For richer, for poorer: the relationship between adolescent obesity and future household economic prosperity

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Key words: adolescent; childhood; obesity; household income; socioeconomic status

Abstract

Adolescent obesity not only has serious long-term health implications, but also the potential to lead to a socioeconomic trajectory of lower earnings and household income. However, the magnitude and mechanisms of such outcomes across the life course are poorly understood. Using cohort data from the British National Child Development Study (1958 to 2008), we examined the relationship between adolescent obesity (at age 16) and future household income, employment, wages, marriage and spousal income when individuals are in their 30s, 40s and 50s. We additionally investigated the role of obesity persistence from childhood (age 11) through to adulthood. After adjusting for a rich set of childhood characteristics, compared to normal weight, obesity at age 16 is associated with significantly lower levels of future household income for females (by approximately 14%), but not males. This household income penalty is greater for females who were also obese in childhood and adulthood. The household income penalty for females appears to be driven by a lower likelihood of marriage and lower spousal incomes for those who are married, and not by their own wage penalties in the labour market. The spousal earnings penalty occurs even when obesity does not persist into adulthood, suggesting that adolescence is a particularly sensitive period for selecting a higher-earning spouse.

1. Introduction

About one in three young adolescents in England are overweight or obese [1] and are at an increased risk of serious health problems in the short-term and later in adulthood [2]. They may also face an increased risk of a trajectory of lower earnings and household income [3]. However, the magnitude and mechanisms of such economic outcomes across the life course are poorly understood.

Adolescent obesity may influence adult economic prosperity in a number of ways. First, it may affect the acquisition of human capital – an individual's knowledge, skills and attributes that enable an individual to be productive. Cognitive skills (such as problem solving and critical thinking) and socioemotional skills (such as self-esteem and social skills) are important for academic achievement, high school completion, employment and wages [4, 5]. Recent evidence suggests that after accounting for socioeconomic background, and child and school characteristics, childhood obesity may hinder the development of cognitive skills [6-8] and socioemotional skills [9, 10]. One possible individual-level mechanism is childhood health problems, which can lead to absences from school or interfere with concentration and learning through fatigue and stress. Societal-level mechanisms may also be at play: weight stigma and bullying may also affect the development of skills by affecting self-confidence and self-esteem, or by negatively biasing teacher assessments [11].

Second, adolescent obesity may affect adult economic prosperity through an increased risk of adult obesity [12, 13], which has been shown to reduce employment opportunities [14, 15] and wages [16-20] after controlling for potential confounders. This labour market penalty associated with obesity is typically larger and more consistently demonstrated for females than males [21]. It has been hypothesised that the penalties in the labour market may be due to individuals with obesity possessing certain traits that affect their employment prospects. These can be at the individual level, such as lower self-esteem [22, 23]; or at societal level, including discrimination in the hiring and promotion of workers with obesity [24]. Third, obesity may influence future household income through opportunities for marriage and the contribution of spousal earnings. Women with obesity have been shown to be less likely to enter cohabiting relationships or marriage [25, 26].

Findings from a limited number of studies suggest that adolescent obesity is associated with lower household income [3, 17] and wages [27, 28] in young adulthood (up to age 31), particularly for females. What remains unclear, however, is whether these penalties extend

beyond early adulthood and into middle-age. Such information is important in understanding the economic consequences of adolescent obesity over the life course.

This study contributes to the existing literature in several ways. We utilise the 1958 British Cohort Study to examine the relationship between adolescent obesity and economic prosperity between one's 30s and 50s. Our analysis across multiple time points in adulthood enables us to examine whether a relationship exists across adulthood, rather than appearing spuriously at one point. We carefully control for a range of potential confounders, particularly relating to the child's socioeconomic background, which may determine both obesity status (e.g. through social influences and access to healthy diets) [29] and later economic prosperity [30]. We explore possible mechanisms, including opportunities in the labour and marriage markets, and we further investigate the roles of educational attainment, health and self-belief. Additionally, we investigate whether obesity persistence is important in determining adult economic prosperity.

2. Study design

2.1 National Child Development Study (NCDS)

The NCDS follows 17,413 individuals born in England, Scotland, and Wales in 1958. Rich data on their health and socioeconomic circumstances, among other information, have been collected from birth. Childhood information was collected from parents, teachers and medical examiners; in adulthood, information was collected primarily from the cohort members. Despite considerable attrition across five decades of follow-up, with just over 50% of the original birth cohort present at age 50, we show in supplementary analyses (Appendix B) that our main findings are robust to the presence of non-random attrition.

Parental consent was obtained for all childhood surveys, and individual consent was obtained for all adult surveys. Ethical approval was sought from 2000 onwards from the London Multicentre Research Ethics Committees, United Kingdom. This study was exempt from ethical approval by the Monash University Human Research Ethics Committee.

2.2 Adulthood economic prosperity

Household income is our main measure of economic prosperity because it is arguably a more comprehensive measure of economic resources available to the individual [31]. It is the weekly sum of all self-reported income (net of taxes), including own and partner's earnings, benefits, and pension. We examine this at ages 33y, 42y, and 50y, in 1991, 2000, and 2008 – adjusted

to 2005 prices (Great Britain). In all regressions, natural logarithm of income is used. To understand the relative importance of income from the labour and marriage markets, we examine alternative outcome measures: employment (1=employed/self-employed; 0=otherwise), log hourly wages for employed respondents, married (1=married/in a cohabiting partnership; 0=otherwise) and log partner's weekly earnings for married respondents.

2.3 Obesity

We focus on obesity status at 16y (in 1974) because adolescence is identified as a critical period for the development and persistence of obesity [32]. Obesity status in adulthood at 33y (in 1991) is additionally used to explore the role of obesity persistence from adolescence to adulthood. Here, individuals are grouped into four categories: persistent obesity (obese at both 16y and 33y), non-persistent obesity (obese at 16y but not 33y), adult-onset obesity (obese at 33y but not 16y), and not obese at 16y and 33y (reference category). Obesity in childhood at 11y (in 1969) is used in another specification to examine whether obesity persistence beginning in childhood is associated with additional economic penalties. Here, we maintain the above categories but split the persistent obesity group into: a) persistent obesity from childhood (obese at 11y, 16y and 33y), and b) persistent obesity from adolescence (obese at 16y and 33y, but not 11y).

Obesity status is measured using body mass index (BMI) (kg/m^2), calculated from interviewer-measured height and weight at 11y, 16y and 33y. At 11y and 16y, individuals are classified as obese if BMI≥90th percentile of study cohort by gender. We further classify individuals as overweight (80th percentile≤BMI<90th percentile), normal (10th percentile≥BMI<80th percentile) and underweight (BMI<10th percentile). Normal weight is the reference category.[1] For adults, BMI≥30 indicates obesity. Appendix A shows the mean BMI at 16y and 33y by BMI categories when respondents were 16y. Adolescents with obesity have higher BMI at 33y than their non-obese counterparts. At 33y, 10.5% of males and 11.8% of females had obesity.

[1] These BMI cut-offs were considered more appropriate than modern international cut-offs due to the much smaller proportion of children in this 1958 cohort who were obese (only about 1.5% at 11y and 16y according to cut-offs from Cole et al. [33]). When using these international cut-offs [33, 34], our main findings are either very similar or show an even stronger relationship between obesity and adult outcomes.

2.4 Covariates

In all regressions we adjust for covariates that are likely to influence both childhood obesity and human capital development, as these may confound the relationship between obesity and future economic outcomes. To this end we consider several child's family background characteristics [30, 35]: mother's smoking status while pregnant and an indicator of low birthweight (<2.5kg) are included to account for early effects on health and development. To account for parents' investments in childhood health and development, mother's age, mother's marital status at child's birth, whether English was usually spoken at home, father's social class at birth, parents' weekly earnings and whether the child was the family's eldest child are included. Means of these variables by obesity status at 16y are shown in Appendix A.

In robustness analyses, we also adjust for additional child characteristics; health, cognitive ability and socioemotional difficulties at 11y. These are excluded from main analyses as they are associated with potential pathways through which obesity may affect adult economic prosperity. Other adult characteristics, including educational attainment, physical health, mental wellbeing and self-efficacy (a measure of self-belief) are excluded from the main analysis, but examined in supplementary analyses investigating potential pathways.

2.5 Empirical approach

We estimate the relationship between adolescent obesity and adult economic prosperity using ordinary least squares (OLS) regression. In models that examine the probability of marriage in adulthood, we employ probit regressions and present the marginal effects of each obesity category. Due to previous studies showing gender differences in economic outcomes associated with obesity [3, 16, 17], models are estimated separately by gender. In specifications that explore the effects of obesity persistence, obesity status at 16y is replaced with obesity persistence variables (Section 2.3). In all models, we test for statistical significance at the 5% level. In robustness models, we use Coarsened Exact Matching [36] to balance the potential confounders prior to the OLS regressions. This enables background differences between the obese and non-obese (at 16y) groups to be matched non-parametrically.[2]

[2] We matched on low birth weight, mother's marital status, mother's smoking status, mother's age at birth, father's social class and father's income. We pruned 3, 6 and 3 unmatched individuals at age 33, 42 and 50.

3.0 Results

3.1 Descriptive statistics

Figure 1 illustrates the mean household income across adulthood by whether the respondent had obesity or was normal weight at 16y. For males (A), household incomes are statistically similar between groups. However, for females (B), compared with normal weight, obesity at 16y is associated with a lower household income trajectory; average household incomes are significantly lower at 33y, 42y, and 50y.

Table 1 shows, by obesity status at 16y, mean weekly household income along with other outcomes, averaged across 33y, 42y, and 50y. Adult females with obesity at 16y have an average weekly household income of £391, which is £74 (16%) less than that of females who were of normal weight. A significant difference of £44 (9%) is also found between females overweight and normal-weight. The likelihood of employment is not significantly different between females with obesity and normal-weight, but hourly wages (for the employed), likelihood of marriage, and spousal earnings (for the married) are all significantly lower for females obese at 16y. These suggest that an economic penalty exists for women who had obesity in adolescence. Similarly, economic penalties are evident for women who were overweight or underweight at 16y, but these are generally smaller and not always statistically significant. For males, average weekly household income is not significantly different between those who had obesity and were normal weight. Overall, there is no clear relationship between obesity at 16y and adult male economic outcomes, even when estimated separately for the different ages.

3.2 Adult household income

Given the associations in Table 1, we further investigate the relationships at each adult time-point for females but not for males.[3] Panel A of Table 2 shows OLS coefficient estimates for obesity status at 16y for household income at 33y (Column 1), 42y (Column 2) and 50y (Column 3). Holding childhood covariates constant, compared to being of normal weight, obesity at 16y is associated with about 14% lower household incomes at each adult time-point considered. Unlike obesity, being overweight or underweight is not strongly associated with adult household income, although coefficients are consistently negative.

[3] For males, the fully-adjusted estimates for adolescent obesity are also insignificant for all economic outcomes at all adult ages.

Panel B examines whether the household income penalty depends on obesity persisting from adolescence into adulthood. Coefficient estimates for persistent obesity (4.6% of the sample at 33y, N=123), non-persistent obesity (5.2%, N=139), and adult-onset obesity (7.2%, N=192) show that compared to females not obese at either adolescence or adulthood, females with persistent obesity experience a much larger penalty, especially in later adulthood (Columns 1-3). For example, by 42y, females with persistent obesity have 34% lower household incomes. Adult-onset obesity is also independently associated with lower adult household incomes, but this effect is modest in comparison to persistent obesity, and only statistically significant at age 42y.

Panel C presents estimates of the persistent obesity group, split by whether they had obesity at 11y. These suggest that the penalty associated with obesity persistence is driven by individuals with obesity in childhood. Females with persistent obesity from childhood to adulthood (2.4% of the sample) suffer a 50-60% larger penalty than those with obesity only in adolescence and adulthood.

3.3 Wages

In Columns (4)-(6) of Table 2 we examine labour market penalties among females. Regression estimates demonstrate no significant association between adolescent obesity and adult employment at any adult age, consistent with Table 1; we therefore focus on whether wage penalties exist among the employed. After adjusting for childhood covariates, adolescent obesity is associated with a 6.5% wage penalty at 33y, but not at 42y or 50y. Taking into account persistence of obesity (Panel B), adolescent obesity is not significantly associated with lower wages at any age. Even when persistence of childhood obesity is considered (Panel C), there is little relationship between adolescent obesity and adult labour market outcomes. In contrast to the weak association between adolescent obesity and future wages, adult-onset obesity is associated with 8-12% lower wages across adulthood, compared with not being obese in either adolescence or adulthood.

3.4 Marriage and spousal income

Table 3 examines success in the marriage market among females: Columns (1)-(3) of Panel A show marginal effects for adolescent BMI categories on the probability of marriage across adulthood, after controlling for childhood covariates. Females with obesity at 16y are about 5 percentage points less likely to be married at each adult age. Panel B shows the marriage penalty depends on obesity persisting into adulthood – persistent obesity is associated with a 5

to 7 percentage point lower probability of marriage across adulthood. When considering the persistence of obesity from earlier in childhood, marriage penalties are generally slightly larger for individuals with obesity from 11y (Panel C).

We investigated the relationship between adolescent obesity and spousal income among those who married (78% of the sample across the adult ages). Columns (4)-(6) of Table 3 show coefficient estimates for log earnings of the respondent's partner if married at 33y, 42y and 50y. Panel A shows that female adolescents with obesity tend to partner with individuals who earn significantly less than spouses of females of normal weight in adolescence (ranging from about 13% at 33y to 18% at 42y and 50y). Panels B and C further reveal that the penalties arise for adolescents with obesity, regardless of their childhood or adulthood obesity status.

3.5 Robustness checks and possible mechanisms

When we balance the covariates between the obese and non-obese (at age 16) groups using Coarsened Exact Matching [36] prior to the OLS regressions, we obtain very similar regression estimates to our main results.[4] This suggests that the main estimates from adjusted OLS models sufficiently account for differences in observed background characteristics (Section 2.5) between obese and normal-weight adolescents.

Table 4 displays results of the main regressions with the inclusion of childhood health, cognitive ability and socioemotional skills, as captured at 11y. The estimated effect of adolescent obesity on household income reduces by 18-32% and the significance drops to the 10% level, suggesting these characteristics play an important role in the relationship between adolescent obesity and adult household income: cognitive ability has the largest influence, followed by socioemotional skills and finally physical health. Estimates for wages also reduce when these characteristics are included, and is no longer significant at 33y. In contrast, associations for marriage and spousal income appear robust to the inclusion of these childhood characteristics, with minimal changes to the significance or size of coefficients across adulthood.

To further investigate whether marriage market penalties are a likely pathway through which adolescent obesity relates to reduced household income among women, we included marriage and spousal earnings (for the married) as separate covariates in supplementary models of household income. The coefficient on adolescent obesity reduces considerably across

[4] In OLS regressions of household income at age 33, 42 and 50, the coefficient for obesity at age 16 is -0.140, -0.133 and -0.142 respectively, all statistically significant $p<0.05$

adulthood (by 23-26% when marital status is included, and by 40-85% when spousal earnings is included) and is no longer significant, except at age 33. Similarly large reductions in the persistent obesity coefficients occur when these variables are included. In contrast, when wages (for the employed) are included as a covariate in the household income models, the penalties for adolescent obesity and persistent obesity change little in size and remain statistically significant at ages 42 and 50.

Possible mechanisms for why adolescent obesity is associated with marriage and spousal earnings penalties is explored by including adult educational attainment, mental wellbeing, general health and self-efficacy (separately and together). Appendix Table A2 shows the marriage and spousal earnings penalties associated with adolescent obesity hold with the inclusion of all covariates measuring these potential pathways.

4.0 Discussion

While a large literature examines the labour market consequences of adult obesity [14, 16], relatively little attention has been given to long-term effects of childhood and adolescent obesity on adult economic prosperity. This study uses the 1958 British Cohort Study to investigate the long-term relationship between adolescent obesity and household income, employment, wages, marriage and spousal income. We uniquely examine adult economic prosperity when cohort members are in their 30s, 40s and 50s, and explore whether economic penalties depend on whether obesity status persists from earlier in childhood and into adulthood. Additional strengths of this study are that it utilises measured height and weight to calculate BMI, along with rich childhood and at-birth information in regression models to isolate the effect of youth obesity.

After controlling for childhood circumstances, we find obesity at 16y is associated with about 14% lower adult household incomes at 33y, 42y and 50y, for females but not males. The household income penalty is greatest for adolescents with obesity who also had obesity in childhood (11y) and in adulthood (33y). This suggests that the penalty operates largely through the persistence of obesity into adulthood and highlights the importance of not only obesity during adolescence but also earlier in childhood. Women with persistent obesity had, on average, a higher BMI in adulthood (mean of 36.4 kg/m^2 at 33y) compared with women with adult-onset obesity (33.4 kg/m^2) or non-persistent obesity (25.8 kg/m^2). Our significant finding for a household income penalty for females corresponds with previous studies that used data from the United States National Longitudinal Survey of Youth (NLSY) to investigate

relationships between late adolescent obesity (16-24y) and socioeconomic outcomes just seven years later (23-31y) [3, 17].

Among females, adolescent obesity is only weakly associated with lower own wages (and only at 33y), suggesting that the labour market is not the primary mechanism for economic penalties relating to adolescent obesity. Our study demonstrates the importance of examining the wage penalty in later adulthood; previous studies that only examined this relationship during early adulthood only capture part of the picture. We show that adult-onset obesity is particularly detrimental for own wages, supporting previous findings of associations between adult obesity and wages [16, 37]. Further research is needed to understand why wage penalties fall predominantly on women with adult-onset (rather than persistent) obesity.

In contrast to the weak labour market penalty, adolescent obesity is strongly associated with a lower probability of marriage, and for those who marry, lower spousal earnings throughout adulthood. Marriage and spousal earnings explain a large proportion of the relationship between adolescent obesity and lower household incomes. Averett and Korenman [17] similarly found that the economic deficit in young adulthood associated with obesity among American women (born 1958-65) is largely driven by differences in the marriage market, not the labour market. It is noteworthy that we obtain similar findings in a 1958 British cohort and show that the pattern extends into one's 40s and 50s. While the marriage penalty appears to be driven by women with persistent obesity, we find that the spousal earnings penalty among married women are large for women whose obesity did not persist from adolescence to adulthood (as well as those with persistent obesity), suggesting that adolescence is a particularly sensitive period for selecting a higher-earning spouse. For this sample of married women, having non-persistent obesity is also associated with household income penalties in adulthood. Our supplementary models show that neither educational attainment nor health or self-efficacy explain the marriage market penalties. Other characteristics that we were unable to measure, such as attractiveness [38], self-esteem [22] and social skills [10] may offer possible explanations [22].

The gender inequalities in the economic penalties associated with obesity is consistent with a culture that places a greater importance on thinness and attractiveness for females than for males, and an unrealistic ideal thinness for women; these can contribute to gender differences in appearance self-esteem [39]. Recent evidence also suggests that the social and emotional consequences of childhood obesity differ for girls and boys [10]. Additionally, there are gender differences in the importance of physical attractiveness and thinness in a prospective partner (men value it more) [40] and in the value of marriage (women value it more) [25],

which may explain the larger marriage market penalties associated with obesity for women, compared with men. To mitigate the economic penalties associated with adolescent obesity, further research is needed to better understand the sociological and individual factors that most strongly play a role in this relationship.

In contrast to our findings and others from the United States and Britain that find no association between adolescent obesity and economic outcomes for males [27, 41], Lundborg et al. [28], in a study of men from the Swedish military enlistment (born 1966-1979), found that obesity at 18y was associated with 18% lower earnings at 28y-38y than being of normal weight. This highlights the importance of investigating the economic penalties associated with obesity in different settings and across different cohorts.

We acknowledge several limitations of this study. Although we account for a rich set of early childhood confounders, and show that covariates in our models are balanced between adolescents with and without obesity, we cannot interpret our estimates as causal. Given the very small sample of siblings/twins in the cohort, we were unable to use sibling fixed-effects as in Averett and Korenman [17] to rule out other fixed unobserved factors not captured by our covariates, but it is encouraging that we find qualitatively similar results to their OLS estimates with the NLSY. We also recognise that household income and other economic outcomes used are self-reported and may be subject to measurement error.

Finally, while a long time-span is necessary to examine the relationship between childhood obesity and adult circumstances, this inevitably means that children in our study lived in different times from the children of today. There have been changes in gender roles and a normalisation of overweight and obesity, which may affect the generalisability of our results to contemporary children. However, evidence suggests that the stigmatisation of obesity by children has increased since the 1960's [42] and the value placed on physical attractiveness in a potential spouse has also increased over the last half-century for both sexes [43]. Therefore, it is unclear how generalizable our results are to contemporary adolescents with obesity.

This study demonstrates that obesity in childhood and adolescence is associated with less favourable socioeconomic outcomes throughout adulthood, particularly for females. Such negative consequences can have a substantial impact on the future wellbeing of children and adolescents, yet are rarely accounted for in economic evaluations. In order to measure the benefits of obesity prevention programs more holistically, future economic evaluations should work towards capturing the socioeconomic, in addition to health, consequences across the lifespan that are due to childhood and adolescent obesity.

Acknowledgements

We are grateful to the Centre for Longitudinal Studies (CLS), UCL Institute of Education for the use of the National Child Development Study (NCDS) data and to the UK Data Service for making them available. However, neither CLS nor the UK Data Service bear any responsibility for the analysis or interpretation of these data.

Conflicts of interest: None

Funding: NB was supported by an Australian National Preventive Health Agency Research Fellowship (2AUN2013F).

Data sharing: The NCDS is available to the scientific community. Please refer to the Centre for Longitudinal Studies, Institute of Education: http://www.cls.ioe.ac.uk/default.aspx

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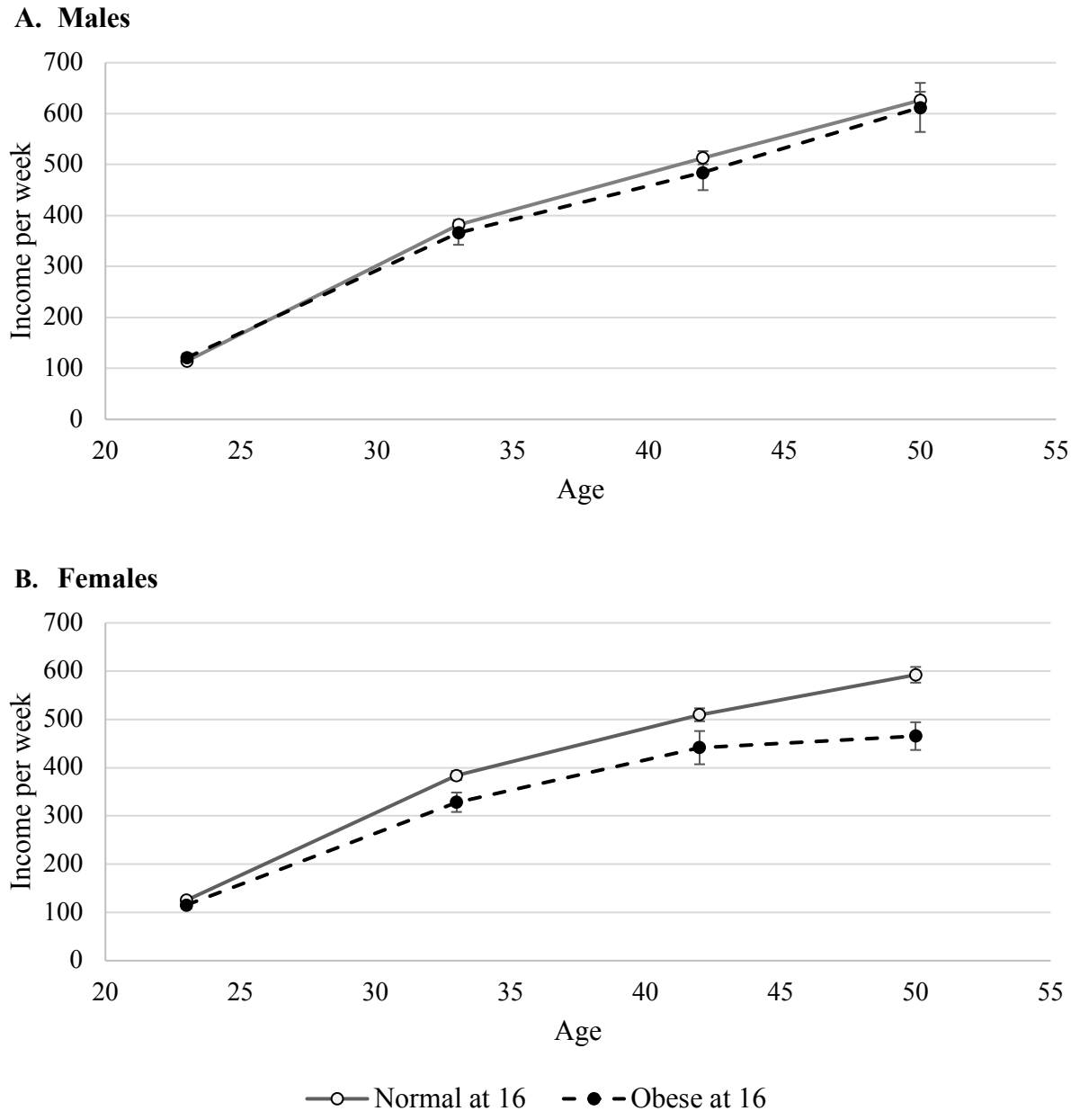
Figure 1. Mean household income across adulthood by obesity status at age 16



Notes: Data is from the British NCDS. Age 16 obesity status is measured in 1974. Household income is measured at age 23, 33, 42 and 50 in 1981, 1991, 2000 and 2008 respectively (adjusted to 2005 GBP). Bars indicate the 95% confidence interval. Those were underweight or overweight are excluded from the figure to reduce clutter, but the trajectories for these individuals lie between those of normal-weight and obese individuals.

Table 1. Mean economic outcomes across adulthood by age 16 obesity status

Age 16 obesity status category	Obese	Overweight	Normal	Underweight
Males				
Household income (£/week)	445.23	447.29	463.08	441.39
Employed	0.87	0.92	0.90	0.89
Hourly wage (£/hour)	8.26	8.26	8.50	8.21
Married	0.77	0.78	0.79	0.68***
Partner's earnings (£/week)	121.34	116.75*	133.21	153.14**
Sample	264	270	1866	280
Females				
Household income (£/week)	390.83***	421.17***	464.65	440.83
Employed	0.78	0.73*	0.76	0.74
Hourly wage (£/hour)	6.12***	6.64	6.72	6.51
Married	0.74**	0.76	0.80	0.79
Partner's earnings (£/week)	243.72***	300.32*	323.97	321.31
Sample	284	295	1991	284

Notes: BMI=Body mass index. Data is from the British NCDS. Sample based on regressing age 33 household income on age 16 obesity (in 1974). Adulthood socioeconomic outcomes are averaged across ages 33 (in 1991), 42 (in 2000), and 50 (in 2008) for individuals with ≥1 observation across these waves. Income/wage/earnings are net of taxes and based on 2005 price levels in Great Britain. For every outcome variable three two-group *t*-tests are conducted to examine whether the obese, overweight, and underweight categories differ significantly from the normal weight category. $^{*}p<0.1$,$^{**}p<0.05$,$^{***}p<0.01$. Mean hourly wages are only calculated for those employed and mean partner's earnings are only calculated for those married/cohabiting, leading to slightly smaller sample sizes than those reported.

Table 2. Regression estimates of obesity status for log household income and log wages across adulthood for females

	Household income			Hourly wages		
	(1)	(2)	(3)	(4)	(5)	(6)
	Age 33	Age 42	Age 50	Age 33	Age 42	Age 50
(A) *Adolescent BMI status*						
Obese	-0.145**	-0.138**	-0.139**	-0.065**	-0.050*	-0.011
	(0.064)	(0.061)	(0.058)	(0.027)	(0.030)	(0.029)
Overweight	-0.032	-0.034	-0.180**	-0.049*	-0.034	0.002
	(0.048)	(0.042)	(0.085)	(0.026)	(0.032)	(0.029)
Underweight	-0.069	-0.086	-0.210*	-0.017	-0.059*	-0.012
	(0.068)	(0.059)	(0.111)	(0.025)	(0.032)	(0.029)
N	2854	2915	2361	2145	2580	2313
(B) *Adolescent & adult obesity status*						
Adolescent & adult	-0.152*	-0.335**	-0.279**	-0.071*	-0.056	-0.004
	(0.083)	(0.132)	(0.113)	(0.041)	(0.042)	(0.045)
Non-persistent	-0.048	-0.025	0.026	-0.056*	-0.059	-0.037
	(0.077)	(0.056)	(0.065)	(0.033)	(0.045)	(0.039)
Adult onset	-0.083	-0.159***	-0.113*	-0.124***	-0.125***	-0.083**
	(0.063)	(0.049)	(0.063)	(0.027)	(0.044)	(0.034)
N	2681	2505	2018	2031	2226	2000
(C) *Persistence from childhood*						
Adolescent & adult & childhood	-0.233	-0.433**	-0.394**	-0.070	-0.010	0.074
	(0.142)	(0.194)	(0.195)	(0.050)	(0.061)	(0.063)
Adolescent & adult & not childhood	-0.062	-0.219	-0.156	-0.072	-0.114**	-0.085
	(0.073)	(0.170)	(0.103)	(0.068)	(0.054)	(0.059)
Non-persistent	-0.051	-0.024	0.027	-0.057*	-0.058	-0.038
	(0.077)	(0.057)	(0.065)	(0.033)	(0.045)	(0.039)
Adult onset	-0.084	-0.158***	-0.112*	-0.124***	-0.124***	-0.083**
	(0.063)	(0.049)	(0.063)	(0.027)	(0.044)	(0.034)
N	2681	2505	2018	2031	2226	2000

Notes: Figures are OLS coefficients (robust standard errors). All covariates detailed in Section 2.4 and Appendix A are included: these are whether child is first born in the family; whether below 2.5kg at birth; father's social class, mother's marital status, and mother's age (below 21y, 21y-30y, or above 30y) at the time of birth; whether mother smoked during pregnancy; whether English usually spoken at home; and father's and mother's weekly earnings. Regressions for wages additionally include an indicator for working part-time (<30 hours per week). Normal weight is the reference category for Panel A. Not obese at either age is the reference category for Panels B and C. Data is from the British NCDS. Obesity status is measured in 1969 (age 11), 1974 (age 16) and 1991 (age 33). Outcomes measured in 1991 (age 33), 2000 (age 42) and 2008 (age 50). $^{*}p<0.1$,$^{**}p<0.05$,$^{***}p<0.01$

Table 3. Regression estimates of obesity status for probability of marriage and log spousal earnings for females

	Marriage			Spousal earnings		
	(1)	(2)	(3)	(4)	(5)	(6)
	Age 33	Age 42	Age 50	Age 33	Age 42	Age 50
(A) *Age 16 status*						
Obese	-0.047**	-0.051**	-0.056**	-0.125***	-0.183***	-0.184***
	(0.020)	(0.021)	(0.023)	(0.030)	(0.040)	(0.041)
Overweight	-0.036*	-0.011	-0.012	-0.066**	-0.062	-0.110**
	(0.020)	(0.021)	(0.024)	(0.030)	(0.045)	(0.046)
Underweight	0.013	0.004	-0.003	-0.055*	-0.062	0.024
	(0.022)	(0.023)	(0.025)	(0.033)	(0.051)	(0.052)
N	3733	3772	3294	2070	2227	1572
(B) *Adolescent & adult obesity status*						
Adolescent & adult	-0.051*	-0.074**	-0.074**	-0.129***	-0.177***	-0.153**
	(0.030)	(0.032)	(0.036)	(0.045)	(0.052)	(0.063)
Non-persistent	-0.026	-0.011	-0.021	-0.100**	-0.170***	-0.157***
	(0.028)	(0.030)	(0.032)	(0.041)	(0.061)	(0.054)
Adult onset	-0.019	-0.049*	-0.035	-0.066	-0.089	-0.179**
	(0.030)	(0.032)	(0.034)	(0.041)	(0.058)	(0.078)
N	3510	3207	2803	1927	1926	1366
(C) *Persistence from childhood*						
Adolescent & adult & childhood	-0.067	-0.073*	-0.091*	-0.153*	-0.250***	-0.132
	(0.041)	(0.044)	(0.048)	(0.080)	(0.084)	(0.105)
Adolescent & adult & not childhood	-0.033	-0.074	-0.056	-0.109**	-0.106*	-0.169**
	(0.043)	(0.045)	(0.051)	(0.048)	(0.059)	(0.076)
Non-persistent	-0.026	-0.011	-0.021	-0.100**	-0.171***	-0.158***
	(0.028)	(0.030)	(0.032)	(0.041)	(0.061)	(0.054)
Adult onset	-0.019	-0.049*	-0.035	-0.066	-0.090	-0.180**
	(0.025)	(0.026)	(0.030)	(0.041)	(0.058)	(0.078)
N	3510	3207	2803	1927	1926	1366

Notes: All covariates detailed in Section 2.4 and Appendix A are included: these are whether child is first born in the family; whether below 2.5kg at birth; father's social class, mother's marital status, and mother's age (below 21y, 21y-30y, or above 30y) at the time of birth; whether mother smoked during pregnancy; whether English usually spoken at home; and father's and mother's weekly earnings. Probit regressions are used to model marriage; figures are marginal effects (robust standard errors). Regressions for spousal earnings (for the married) include an indicator for the partner working part-time; figures are OLS coefficients (robust standard errors). Normal weight is the reference category for Panel A. Not obese at either age is the reference category for Panels B and C. Data is from the British NCDS. Obesity status is measured in 1969 (age 11), 1974 (age 16) and 1991 (age 33). Outcomes measured in 1991 (age 33), 2000 (age 42) and 2008 (age 50). $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

Table 4. Robustness of regression estimates of age 16 obesity for all outcomes across adulthood for females

	Age 33		Age 42		Age 50	
	(1) Base	(2) Child controls	(3) Base	(4) Child controls	(5) Base	(6) Child controls
Household income						
Obese at 16	-0.145**	-0.107*	-0.138**	-0.112*	-0.139**	-0.096*
	(0.064)	(0.063)	(0.061)	(0.062)	(0.058)	(0.056)
N	2854	2854	2915	2915	2361	2361
Hourly wages						
Obese at 16	-0.065**	-0.046*	-0.050*	-0.035	-0.011	0.010
	(0.027)	(0.025)	(0.030)	(0.029)	(0.029)	(0.028)
N	2145	2145	2580	2580	2313	2313
Marriage						
Obese at 16	-0.047**	-0.039*	-0.051**	-0.047**	-0.056**	-0.049**
	(0.020)	(0.020)	(0.021)	(0.021)	(0.023)	(0.023)
N	3733	3733	3772	3772	3294	3294
Spousal earnings						
Obese at 16	-0.125***	-0.115***	-0.183***	-0.172***	-0.184***	-0.162***
	(0.030)	(0.030)	(0.040)	(0.040)	(0.041)	(0.041)
N	2070	2070	2227	2227	1572	1572

Notes: Figures are OLS coefficients (robust standard errors). Overweight and underweight indicators not shown for brevity. (1), (3) and (5) Base follows the regression estimates from Panel A of Tables 2 and 3 (includes all main covariates). (2), (4) and (6) Child controls include all main covariates plus: an indicator for major physical health problems from medical examinations at age 11; the general cognitive ability total score at age 11; and socioemotional difficulties from the Bristol Social Adjustment Guide score at age 11 (teacher-reported). To maintain sample size, missing values are imputed as zero and indicators for those respondents with missing values are included in the models. Data is from the British NCDS. Obesity status is measured in 1974 (age 16). Outcomes measured in 1991 (age 33), 2000 (age 42) and 2008 (age 50). $^{*}p<0.1$,$^{**}p<0.05$,$^{***}p<0.01$

APPENDIX A

Table A1. Mean BMI and key covariates by age 16 obesity status

	Males				Females			
	Obese	Over-weight	Nor-mal	Under-weight	Obese	Over-weight	Nor-mal	Under-weight
BMI at 16	26.15	22.58	19.61	16.54	27.38	23.70	20.30	16.84
BMI at 33	29.79	27.51	24.98	22.43	30.76	26.85	23.72	21.19
Childhood covariate								
First-born [a]	0.30	0.36	0.34	0.38	0.32	0.37	0.33	0.36
Below 2.5kg at birth	0.03	0.03	0.05	0.07	0.05	0.07	0.07	0.11
Father's social class								
I Professional	0.02	0.04	0.06	0.04	0.03	0.04	0.04	0.05
II Managerial and technical	0.10	0.14	0.13	0.13	0.08	0.14	0.14	0.11
III Skilled, non-manual	0.08	0.10	0.12	0.11	0.08	0.08	0.10	0.08
III Skilled, manual	0.51	0.48	0.49	0.47	0.55	0.44	0.49	0.51
IV Partly skilled	0.14	0.13	0.11	0.11	0.12	0.16	0.11	0.12
V Unskilled	0.09	0.05	0.07	0.08	0.08	0.08	0.07	0.08
No father/other	0.06	0.06	0.04	0.04	0.05	0.05	0.04	0.04
Mother married	0.97	0.97	0.98	0.96	0.95	0.97	0.97	0.96
Mother smoked while pregnant	0.39	0.34	0.31	0.28	0.42	0.34	0.30	0.30
Mother's age at birth								
Below age 21	0.08	0.10	0.08	0.11	0.09	0.09	0.09	0.09
Ages 21 to 30	0.55	0.64	0.65	0.65	0.58	0.61	0.63	0.66
Above age 30	0.38	0.25	0.28	0.24	0.33	0.29	0.28	0.25
English usually spoken at home [a]	0.86	0.86	0.86	0.86	0.87	0.83	0.85	0.88
Father's earnings (£/week) [b]	29.08	30.39	29.51	30.36	26.37	29.14	30.18	29.16
Mother's earnings (£/week) [b]	8.04	9.30	8.31	8.13	9.13	7.90	8.71	7.88
Sample	264	270	1866	280	284	295	1991	284

Notes: BMI=Body mass index. Data is from the British NCDS. Obesity status is measured in 1974 (age 16). Sample based on regressing age 33 household income on age 16 obesity. Childhood covariates are all measured at birth (in 1958), except whether English is spoken at home which is measured at age 11 (in 1969); and parent's earnings which are measured when respondents are age 16. Father's social class is based on Registrar General's Social Classes assigned in 1951. Parental earnings were recorded in the form of 12 brackets ranging from £0-£4 to ≥£60; means are calculated from the bracket midpoints and retained at 1974 price levels.

[a] To avoid loss of observations, missing values are imputed as zero. When included in regressions, an indicator for respondents with missing values is additionally included.

[b] Missing values imputed as zero if the cohort member has no father or if father/mother does not work, otherwise imputed as the social class average. When included in regressions, an indicator for respondents with missing values is additionally included.

Table A2. Robustness of regression estimates of age 16 obesity for marriage market outcomes for females at age 42 – including potential mechanisms

Age 42 outcomes	(1) Base	(2) Educ	(3) Educ years	(4) Health 23	(5) Mental 23	(6) Health 33	(7) Mental 33	(8) Self-Efficacy
Marriage								
	-0.047**	-0.045**	-0.047**	-0.045**	-0.047**	-0.046**	-0.046**	-0.041**
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
N	3772	3772	3772	3772	3772	3772	3772	3772
Spousal earnings								
	-0.172***	-0.166***	-0.161***	-0.166***	-0.171***	-0.167***	-0.172***	-0.164***
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
N	2227	2227	2227	2227	2227	2227	2227	2227

Notes: Data is from the British NCDS. Obesity status is measured in 1974 (age 16). Outcomes measured in 2000 (age 42). Figures are OLS coefficients (robust standard errors) for obesity at age 16. Overweight and underweight indicators not shown for brevity. (1) Base corresponds with the regression estimates from Column 4 of Table 4 (includes extra child controls); (2) includes an educational attainment variable (ranging from 0 to 12) from administrative data, reflecting performance in O- and A-Level examinations at ages 16 and 18; (3) captures age left full-time education; (4) and (6) include 4 indicators of general self-assessed health (excellent, good, fair, and poor) measured at age 23 (in 1981) and 33 (in 1991) respectively; (5) and (7) includes Malaise Inventory score (24 items) which measures perceived emotional disturbances and somatic symptoms, measured at age 23 and 33 respectively; (8) includes total self-efficacy score measured at age 33. If all additional covariates from (2) to (8) are included, the obesity at 16 coefficient (SE) is -0.040* (0.021) for Marriage and -0.153*** (0.040) for Spousal earnings. $^{*}p<0.1$,$^{**}p<0.05$,$^{***}p<0.01$

APPENDIX B

Testing for Attrition

Given our working sample only comprises approximately 30% of the original birth cohort; we explore the data for any obesity-related attrition that may bias our main estimates. We employ two tests, based on analyses conducted by Frijters et al. [44]. First we estimate three separate probit attrition models for each gender, regressing a binary indicator for whether the individual was present in the estimation sample on all childhood covariates plus a) age 16 obesity status variables, or b) the obesity persistence from childhood variables, or c) the obesity persistence into adulthood variables. Being the first-born, father's social class, mother's marital status, and having a younger mother seem to predict attrition among males but not females. Importantly, we find that all obesity status variables do not significantly predict attrition from our working sample.

Our second test involves a Heckman sample selection model to control for omission from the working sample when estimating the effects of age 16 obesity on adulthood household income. This model assumes that certain unobserved variables influencing household income are correlated with those influencing nonresponse. We impose certain restrictions on this correlation instead of exclusion restrictions, given there are no clear valid 'instruments' in the dataset. We adjust the values of this correlation to .2, .4, .6, and .8; thereby assessing the sensitivity of the estimates to attrition. Results from estimating these four Heckman models indicate that our main findings from this regression are robust: using specification (2) in Table 2 Panel A as an example, the effect of age 16 obesity remains significant between -0.146 and -0.156 when the correlation is adjusted between the four values (as a comparison, the OLS estimate without accounting for the correlation is -0.145). These tests suggest that our main findings are robust to the presence of any non-random attrition.