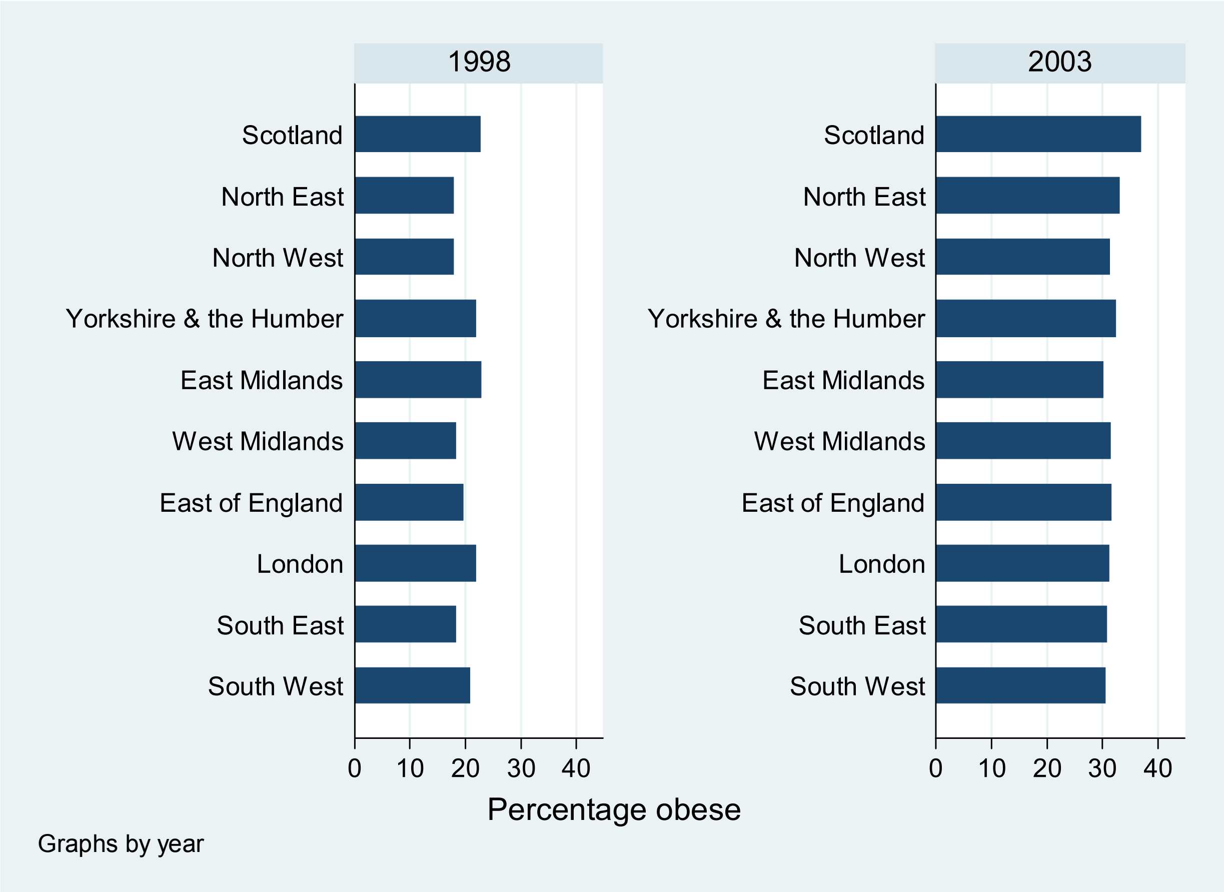


Table 74: Adjusted odds ratios for obesity, overweight and high waist-hip ratio among men and women by region (HSE & SHS)

	Men	Women
	OR* (95% CI)	OR* (95% CI)
Obese		
Country	[*n=23285, P<0.001*] †	[*n=26078, P<0.001*] †
Scotland	1	1
North East	0.84 (0.70-1.02)	0.99 (0.84-1.16)
North West	0.87 (0.76-1.00)	0.95 (0.84-1.06)
Yorkshire & the Humber	1.00 (0.86-1.15)	0.93 (0.81-1.06)
East Midlands	0.92 (0.79-1.07)	1.11 (0.97-1.27)
West Midlands	1.12 (0.98-1.29)	1.19 (1.05-1.35)
East of England	0.88 (0.76-1.01)	0.87 (0.76-0.99)
London	0.73 (0.63-0.85)	0.82 (0.72-0.93)
South East	0.86 (0.75-0.97)	0.75 (0.67-0.85)
South West	0.88 (0.76-1.03)	0.81 (0.71-0.93)
Overweight		
Country	[*n=23285, P=0.0094*] †	[*n=26078, P<0.001]* †
Scotland	1	1
North East	1.01 (0.87-1.18)	1.06 (0.92-1.21)
North West	0.97 (0.87-1.08)	1.01 (0.92-1.10)
Yorkshire & the Humber	1.11 (0.98-1.25)	0.87 (0.78-0.96)
East Midlands	1.05 (0.93-1.19)	0.99 (0.88-1.11)
West Midlands	1.06 (0.94-1.20)	1.14 (1.02-1.27)
East of England	0.99 (0.88-1.11)	0.86 (0.78-0.95)
London	0.82 (0.74-0.92)	0.77 (0.70-0.85)
South East	1.04 (0.94-1.15)	0.80 (0.73-0.87)
South West	1.00 (0.88-1.13)	0.90 (0.81-1.00)
High waist-hip ratio		
Country	[*n=13378, P=0.0172*] †	[*n=15304, P<0.001*] †
Scotland	1	1
North East	1.10 (0.86-1.39)	0.78 (0.62-0.99)
North West	1.22 (1.04-1.44)	0.79 (0.68-0.93)
Yorkshire & the Humber	1.13 (0.94-1.35)	0.84 (0.70-1.00)
East Midlands	1.30 (1.07-1.57)	0.75 (0.62-0.90)
West Midlands	1.30 (1.08-1.57)	0.79 (0.66-0.95)
East of England	1.07 (0.89-1.29)	0.69 (0.57-0.82)
London	1.05 (0.88-1.27)	0.77 (0.65-0.91)
South East	0.99 (0.85-1.17)	0.61 (0.52-0.71)
South West	0.94 (0.78-1.13)	0.68 (0.56-0.81)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms immediately below

There was a significant association between region and each of the outcomes in both men and women. This shows there is variation between regions in the prevalence of obese and overweight adults. Interactions between each outcome and both region and year, and region and age were all tested for significance. The only significant interaction was between region and age for obesity in women (P=0.0096).

Regional comparisons, including Scotland: children

Data were only available for children in 1998 and 2003 and only for obesity and being overweight. Figure 67 to Figure 70 show the prevalence of obesity and overweight in boys and girls by region, with odds rations reported in Table 75.

Figure 67: Prevalence of obese boys by region (HSE & SHS)

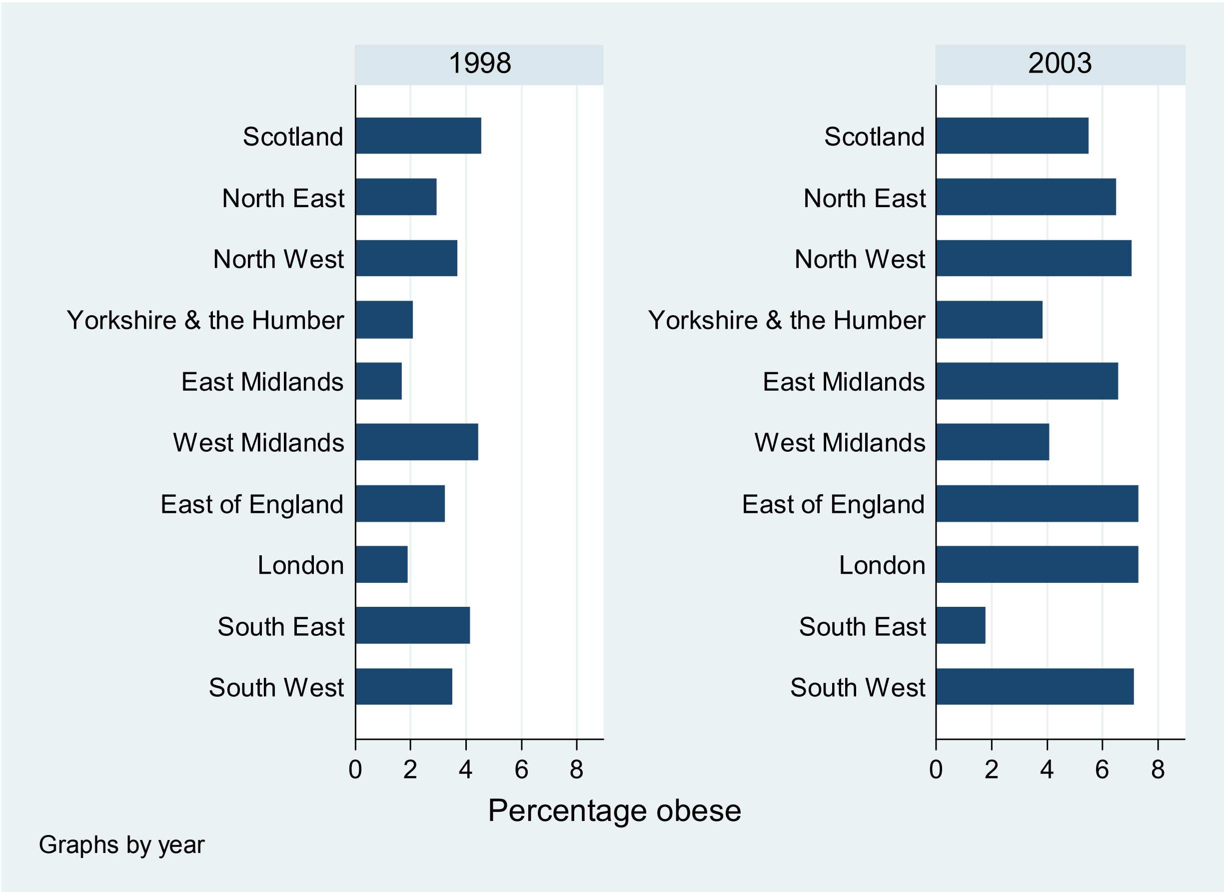


Figure 68: Prevalence of obese girls by region (HSE & SHS)

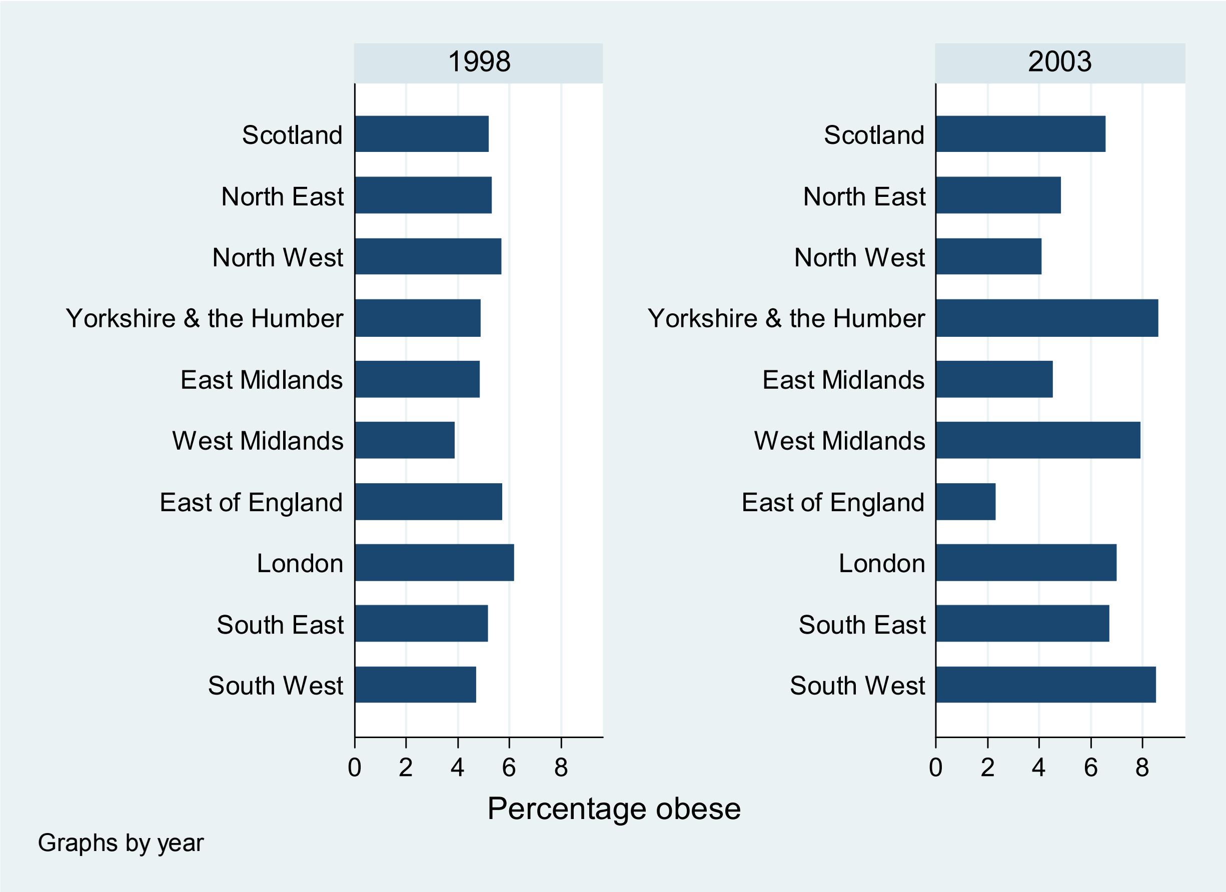


Figure 69: Prevalence of overweight boys by region (HSE & SHS)

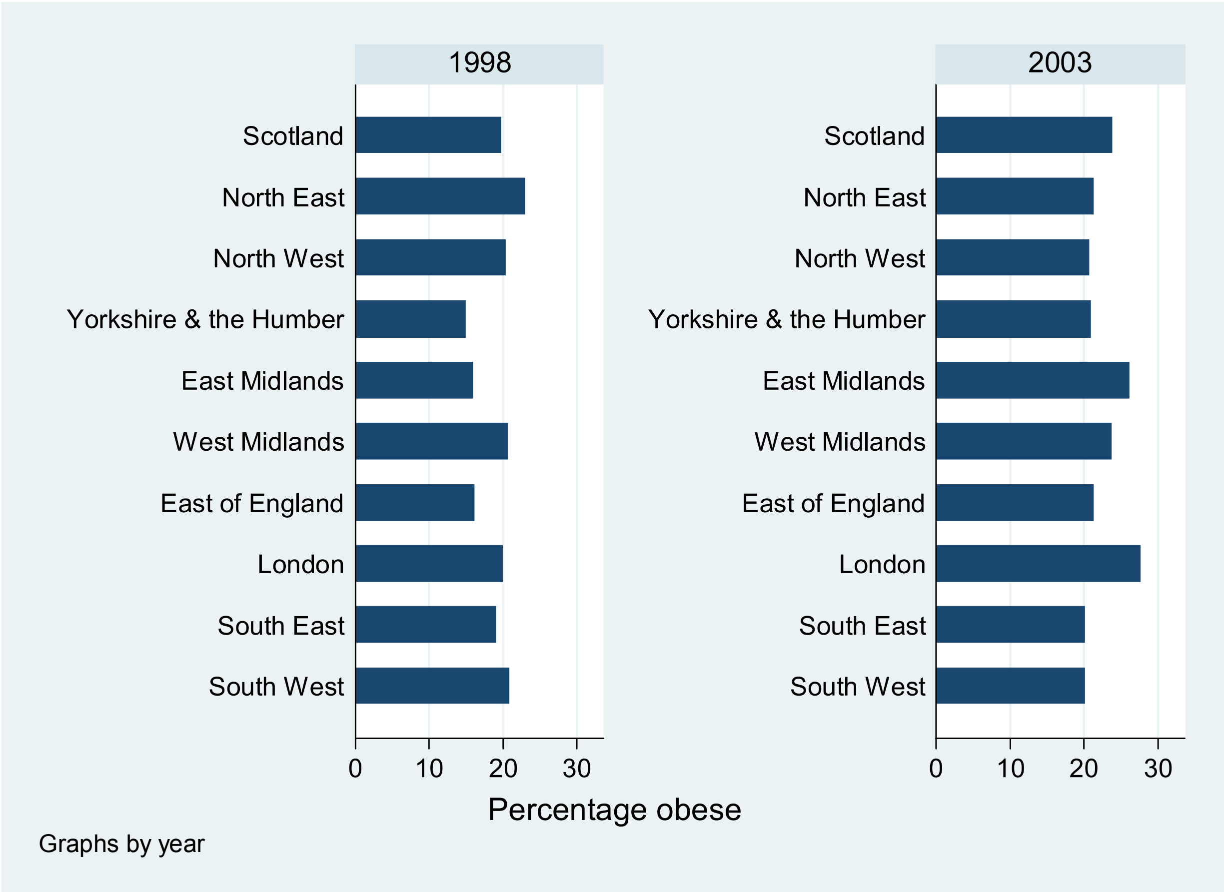


Figure 70: Prevalence of overweight girls by region (HSE & SHS)

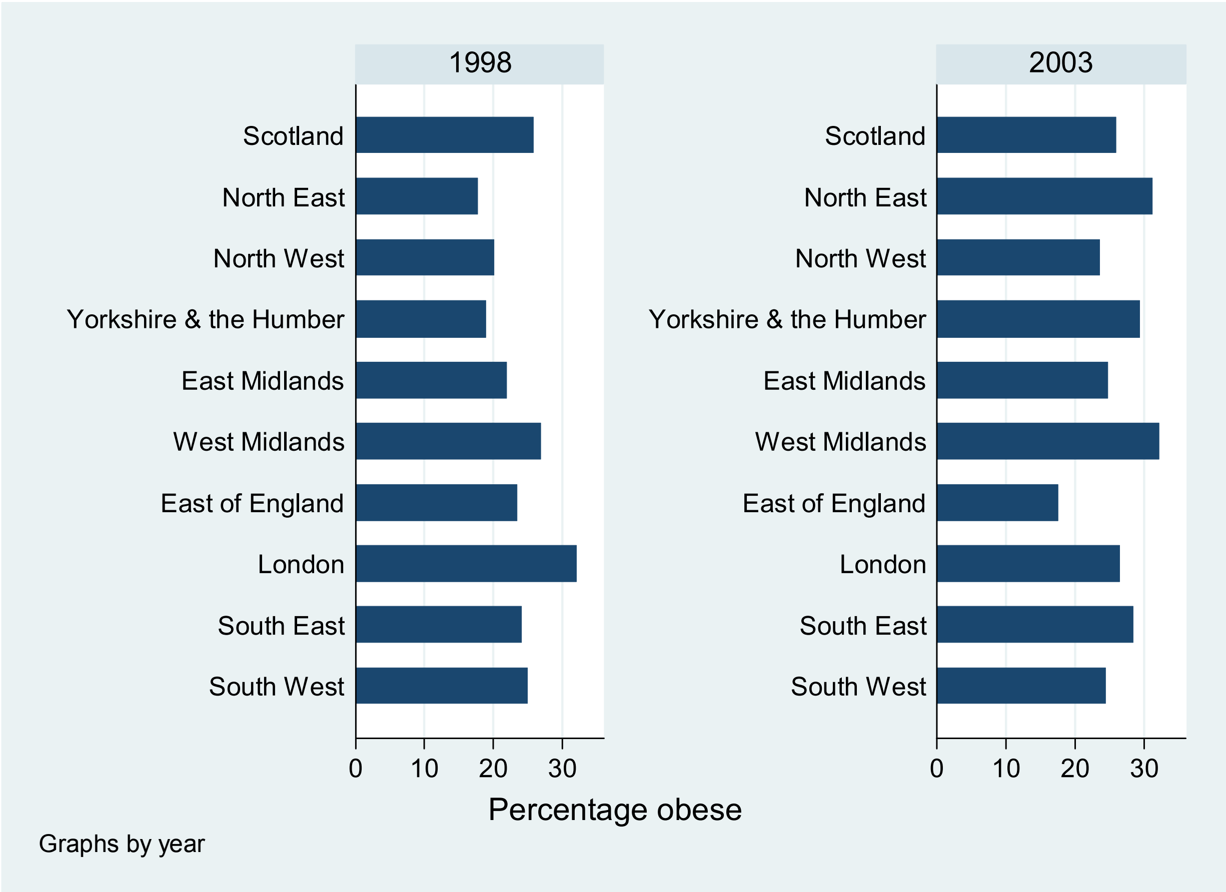


Table 75: Adjusted odds ratios for obesity and overweight among children by region (HSE & SHS)

	Boys	Girls
	OR* (95% CI)	OR* (95% CI)
Obese		
Country	[*n=7923, P=0.7907*] †	[*n=7677, P=0.8461*] †
Scotland	1	1
North East	0.73 (0.38-1.39)	0.94 (0.54-1.66)
North West	0.89 (0.59-1.36)	0.78 (0.52-1.18)
Yorkshire & the Humber	0.72 (0.42-1.22)	1.06 (0.69-1.63)
East Midlands	1.04 (0.65-1.66)	0.94 (0.58-1.52)
West Midlands	0.86 (0.52-1.43)	1.14 (0.76-1.69)
East of England	0.88 (0.54-1.45)	0.83 (0.53-1.30)
London	0.85 (0.54-1.33)	1.12 (0.75-1.67)
South East	0.65 (0.41-1.03)	0.85 (0.57-1.27)
South West	1.01 (0.64-1.59)	1.16 (0.74-1.80)
Overweight		
Country	[*n=7923, P=0.8218*] †	[*n=7677, P=0.1864*] †
Scotland	1	1
North East	0.95 (0.70-1.29)	0.94 (0.70-1.28)
North West	0.95 (0.76-1.17)	0.78 (0.63-0.96)
Yorkshire & the Humber	0.89 (0.69-1.16)	0.95 (0.75-1.19)
East Midlands	1.07 (0.83-1.37)	0.92 (0.72-1.19)
West Midlands	0.97 (0.76-1.24)	1.09 (0.87-1.37)
East of England	0.82 (0.64-1.05)	0.82 (0.65-1.04)
London	1.05 (0.83-1.32)	1.10 (0.89-1.37)
South East	0.91 (0.74-1.13)	0.93 (0.76-1.14)
South West	0.89 (0.70-1.14)	1.06 (0.83-1.34)

* Separate logistic regressions for each outcome by gender adjusted for survey year and age-group
† n = weighted sample size for logistic regression model; P-value derived from Wald test for set of model terms below

There were no significant associations between the three outcomes and regions. This shows there is no variation between regions in the prevalence of obese and overweight children. There were no significant interactions between the regional variable and year and the regional variable and age group for any of the outcomes.

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