

## Adult socioeconomic, educational, social, and psychological outcomes of childhood obesity: a national birth cohort study

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### Abstract

**Objectives** To assess adult socioeconomic, educational, social, and psychological outcomes of childhood obesity by using nationally representative data.

**Design** 1970 British birth cohort.

**Participants** 16 567 babies born in Great Britain 5-11 April 1970 and followed up at 5, 10, and 29-30 years.

**Main outcome measures** Obesity at age 10 and 30 years. Self reported socioeconomic, educational, psychological, and social outcomes at 30 years. Odds ratios were calculated for the risk of each adult outcome associated with obesity in childhood only, obesity in adulthood only, and persistent child and adult obesity, compared with those obese at neither period.

**Results** Of the 8490 participants with data on body mass index at 10 and 30 years, 4.3% were obese at 10 years and 16.3% at 30 years. Obesity in childhood only was not associated with adult social class, income, years of schooling, educational attainment, relationships, or psychological morbidity in either sex after adjustment for confounding factors. Persistent obesity was not associated with any adverse adult outcomes in men, though it was associated among women with a higher risk of never having been gainfully employed (odds ratio 1.9, 95% confidence interval 1.1 to 3.3) and not having a current partner (2.0, 1.3 to 3.3).

**Conclusions** Obesity limited to childhood has little impact on adult outcomes. Persistent obesity in women is associated with poorer employment and relationship outcomes. Efforts to reduce the socioeconomic and psychosocial burden of obesity in adult life should focus on prevention of the persistence of obesity from childhood into adulthood.

### Introduction

Concerns about the rising prevalence of obesity in children and adolescents have focused on the well documented associations between childhood obesity and increased cardiovascular risk<sup>1</sup> and mortality in adulthood.<sup>2</sup> Childhood obesity has considerable social and psychological consequences within childhood and adolescence,<sup>3</sup> yet little is known about social, socioeconomic, and psychological consequences in adult life.

A recent systematic review found no longitudinal studies on the outcomes of childhood obesity other than physical health outcomes<sup>3</sup> and only two longitudinal studies of the socioeconomic effects of obesity in adolescence. Gortmaker et al found that US women who had been obese in late adolescence in 1981 were less likely to be married and had lower incomes seven years later than women who had not been overweight, while men who had been overweight were less likely to be married.<sup>4</sup> Sargent et al

found that UK women, but not men, who had been obese at 16 years in 1974 earned 7.4% less than their non-obese peers at age 23.<sup>5</sup>

The study of adult outcomes of childhood obesity is difficult because obesity often continues into adult life and therefore poorer socioeconomic and educational outcomes may actually reflect confounding by adult obesity. Yet identifying outcomes related to obesity confined to childhood is important in determining whether people who are obese in childhood and who later lose weight remain at risk for adult adversity and inequalities.

We used longitudinal data from the 1970 British birth cohort to examine the adult socioeconomic, educational, social, and psychological outcomes of childhood obesity. We hypothesised that obesity limited to childhood has fewer adverse adult outcomes than obesity that persists into adult life.

### Methods

#### Participants

The 1970 British cohort study (BCS70) is a continuing, multidisciplinary longitudinal study that takes as its subjects all people living in Great Britain who were born 5-11 April 1970. A total of 16 567 babies born in England, Scotland, and Wales were enrolled in the birth cohort, and they have been followed up at 5, 10, 16, 26, and 29-30 years. Additional people born in the same week who immigrated to the UK or were identified subsequently have been added to the cohort. Longitudinal follow-up was maintained through collection of multiple subject identifiers and mailing of annual birthday cards between follow-up surveys.<sup>6</sup> We obtained electronic data from the various surveys of the BCS70 from the UK Data Archive, University of Essex, and supporting information and code for cleaning the databases and deriving summary variables from the Centre for Longitudinal Studies, London.<sup>6</sup>

At 10 years of age (in 1980), 15 995 cohort members were traced and invited to participate, and data were obtained on 14 875. Analysis showed a significant loss of children of single mothers (loss of 25% of estimated target) and children whose parents were born outside Great Britain (loss of 25% of estimated target). There were, however, no significant social class differences (gain of 1.7% in those with father in manual employment).<sup>7</sup> In 2000, when participants were aged 29-30, 14 087 of an estimated 16 695 cohort members were traced and invited to participate, of whom 11 261 (68%) underwent interview.<sup>6</sup> Marked efforts were made to recruit difficult to reach participants, and response bias compared with the birth survey was less than at 10 years: between the birth and 30 year surveys there was a loss of 17% for those with parents born outside Brit-

ain, 9% for children of teenage mothers, and 15% for children of single mothers. Loss of those from lower social classes was minimal at 4% loss from manual employment.<sup>6</sup>

### Childhood data

Height was measured at 10 years of age by school medical staff with a standardised technique and recorded to the nearest 0.1 cm (or 0.25 inch). Weight was measured in underclothes with a beam balance and recorded to the nearest 0.1 kg (or 0.25 ounce). Body mass index z score at 10 years was calculated from height and weight with the revised UK 1990 growth reference.<sup>8</sup> Obesity at 10 years was defined as body mass index  $\geq$  95th centile. Height and weight of parents were measured or self reported at parental interview in the 10 year survey. Body mass index z scores for parents were calculated from cohort mean and standard deviation. Birth weight was recorded in the original birth survey. Socioeconomic status in childhood was defined by social class (paternal occupation obtained from parental interview at 10 years) and maternal educational status at 10 years. Cognitive ability was assessed at 10 years by completion of the British ability scales (BAS); age appropriate T scores for each subscale and mean T score were calculated with reference norms appropriate for 1980.<sup>9</sup>

### Adult data

Outcomes in adult life were obtained by completion of an interview on computer or self report as part of the 1999-2000 survey of the cohort when participants were aged 29-30. Height and weight were obtained by self report. Women who were pregnant at time of interview were asked to report their weight before pregnancy. Self reported data have been shown to be highly correlated with measured weight and height in adults in previous studies<sup>10</sup> and are accepted as useful in epidemiological studies of risk factors for obesity and overweight.<sup>11</sup> As under-reporting of weight in obese individuals and over-reporting of height may underestimate BMI, however, we chose to define self reported obesity as BMI  $\geq$  28.5 rather than the standard definition of  $\geq$  30, as recent data from a large UK epidemiological cohort showed that obese men and women underestimate their true BMI by a mean of 1.5.<sup>10</sup> Adjustment by this amount is supported by internal data from the cohort: the relation between measured and self reported height and weight was examined at 16 years in a reduced sample of 2795 participants, with obese people more likely to underestimate their BMI. Cohort members who were obese at 10 years underestimated their BMI at 16 by a mean of 1.3 compared with 0.5 for non-obese people.<sup>12</sup>

Data on other adult outcomes included occupational status, annual net income, employment history, educational and vocational achievements, marital and relationship history, and the presence of a long standing illness ( $\geq$  6 months' duration) significantly limiting home or work activities. Mental health was assessed by confidential completion of the Rutter malaise inventory, a 24 item self completed scale designed to assess psychiatric morbidity in epidemiological samples: scores  $\geq$  7 suggested psychiatric morbidity.<sup>13</sup>

### Analysis

We divided participants into four categories of obesity: not obese in childhood or adulthood, obese in childhood only, obese in adulthood only, and obese in childhood and adulthood (persistent obesity). Frequency differences between groups were investigated with  $\chi^2$  tests. For each adult outcome we then constructed multivariable models using logistic regression to calculate odds ratios for the risk of that outcome conferred by childhood and adult obesity. We did this in two ways. Firstly, we examined the

**Table 1** Characteristics of participants with valid measurement of body mass index during follow-up. Figures are percentage (number) unless stated otherwise

	At 10 years (n=12 160)	At 10 and 30 years (n=8490)
Female	48.6 (5908)	52.0 (4371)
Mean (SD) BMI z score at 10 years	-0.1 (1.0)	-0.1 (1.0)
Obese at 10 years (BMI $\geq$ 95th centile)	4.2 (515)	4.3 (362)
Social class in childhood:		
I	6 (698)	6 (515)
II	23 (2772)	24 (2032)
III non-manual	10 (1266)	11 (895)
III manual	40 (4834)	40 (3378)
IV	131 (1590)	13 (1058)
V and VI	5 (598)	4.2 (359)
Missing	3 (402)	3 (253)
Mother achieved $\geq$ 1 A levels	17 (1944/11 352)	18 (1415/7962)

risk of each outcome posed by each of the four obesity categories, using never obese as the reference category. Secondly, to test for possible bias introduced by this double dichotomisation of child and adult obesity variables into four categories,<sup>14</sup> we entered the childhood obesity and adult obesity variables as main effects and then tested for the significance of the interaction between child and adult obesity. In both sets of analyses we included childhood variables (height at 10 years, maternal and paternal body mass index z scores, maternal education, and social class) and adult variables (height and social class) as potential confounding factors. We also included height because body mass index is not completely independent of height, and stature has been associated with adult socioeconomic status.<sup>5</sup> Data were analysed with Stata 8.

## Results

Our sample comprised 8490 participants for whom we knew body mass index at 10 and 30 years (forming 75% of participants at 30 years). Table 1 shows details of the participants at 10 and 30 years. Overall, 362 (4.3%) people were obese at 10 years and 1380 (16.3%) were obese at 30, with about 52% of those obese in childhood also obese at 30 years. One hundred and seventy three (2.0%) were obese in childhood only, 1191 (14%) in adulthood only, and 189 (2.2%) had persistent obesity. Childhood obesity increased the risk of adult obesity in men (odds ratio 4.8, 95% confidence interval 3.3 to 6.8;  $P < 0.0001$ ) and women (4.7, 3.2 to 6.9;  $P < 0.0001$ ) after adjustment for social class and maternal education in childhood, parental BMI z scores, height, and adult social class. Follow-up at 30 years of those with valid BMI at 10 years showed similar loss to follow-up to that reported for the entire cohort, with a higher loss of men and those from lower social classes. Obesity at 10 years was not associated with loss to follow-up at 30 years.

Table 2 shows the prevalence of adverse adult outcomes in the four categories of obesity for men and women. For men, there were significant differences between groups for educational and social outcomes, social class, and long standing illness. For women, there were significant differences in all outcomes apart from unemployment and longstanding illnesses.

Mean annual net income was significantly lower in women who were obese in childhood and persistently obese compared with those not obese at either period (mean for not obese £12 954 (\$24 581; €18 962) (SE £802); obese in childhood only £10 549 (SE £904); obese in adulthood only £11 409 (SE

**Table 2** Prevalence of adverse outcomes associated with childhood, adulthood, and persistent obesity\*

Adult outcome	Overall prevalence % (n)	Obesity category (%)				P value†
		Neither childhood nor adulthood	Childhood only	Adulthood only	Childhood and adulthood	
<b>Men</b>						
Unskilled occupation (social class IV or V)	20 (807)	19	30	21	26	0.02
Never gainfully employed	18 (741)	19	18	17	26	0.2
Currently unemployed and seeking work	4 (175)	4	4	5	5	0.5
Left school aged ≤16	59 (2429)	57	57	66	67	0.0001
Left school with no qualifications	29 (1195)	27	24	37	38	<0.0001
Never been married	56 (2307)	58	59	46	51	<0.0001
Has no current partner	35 (1430)	37	38	27	32	<0.0001
Psychological disorder (malaise inventory score ≥7)	13 (535)	13	9	15	20	0.09
Limiting longstanding illness	10 (412)	10	11	14	6	0.01
<b>Women</b>						
Unskilled occupation (social class IV or V)	21 (899)	20	23	27	28	0.0008
Never gainfully employed	13 (568)	13	19	14	21	0.02
Currently unemployed and seeking work	2 (87)	2	2	3	1	0.7
Left school aged ≤16	49 (2141)	48	55	55	55	0.002
Left school with no qualifications	25 (1093)	23	33	31	27	0.0005
Never been married	43 (1879)	44	35	37	37	0.002
Has no current partner	29 (1265)	29	31	25	42	0.01
Psychological disorder (malaise inventory score ≥7)	19 (830)	19	21	24	25	0.02
Limiting longstanding illness	11 (487)	9	6	7	2	0.07

\*Base numbers varied from 4279 to 4371 for men and from 4036 to 4119 for women because of missing data.

†P values are given for  $\chi^2$  test for four group comparison.

£2075); persistent obesity £9653 (SE £685);  $P < 0.0001$ ). These differences, however, were not significant when they were adjusted for childhood socioeconomic status and parental BMI z scores. Mean annual net income was not associated with obesity category in men.

Table 3 shows adjusted odds ratios for the risk of each adult outcome posed by the four obesity categories. In these analyses, obesity limited to childhood was not significantly associated with any adult outcomes in either sex. Analysis of childhood obesity as a main effect adjusted for adult obesity similarly found that childhood obesity was not associated with any adult outcomes measured in either sex (data not shown). Persistent obesity in men was not significantly associated with any adverse adult outcomes measured, while in women, persistent obesity predicted higher risk of never having been gainfully employed and not having a current partner. In men, obesity limited to adulthood was associated with a higher risk of longstanding illness and leaving school with no qualifications but with a lower risk of never having married or not having a current partner. In women, obesity limited to adulthood was associated with higher risk of psychological disorder and longstanding illness. The same associations for adult obesity were found in each sex when adult obesity was entered as a main effect adjusted for childhood obesity (data not shown). Reanalysis of educational outcomes with adjustment for cognitive ability at 10 years did not materially change results (data not shown).

## Discussion

In this large population based sample, we found that childhood obesity per se did not seem to influence any adult outcomes measured in either sex when we adjusted for a range of potential confounding factors, and only half of those obese in childhood in 1980 remained obese in adulthood in 2000. In contrast,

persistent obesity through childhood and adulthood was associated with increased adversity, although only in women, who were half as likely to have ever been gainfully employed or ever married compared with those not obese at either time point.

Adult obesity was associated with higher risk of psychological morbidity in women, poor educational achievement in men, and limiting longstanding illness in both sexes, but also with positive social (marriage and relationship) outcomes in men, when we adjusted for confounding factors. These associations in adult life, however, were cross sectional and may represent factors contributing to adult obesity rather than outcomes resulting from it.

Our findings suggest that health inequalities and social adversity resulting from obesity develop after childhood, and persistence of obesity from childhood into adulthood is associated with a different pattern of adversity to that of obesity confined to adult life.

### Strengths and limitations

We used data from a large national birth cohort, with data on body mass index that were representative for 10 year old children in Great Britain in 1980. The prevalence of childhood obesity in our sample was identical to that in the whole cohort at 10 years (4.3%) and was appropriate for the period. There was no additional loss to follow-up at 30 years of participants who were obese at 10 years. We controlled our analyses for potential confounding factors including parental body mass index,<sup>15</sup> maternal educational status, childhood and adult social class,<sup>16</sup> and height. As our analyses of obesity in four groups may have introduced bias due to dichotomisation of obesity variables,<sup>14</sup> we repeated analyses entering childhood and adult obesity as main effects in the regression equations, adjusting for the interaction between child and adult obesity. The results were not materially different to those achieved with the four obesity categories. We acknowledge that our findings refer to children who were obese

**Table 3** Adjusted\* odds ratios† (95% confidence intervals) for the associations of childhood, adulthood, and persistent obesity with adverse adult outcomes

	Childhood only	Adulthood only	Childhood and adulthood	P value‡
<b>Men</b>				
Unskilled occupation (social class IV or V)	1.4 (0.8 to 2.5)	0.9 (0.7 to 1.2)	1.2 (0.7 to 0.2)	0.9
Never gainfully employed	1.1 (0.6 to 1.9)	0.9 (0.7 to 1.2)	1.4 (0.9 to 2.3)	0.9
Currently unemployed and seeking work	0.8 (0.2 to 3.2)	1.4 (0.9 to 2.2)	1.4 (0.5 to 3.7)	0.2
Left school ≤16	0.9 (0.5 to 1.5)	1.2 (1.0 to 1.5)	1.0 (0.6 to 1.6)	0.3
Left school with no qualifications	0.8 (0.4 to 1.4)	1.4 (1.1 to 1.7)	1.2 (0.7 to 1.8)	0.01
Never married	0.9 (0.6 to 1.4)	0.7 (0.5 to 0.8)	0.8 (0.5 to 1.2)	<0.0001
Has no current partner	1.1 (0.7 to 1.7)	0.6 (0.5 to 0.8)	0.8 (0.5 to 1.3)	<0.0001
Psychological morbidity (malaise inventory score ≥7)	0.6 (0.3 to 1.5)	1.1 (0.8 to 1.5)	1.5 (0.9 to 2.6)	0.3
Limiting longstanding illness	0.8 (0.4 to 1.9)	1.5 (1.1 to 2.0)	0.4 (0.2 to 1.2)	0.2
<b>Women</b>				
Unskilled occupation (social class IV or V)	0.9 (0.5 to 1.6)	1.2 (0.9 to 1.5)	1.3 (0.7 to 2.1)	0.14
Never gainfully employed	1.6 (0.9 to 2.9)	1.1 (0.8 to 1.5)	1.9 (1.1 to 3.3)	0.06
Currently unemployed and seeking work	0.6 (0.1 to 5.4)	1.4 (0.7 to 2.8)	0.8 (0.1 to 5.8)	0.6
Left school ≤16	1.2 (0.7 to 2.0)	0.9 (0.7 to 1.1)	0.9 (0.5 to 1.4)	0.18
Left school with no qualifications	1.0 (0.6 to 1.7)	1.0 (0.8 to 1.2)	0.7 (0.4 to 1.3)	0.5
Never married	0.7 (0.4 to 1.1)	0.9 (0.7 to 1.1)	1.3 (0.8 to 2.1)	0.7
Has no current partner	1.2 (0.8 to 2.1)	1.0 (0.8 to 1.2)	2.0 (1.3 to 3.3)	0.2
Psychological morbidity (malaise inventory score ≥7)	1.0 (0.6 to 1.9)	1.3 (1.1 to 1.7)	1.5 (0.9 to 2.5)	0.02
Limiting longstanding illness	1.5 (0.8 to 3.0)	1.5 (1.1 to 2.1)	1.4 (0.7 to 2.8)	0.005

\*Adjusted for maternal education, social class in childhood and adulthood, maternal and paternal BMI, and height at 10 and 30 years (analyses for unskilled occupation were not controlled for adult social class).

†Reference category was no obesity in childhood or adulthood.

‡P values for the adjusted regression model for each adult outcome.

in 1980, before the dramatic increase in the prevalence of obesity seen in many countries in the 1990s. Given that the prevalence of obesity in Great Britain had been rising since the 1970s,<sup>17</sup> however, the BCS70 provides an opportunity to study the outcomes of childhood obesity in contemporary young adults.

Weaknesses of this study include the use of self reported height and weight in adulthood. Overestimation of height and underestimation of weight in overweight people will magnify underestimation of body mass index. The effect of this bias is likely to have overestimated the adverse effects of obesity limited to childhood by misclassifying people with persistent obesity as having obesity limited to childhood. To reduce such bias, we used a lower threshold of 28.5 to define adult obesity, a threshold supported by internal cohort data as discussed previously. The prevalence of obesity in our sample with this definition was 16.3%, similar to that reported for those aged 25–34 in the health survey for England 1999 ([www.statistics.gov.uk](http://www.statistics.gov.uk)). Findings for all outcomes were not materially changed when we repeated analyses using 30 to define obesity (data not shown). We were unable to assess whether ethnicity had any impact on the outcome of childhood obesity as nearly all of the participants (96%) were “white.”

### Comparison with literature

We are unaware of previous analyses that examine adult social, educational, mental health, and socioeconomic outcomes of childhood obesity separately from those of persistent or adult obesity.

Longitudinal cohort studies from the 1980s in the UK<sup>5</sup> and US<sup>4</sup> have reported that obesity in adolescence and young adulthood has important social and economic consequences for women, with adolescent obesity reported to result in a 7% decrement in adult hourly earnings in the 1958 British birth cohort.<sup>5</sup> In contrast, while we found that persistent obesity in women was associated with a lower likelihood of having ever found gainful employment (where sought), we identified no association of

childhood or persistent obesity with annual net income (when adjusted for confounding factors), current unemployment, and social class in either sex.

We could not confirm previous reports that men<sup>4</sup> and women<sup>18</sup> who were obese in adolescence were less likely to get married. However, we found that women who were persistently obese were less likely to have a current partner. In contrast, we found that men who were obese only in adulthood were more likely to have been married and more likely to have a current partner. These findings are cross sectional and causality cannot be inferred; while they show that obesity may be associated with improved social outcomes for men, they may also reflect uncontrolled confounding by socioeconomic status (associations were adjusted for adult social class and height).

We identified no significant impact of obesity limited to childhood or persistent obesity on educational attainment in our sample when we adjusted for confounding factors, contrary to three cohort studies that reported that women who were overweight or obese in adolescence completed fewer years of school.<sup>4 5 18</sup> Indeed, we found that men who were obese only in adulthood were more likely to have left school without any qualifications, although again this finding was cross sectional and causality cannot be inferred. Our findings were not materially changed when we controlled for cognitive ability at 10 years and suggest that previous reports of educational adversity relate to adolescent or adult obesity rather than to childhood obesity.

We found that child and persistent obesity were not associated with later psychological morbidity. Despite evidence of an association between psychological distress and obesity in childhood<sup>19</sup> and adolescence,<sup>20</sup> we are unaware of longitudinal studies of adult psychological outcomes of childhood obesity. Consistent with previous reports that obesity is associated with psychological disorders in women,<sup>21</sup> we found that obesity only in adulthood was cross sectionally associated with psychological morbidity in women but not men.



We did not find that obesity limited to childhood or persistent obesity increased the risk of having a limiting longstanding illness. While the tracking of childhood obesity into adulthood is strongly associated with increased cardiovascular risk<sup>1</sup> and mortality from multiple causes,<sup>2</sup> it remains unclear whether cardiovascular risk is higher in those whose obesity is limited to childhood.<sup>22-23</sup> Unsurprisingly, adult obesity was strongly associated with limiting longstanding illness in both sexes.

The adult outcomes of obesity limited to childhood and persistent obesity were less adverse in this cohort than reported by a previous longitudinal analysis from the US<sup>4</sup> and from a British birth cohort born 12 years before the BCS70.<sup>5</sup> There are several possible explanations for these differences. Firstly, previous studies evaluated the outcome of adolescent rather than childhood obesity. Secondly, as previous reports evaluated young adults in the 1980s, differences may reflect temporal changes in the social valuation or stigmatisation of obesity over this time as the prevalence of obesity increases. Thirdly, early obesity may have different effects across the later life course. Previous studies assessed outcomes at 21<sup>4</sup> and 23,<sup>5</sup> whereas we assessed outcome at 30 years, and it may be that early obesity impairs social and economic transition from adolescence into young adulthood but that these effects become attenuated in later adult life.

### Conclusions

Obesity limited to childhood has little impact on adult socioeconomic, educational, social, and psychological outcomes. Persistent child and adult obesity in women is associated with somewhat poorer employment and relationship outcomes, although adversity is substantially less than previously reported. These data suggest that the long term social and psychological impact of the apparent epidemic of childhood obesity may be less than previously thought, particularly in those in whom obesity resolves after childhood. Efforts to reduce the socioeconomic and psychosocial burden of obesity in adult life should focus on prevention of the persistence of obesity from childhood into adulthood.

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### What is already known on this topic

Some studies have linked childhood obesity with poorer quality of life, low self esteem, depression, and poor academic achievement within childhood and adolescence

Longitudinal studies of obese adolescents suggest they have poorer socioeconomic and financial outcome in adult life

Research has not separated the effects of childhood obesity from that of persistent child and adult or adult onset obesity, and poorer socioeconomic and educational outcomes may actually reflect confounding by adult obesity

### What this study adds

Obesity limited to childhood has little impact on socioeconomic, educational, social, and psychological outcomes in adult life.

Persistent child to adult obesity is associated with somewhat poorer employment and relationship outcomes in women only

Health inequalities and social adversity related to obesity probably develop after childhood

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