No Country for Fat Men? Obesity, Earnings, Skills, and Health among 450,000 Swedish Men*

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Abstract:
We analyze the relationship between teenage obesity and adult earnings using data on 450,000 males and 150,000 male siblings from the Swedish military enlistment records. We show that there is a significant and large later life earnings penalty for being obese at age 18, whereas later life obesity does not matter for the earnings of men. Moreover, we show that the obesity penalty is fully explained by labour supply side characteristics that are associated with both earnings and teenage obesity. In particular, we show that the penalty reflects the negative associations between obesity, on the one hand, and cognitive skills, non-cognitive skills, and physical fitness, on the other. Analysing additional survey data from Sweden, the UK, and the US, we are able to confirm that teenage obesity is a much stronger predictor of low later life adult earnings than adult obesity status.

Keywords: obesity, overweight, earnings, cognitive ability, non-cognitive ability, health, physical fitness

JEL- codes: I10, J10, J70

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1. Introduction

There has been a dramatic increase in the prevalence of overweight and obesity in most Western Countries during the last couple of decades (WHO, 2000). In the U.S., the share of obese adults increased from 15 percent in the late 1970s to 31 percent at the turn of the millennium (Cawley, 2004). Although starting at a lower level, Sweden, the country at focus in this study, is no exception and the share of obese adults rose from 5 to 10 percent during the same time span, while the share being classified as overweight has risen from a quarter to about a third (Kallings, 2002).[1,2]

There are no signs that future generations will be any less overweight or obese. According to the Center for Disease Control and Prevention, obesity rates among young adults are increasing dramatically nationwide. From 1998 to 2008, the number of states reporting that 40 percent or more of young adults are overweight or obese has risen from 1 to 39. A similar increase in weight has occurred among Swedish 18 year old male enlistees, for whom the share being overweight and obese increased from 6 and 1 percent, respectively, in 1971, to 13 and 4 percent, respectively, in 1997 (Rasmussen et al., 2000).[3]

The rapid increase in overweight and obesity has raised major public health and welfare concerns, since evidence links overweight and obesity to serious health problems, such as cardiovascular disease, diabetes and some cancer forms, as well as to low fertility and fecundity (e.g. Dixon, 2010; Despres, 2006; Calle et al., 2003; Gregg et al, 2007; Norman and Clarke, 1998; Jokela et al., 2008; Sallmén et al., 2006).

In addition to being health threat, the increase in obesity among adolescents and young adults has recently even been labeled a national security threat in the US. In a recent column in the Washinton Post, the retired army generals John M. Shalikashvili and Hugh Shelton wrote that "Obesity rates threaten the overall health of America and the

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[1] Body Mass Index (BMI) is calculated as the person's weight (in kilograms) divided by the square of his/her height (in meters). A person is classified as overweight if his BMI is between 25 and 30 and as obese if his BMI exceeds 30.

[2] See Brunello, Michaud and Sanz-de-Galdeano (2008) for the obesity share among other European countries.

[3] Swedish men who enlisted for the army during the time period 1984-1997 constitute the study population in this paper. The share of overweight and obese individuals in this data is 10 and 2 percent, respectively.

future strength of our military. We must act, as we did after World War II, to ensure that our children can one day defend our country, if need be." The worries expressed by the generals reflect the fact 27 percent of all Americans ages 17 to 24 -- were too overweight to serve in the military, according to the Army's analysis of national data.[4]

Being obese may also affect one's ability to work. Such concerns have been addressed by economists, who have analyzed the association between overweight/obesity and labor market outcomes, such as earnings, wages, and employment. The mostly U.S.-based studies usually find a substantial obesity penalty in wages for women, whereas the results for men are usually found to be insignificant, even in descriptive analyses (see e.g. Averett and Korenman, 1996; Behrman and Rosenzweig, 2001: Cawley, 2004; Conley and Glauber, 2006; Han et al. 2009). Studies on European data confirm this picture (e.g. Lundborg et al. 2006; Brunello and D'Hombres, 2007).

The literature to date has in large focused on the association between obesity and earnings among adults. In this paper, we instead focus on the association between obesity status as a teenager and later adult earnings. We argue and show that the association between being obese as a teenager and adult earnings is very different from the corresponding association as an adult. To show this, we use large-scale military enlistment data set covering 450,000 Swedish males and 150,0000 male siblings, that underwent mandatory enlistment at age 18 during the years 1984-1997. Since the data was collected during a period when enlistment was mandatory in Sweden, the data covers almost the entire population of Swedish men that were about 18 during this period.

Through linking the data to tax registers on earnings, we are able to study the link between obesity as a teenager and later adult earnings with large precision. Our results show a huge obesity adult earnings penalty of 18 percent for being obese as a teenager. We then set out to investigate to what extent this obesity penalty reflect limitations in important supply-side productive characteristics of obese teenagers. For this purpose, we are able to exploit the rich information in the enlistment data on cognitive and non-cognitive test scores, and physical fitness, which are all measured in advance of entrance

[4] Concerns about the poor fitness of military recruits have also been expressed in the UK, where 67 per cent of all 16-year-olds were found to exceed the maximum Body Mass Index for military recruits in 2006 (Hickely 2006).

to the labor market, In particular, we build on recent evidence of a negative association between obesity, on the one hand, and cognitive skills, non-cognitive skills, and physical fitness, on the other. Our results show that the lower cognitive and non-cognitive skills of obese people in adolescence explain a large part of their crude later life obesity earnings penalty, but that an even larger part is explained by the lower physical fitness (which we argue is strongly linked to health), that accompanies obesity. Accounting for both skills and fitness we are able to explain virtually the entire obesity penalty. Our results are similar when using the subsample of 150,000 siblings and accounting for family fixed effects.

Whereas our core analysis is based on the enlistment data described above, the military data only covers information on obesity at age 18. In order to compare the impact of obesity at age 18 to that of obesity as an adult, we therefore turn to other data sources. First of all, using two Swedish surveys, we confirm the common finding that there is no adult obesity penalty for men. Second, we turn to the UK National Child Development Study and to the U.S. NLSY, both which contain a sequence of individual obesity status information records running from late adolescence to middle-age. Using both data sets, the results reveal that obesity in late adolescence is much more strongly linked to middle-life earnings than obesity status in any other period, which confirm our findings on the Swedish data.

In sum, our results strongly suggests that that there is something special about being obese as a teenagers that is not comparable to being obese as an adult. Obese teenagers are doing worse as adults, but this is because of the lower skills that they bring to the market. This has potentially important implications. If obesity *leads* to lower mental and physical skills, one should be greatly concerned about the high fraction of obese teenagers. While we cannot directly address the question of causality, our results are in line with what Persico et al. (2004) and Case and Paxson (2009) obtained for height, where shorter status as a teenager was associated with lower earnings. This was also to a large extent explained by the lower cognitive skills and lower social skills that individuals of shorter status brought to the market.

The remainder of this article is organized as follows. In Section 2, we review the evidence for a negative association between obesity, on the one hand, and cognitive skills, non-cognitive skills, and physical fitness, on the other, and discuss possible reasons for these associations. In section 3, the Swedish enlistment data, which is at the heart of this study, is described, section 4 discusses our empirical method and the results are presented in section 5. The survey data from UK are presented and analyzed in section 6. Section 7 concludes.

2. Literature review

Among economists, there has been a substantial debate about the sources of the obesity wage penalty. The penalty may reflect pure taste-based discrimination, where employers, co-workers, or customers hold preferences against obese workers, irrespective of their productive potential. Rooth (2009) found strong indications of discrimination against obese workers by measuring employer callbacks on fictitious job applications to real jobs, where pictures of an obese or non-obese person were randomly assigned to similar applications.[5,6] These results could also reflect statistical discrimination, however, where obese workers are discriminated against due to the existence of certain underlying personal labor supply side characteristics that are linked to both productivity and obesity. Another explanation for the obesity wage penalty is that low wages affect the probability of being obese, for instance if low-wage workers consume relatively more of cheap and fattening food.

Since this paper is concerned with the association between teenage obesity and later earnings, we do not address the possibility that earnings may affect obesity. Instead, we draw on the recent literature on an association between obesity on the one hand and cognitive skills, non-cognitive skills, and physical fitness on the other hand, where the latter captures elements of long-term health. Our paper is thus related to the recent labour

[5] Although discriminating between people on the grounds of weight is lawful in Sweden, we still use the term *discrimination* instead of *differential treatment* to comply with the jargon in the economic discrimination theories being discussed.

[6] The callback rate was significantly lower (about seven percentage points) for the obese applicants, which is clearly indicative of the existence of discrimination already in the earliest stages of the hiring process. Although providing strong evidence on discrimination, it is not possible to disentangle whether the result reflects taste-based discrimination or statistical discrimination.

economics literature that highlights the importance of cognitive and non-cognitive skills for labor market outcomes in the developed world (Cawley et al., 2001; Heckman et al., 2006; Heckman and Rubinstein, 2001; Thomas and Strauss, 1997). Moreover, our paper relates to the growing economics literature that analysis the returns to various physical traits, such as beauty and height (Hamermesh and Biddle 1994; Persico et al 2004; Case and Paxson 2008, Lundborg et al. 2009). Recently, variations in cognitive and non-cognitive skills have been found to explain important parts of the observed height premium in wages and earnings (Case and Paxson 2008, Lundborg et al. 2009). Whether such characteristics also explain important parts of the obesity penalty has to our knowledge not been thoroughly investigated before.

Skills and obesity

A growing literature finds evidence of a negative association between obesity and cognitive ability. The association has been indicated very early in the life span, i.e. among 2-3 years old children, controlling for a wide range of child, parent, and family characteristics (Cawley and Spiess 2008). Several different biological and socially orientated explanations for the association between obesity and cognitive skills have been proposed. Some researchers believe that overweight and obesity may cause physiologic brain changes that could impair general cognitive function or performance in some cognitive areas (Gustafson et al. 2003; Gustafson 2004).[7] Another explanation is that obesity leads to less skill acquisition due to discrimination by teachers or classmates or because of obesity-related illness episodes. Yet other explanations focus on common genetic, environmental, or biologic factors that could play a role in the development of both cognitive ability and overweight and obesity. Poor early life conditions and/or parental background may for instance affect both subsequent body size as well as cognitive skills.

While there is no consensus in the literature on the mechanisms underlying the negative association between skills and obesity, it is interesting to note that the association appears very early in life, before school entry. This suggests that the

[7] According to the cited studies, this may happen through subclinical inflammatory changes, vascular changes, or dysmyelinization of white matter.

association may not be purely driven by discrimination of obese children by teachers or class-mates, even though evidence for this exists as well (see e.g. Puhl and Latner 2006).

Besides cognitive ability, the recent labor economics literature has paid growing attention to the role of so called non-cognitive skills. In the literature, these type of skills essentially describes a range of personal characteristics potentially affecting productivity, but distinct from cognitive skills, such as motivation, self-confidence, sociability (the capability of interacting and working with others), persistence, time preference (the ability or will to postpone instant pleasures in favor of future returns), and charm. It is uncontroversial to presume that non-cognitive abilities are valued by employers, coworkers and potential customers in almost any kind of occupation. Indeed, this is what a recent body of research has shown, linking non-cognitive skills to various socioeconomic outcomes (see e.g. Heckman and Rubinstein 2001; Heckman et al 2006). In fact, some studies suggest that non-cognitive skills are at least as important as cognitive skill in determining earnings and employment (Heckman 2008; Heckman et al. 2006; Borghans et al. 2008; Lindqvist and Vestman 2010).

Non-cognitive skills have recently also been linked to overweight and obesity. This relationship has been relatively less attributed to biological processes and more to social processes.[8] For instance, if overweight and obese people are excluded from non-cognitive skill building relations, activities and environments, there is a clear connection between obesity and this type of skills. Evidence in Cawley and Spiess (2008) provides evidence of a connection between obesity and social skills as early as among 2-3 years old children. According to the authors, there are several underlying mechanisms by which this finding could be explained. It may be that children who lack social skills get fewer friends and therefore play less, which increases the risk of obesity. Alternatively, children who are stigmatized for their obesity do not get the opportunities to develop their social skills. Well in line with this reasoning, Cramer and Steinwert (1998) found that obese children are viewed as less desirable playmates among 3 year olds. Moreover, obese children have been found to be almost twice as likely to be bullied as normal-weight

[8] An exception is Cortese et al. (2008), who argue that poor control of neural centers that are related to traits such as impulsivity and addictive tendencies could damage the control of food intake, possibly leading to overeating and subsequent overweight and obesity.

children, regardless of other demographic, social, and academic factors (Lumeng et al 2010). Similar mechanisms may obviously be at work at older ages when it comes to relations with e.g. partners, employers, customers, and coworkers.

In a parallel vein of research, Persico et al. (2004) found that teen height explains a large part of the height premium in earnings, and that the premium is reduced when controlling for participation in high school sports and clubs. This caused them to conclude that participation in such activities shapes social skills. If this is true, it is not farfetched to assume that obesity, presumably being connected to low levels of participation in sports and related activities, may also be related to low accumulation of social skills during adolescence. Given that the stock of adult non-cognitive skills is mainly accumulated during childhood and adolescence, the implications of such processes for the dynamic interplay between obesity and earnings would be that it is adolescent, rather that adult, obesity that is negatively associated with adult earnings.

There is thus substantial evidence linking non-cognitive skills to both socio-economic outcomes and obesity. Given these associations, it is straightforward to formulate a hypothesis where part of the obesity penalty in earnings is reflecting the lower non-cognitive skills of obese people, in a similar vein as with cognitive skills.

Obesity, physical fitness, and health

Besides mental skills, i.e. cognitive and non-cognitive skills, obese people may also differ from non-obese people regarding physical skills. It should come as no surprise to anyone that obese people are less physically fit and less healthy than non-obese people on average. For instance, obesity increases the risk of coronary heart disease (Willett, 1995), type 2 diabetes (Colditz,1995), stroke and some types of cancer (Michaud, 2001). At the same time, there are several reasons to believe that physical fitness and health are rewarded traits on the labor market. Firstly, people in good physical shape may be more productive at work, work longer hours, and may be less on sick-leave. Such arguments are consistent with findings that link physical fitness, often measured through cardiorespiratory fitness (see the data section for a discussion), to a diminished risk of coronary artery disease, myocardial infarction, and all-cause mortality (see e.g. Metter et al. 2002; Gale et al. 2007; Wijndaele et al. 2007; Rowland, 2007).[9] Employers may thus use obesity as a marker of long-run health and productivity in order to statistically discriminate. In line with this, numerous studies have documented a link between health and labor market outcomes, which is also suggestive of a positive association between physical fitness and labor market outcomes (see e.g Currie and Madrian 1999 for an overview).

Secondly, physical fitness may signal other traits that are valued on the labor market. Cardiovascular fitness, for instance, requires regular physical activity and a balanced diet and may hence be associated with personality traits, such as self-control, temperance, planning capabilities, endurance and patience, etc., thus coinciding with certain dimensions of non-cognitive skills. It should also be noted that there is a small but growing literature showing that individuals being engaged in leisure sport activities receive higher wages (see e.g. Lechner 2009 and the references therein, and Rooth 2010).

To sum up, there is extensive evidence linking adolescence obesity to cognitive skills, non-cognitive skills, and physical fitness, and health. The same set of traits has been shown to be important determinants of later life labor market outcomes in a large number of studies. In our main empirical analyses of the register enlistment data, we will therefore consider to what extent the observed adolescence obesity penalty in later life earnings is explained by these respective types of traits.

3. Data and descriptive statistics

Our empirical analysis is based on a data set constructed by integrating registers from Statistics Sweden (SCB) and the Swedish National Service Administration. The latter contains information on every individual living in Sweden in the year 1999 who enlisted

[9] It is not fully known why the body's capacity to transport oxygen to exercising muscles should have a positive effect on a range of health outcomes [US Department of Health and Human Services, 1996]. It has been hypothesized that the influence of cardiorespiratory fitness may be a direct one, through enhanced peripheral vascular reactivity or myocardial vascularisation, inhibition of thrombosis, or reduced risk of arrhythmias with higher cardiorespiratory fitness mitigating the effects of atherosclerotic vascular disease. An alternative hypothesis is that an expanded cardiovascular system and improved oxygen delivery may depress risk factors for cardiovascular disease. Yet an alternative hypothesis is that both cardiorespiratory fitness and health are affected independently by some third factor, such as genes or family environment.

for the military between 1984 and 1997.[10] Our study population consists of all males who were 28-38 years old in 2003, who enlisted for the military, and for whom there is full information on relevant variables. Enlisting for the military is carried out during a two-day procedure and is mandatory for all male Swedish citizens the year they turn 18. Only persons with severe handicaps, institutionalized persons (both due to mental disorders or being in prison), or persons living abroad are exempted from enlisting.[11] It should also be noted that a refusal to enlist results in fines, and eventually in imprisonment. In order to avoid any confounding influence of ethnic discrimination, we restrict our analyses to native Swedish males, i.e., those born in Sweden to Swedish-born parents.[12] Given these restrictions, our study population covers about 92 percent of the total native male Swedish population in the relevant cohorts.

Our base sample consists of 468,312 individuals. Out of these, 96 percent had positive annual earnings in 2003, i.e., 448,702 individuals, which is the sample that we use in our analyses. Hence, there is very little attrition in the data and it more or less covers the entire native born male Swedish population. In some parts of the analysis, we instead focus on variation between siblings, which reduces the sample being analyzed to 145,210 individuals. Since the enlistment variables are measured by military personnel, and earnings by tax authorities, our results are not influenced by any reporting bias, which often plagues survey data.

Our measure of annual earnings includes income from work, self-employed income and social insurance benefits such as sickness benefits, child allowance and parental benefits for the year 2003 and is taken from the tax records. A sensitivity analysis conducted in Section 4.2.2, where only income from work and self-employed income is included in the measure of earnings, shows that the inclusion of social insurance benefits does not affect our results.

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[10] The individuals had to live in Sweden during 1999, since many important variables, e.g. the enlistment information and the family information, are collected for the 1999 population data.

[11] Since the persons in our sample enlisted during the years 1984-1997, and since earnings are followed up in 2003, this implies that we lose a small number of people due to death and emigration. There is no information available on why a particular individual did not enlist.

[12] Moreover, non-native ethnic groups have a much lower participation rate for enlisting since only about fifty percent (or less) are Swedish citizens, making selective participation an issue for these groups.

Cognitive skills are measured using a test similar in style to the AFQT in the US. The test is called the Enlistment Battery 80 and includes four separate tests; Instructions, Synonyms, Metal Folding and Technical Comprehension. The separate scores of these tests are aggregated into a standard composite measure calculated by the military enlistment service, which we also use in the analyses. The measure ranges from 1 to 9.[13]

Non-cognitive skills are measured through interviews carried out by certified psychologists employed by the Swedish army. The ultimate purpose of the interview is to evaluate the conscript's ability to perform military service and to function in a war situation. This is achieved through an assessment of the enlistee's psychological stability and endurance, capability of taking initiatives, responsibility, and social competence. The assessment results in a composite enlistment score of non-cognitive skills, ranging from 1 to 9, which we standardize and use in our analyses.

Though the original purpose of the non-cognitive skill measure used here is to evaluate peoples' suitability to serve in a war situation, it seems reasonable to assume that the character traits valued by the military psychologists (psychological stability and endurance, capability of taking initiatives, responsibility and social competence etc.) may also be appreciated and rewarded in the labor market. Indeed, this is what we find in the empirical analysis.

Our main measure of physical fitness is cardiovascular fitness. This is measured as the maximum resistance attained in watts when riding on a stationary bike during a specific time period (around 5 minutes).[14] The measure is often denoted as Maximum Working Capacity (MWC) and is closely related to maximum oxygen consumption (VO2max), which has been labeled as the single best measure of cardiovascular capacity

[13] The general intelligence factor, G, is the variable used in this study. For more information about the G factor, see Caroll (1993).

[14] In the cycle ergonometry test, the subject was instructed to maintain pedal cadence between 60 and 70 rpm. The test was initiated with 5 min of submaximal exercise at work rates of 75 to 175 W, depending on expected fitness. The work rate was then continuously increased by 25 W/min until volitional exhaustion. In the end, the final work rate (Wmax) was recorded. For more details on the test procedure, see Lundborg et al. (2009).

and maximal aerobic power (Hyde and Gengenbach 2007).[15] A correlation of 0.9 between the two measures has been reported in the literature and it has therefore been concluded that MWC provides a suitable measure of cardiovascular capacity (Patton et al. 1982).

Since individual needs for energy vary with body size, our measure of maximum oxygen consumption is expressed relative to body weight. Evidence also suggests that obesity is not related to maximum oxygen consumption in absolute terms but have a strong effect on consumption per kg body weight, which is usually considered to be the best indicator of physical fitness and has been found to be an important predictor of mortality among healthy men (e.g. Sandvik et al. 1993).[16]

Physical strength is captured by the maximum pressure exerted squeezing a bar by the strongest hand. Measurement of handgrip strength is a valid indicator of, and commonly used to assess, overall muscle strength (e.g. Metter et al. 2002, Gale et al. 2007).

In order to construct our indicators of being underweight, normal weight, overweight, or obese, we use information on Body Mass Index (BMI, see also footnote 1). Generally, a BMI (for men) ranging between 25 and 30 is usually thought to reflect "overweight", whereas men with BMIs exceeding 30 are considered to be "obese". When it comes to "normal weight", the upper bound of 25 is commonly used whereas the definitions of the lower bound varies somewhat. Most previous studies on labour market outcomes define normal weight within the range 20-25, and low weight below 20, whereas the World Health Organization uses a lower bound of 18.5 for their "normal" weight definition (WHO 2006). In this study we employ the former definition yielding four BMI categories of low (<20), normal (20-25), over-weight (25-30), and obese (>30).

It should be noted that there are no strong incentives to underperform deliberately at the enlistment tests. The reason is that, for our study sample, the results of the tests had

[15] Directly measuring maximum oxygen consumption is costly and time-consuming, meaning that indirect measures are often preferred when large numbers of people are being tested.

[16] In contrast, *absolute* maximum oxygen consumption was shown by Lundborg et al. (2009) to explain a large share of the observed height premium in earnings. In the case of height, there are physical reasons to expect an association between height and maximum oxygen consumption in absolute terms, see Lundborg et al. (2009).

no impact on the probability of doing military service or not, since almost all people that enlisted during our study period also completed military service. Instead, the test results merely influenced the individual's placement within the army, meaning that poorer results typically led to a less qualified and meriting placement. We will however perform some sensitivity tests in order to examine if suspiciously low scores on the tests have any impact on our results.

For some of the explanatory variables there is missing information. This is most common for parental education and income for which information is missing for at most 12-13 percent of the sample. When there is missing information in a variable for an individual, we have imputed the individual's data with the sample variable mean and created an additional binary variable indicator taking on the value one when information is missing and zero otherwise. The same procedure is followed for non-cognitive skill and the physical capacity enlistment variables.[17]

***** Table 3.1 about here *****

Descriptive statistics

In Table 3.1 we show descriptive statistics on the key variables used in the empirical analysis, subdivided by BMI-class. The main picture that emerges is that men of normal weight on average earn more than overweight or obese men. The raw differences are quite large and a normal-weight man earns about 21 percent more than an obese man.[18] Overweight and obese men also fare worse when it comes to cognitive and non-cognitive skills and measures of cardiovascular fitness and muscular strength.

The bivariate associations between earnings in 2003, skills and cardiovascular fitness on the one hand and BMI (at age 18) on the other, for the full sample are illustrated in figures 1-5. The pattern of log earnings along the BMI distribution is inversely J-shaped, with earnings peaking at a BMI-level of 22, which is in the midst of our "normal weight" BMI range (see Fig 1).

[17] For these last three variables less than 0.1 percent of the population has missing information.

[18] Mean logarithm earnings for men of normal and obese BMI are 12.35 and 12.16, respectively.

***** Figure 1 about here *****

Interestingly, the connection between earnings on the one hand, and cognitive non-cognitive skills, follow a very similar pattern, as shown in Figures 2 and 3. Cognitive skills peak at a somewhat lower BMI-level that earnings, whereas non-cognitive skills peak at about the same point as earnings, i.e around a BMI of 20.

***** Figure 2 about here *****

***** Figure 3 about here *****

Turning to physical fitness, we obtain a somewhat different pattern, where cardiovascular fitness is relatively constant up to a BMI level of 21, but then decreases rather linearly and steeply through the rest of the BMI span (fig 4). For muscular strength, the association with BMI is less clear (see fig 5). The relation is positive up to a BMI level of about 25 but is rather constant thereafter.

In the bivariate analyses, there is thus a clear connection between BMI and earnings, and also between BMI, on the one hand, and important supply side factors such as physical as well as cognitive and non-cognitive capabilities, on the other. In the empirical section, we will try to unravel whether, and to what extent, these capabilities may be associated with the observed obesity penalty in earnings.

***** Figure 4 about here *****

***** Figure 5 about here *****

Method

In our empirical specification, we follow Neal and Johnson (1996) and only include variables determined in advance of entering the labor market. Controlling for factors like occupation, post-secondary education, and marital status may result in an underestimation of the obesity penalty, if part of it works through obese people sorting themselves into certain occupations, education levels or marital statuses.[19] Our main earnings

[19] A similar argument was put forth by Case and Paxson (2008), analysing the height premium in earnings.

specifications therefore only include our measures of skills and physical capacity together with parental characteristics, such as education and earnings. Equation 1 shows the model being estimated for the total population data using ordinary least squares:

1) $lny_i = a + b*W_i + c*X_i + d*F_i + e_i$,

where lny_i denotes log earnings for individual *i*, W_i is a vector of dummy variables indicating underweight, normal weight, overweight, and obesity, *X* is a vector of controls for the individual characteristics measured when enlisting, and *F* a vector of the parental characteristics. The model is altered by including different sets of variables into *X*. Our second specification controls for unobserved family and parental characteristics by estimating a sibling fixed effects model:

2) $lny_{ij} = a + bW_{ij} + c*X_{ij} + f_j + e_{ij}$

where *ij* is an index for individual *i* in family *j* and f_j represents family fixed effects capturing family characteristics common to all siblings within the same family, while e_{ij} represent an individual specific error term. Identification of the coefficient *b* thus relies upon sibling variation in BMI classification at age 18. In this specification, the estimate of *b* should not be subject to any bias due to the influence of family-level unobservable factors.

We believe that the possibility to run sibling fixed effects models is an important strength, since a lot of the unobserved factors that one perceives to be important for becoming obese as a teenager are likely found at the family level. The same unobserved factors may also directly relate to earnings, in which case our estimates that relies mainly on between-family variation would be biased. Sibling teenagers, however, are likely to share important unobserved factors such as food supply in the home, family patterns of physical activity, but they are also likely to attend the same school and thus face the same school environment and neighbourhood characteristics. Since the influence of some of these environmental factors are taken out in our fixed effects model, we are left with variation in obesity that is due to non-share genes affecting obesity and non-shared environmental factors. We think it is reasonable to assume that environmental factors should be more important for the variation in obesity across families, whereas genetic factors should be more important within families, where the members to a greater extent share a common environment.[20] If true, our sibling approach would thus generate estimates of the obesity coefficient that mainly measures the impact of genetically induced variation in teenage obesity. In such a case, it is also interesting to note the "genetic lottery" which means that within a family, it is random which child inherits a particular gene.[21]

In our OLS regressions, we control for age fixed effects, which picks up any non-linearity in the age profile for earnings but also any changes in the measurement of the enlistment variables from year to year. Since 99 percent of the conscripts enlisted at age 18 or 19 (86 and 13 percent, respectively) the age fixed effects also pick up anything specific for the year the conscript enlisted. It is therefore reassuring that the results are insensitive to how we handle the age and age-when-enlisting variables, that is, including additional controls for age (fixed effects) when enlisting, or only including a control for linear age, does not change the results at all.

4. Results

4.1 Explaining the obesity penalty

4.1.1 Results for the total population data

We start out with the full set of 448,667 observations and first ask ourselves if there is any significant association between obesity and earnings in our data. Our first earnings regression only includes our BMI classification and age as explanatory variables (Model A in Table 4.1). The results show a large and significant obesity earnings penalty of 18.3 percent. This is larger than any estimated male obesity penalty in the previous literature that we are aware of. In contrast to most earlier studies, however, it should be

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[20] A number of studies have provided evidence, suggesting that up to 70% of the variation in obesity-related measures, such as those based on body mass index, skinfold thickness, fat mass and leptin levels, is inheritable (see Grilo and Pogue-Geile 1991, for an overview). This fraction is likely higher within families, where the members face a more similar environment than two random members of the population.

[21] To be specific, a gene consists of two alleles, where a child randomly inherits one of the two alleles from each parent at the time of conception (see for instance Fletcher and Lehrer 2009).

remembered that that we do not condition on any other intermediate factors, such as education, occupation, or marriage, since we want to allow the obesity penalty to run exactly through these channels.

The estimated raw obesity penalty of 18 percent may still be perceived as surprisingly large. To put it into perspective, it could be noted that the estimated return to an additional year of schooling in Sweden is about 6 percent. The obesity penalty thus corresponds to three years of schooling, which is equivalent to a university bachelor degree. While our estimated obesity penalty is larger than most previous estimates for males, it should also be remembered that we consider obesity at age 18, whereas most previous studies consider obesity at older ages. As discussed in the introduction, any causal effect of obesity may be rather different depending on at which age the effect is considered at.

If being overweight or obese is associated with shorter stature, one may be worried that the omission of height would bias the coefficient of overweight or obesity downwards. The reason is that it is well established that height is positively associated with earnings (see e.g. Case and Paxson 2008 and Lundborg et al. 2009). The inclusion of height in the regression does not affect the results to any important extent, however, as we show in Model B. Moreover, controlling for parental characteristics in the form of education and earnings only reduces the obesity penalty to 15.4 percent (see Model C). Hence, the estimated obesity penalty does not seem to reflect that obese persons are more likely to come from more disadvantaged families, in terms of parental characteristics.

The estimated obesity penalty of 15.4 percent constitute the starting point of our analysis. Building on the recent evidence of strong associations between obesity on the one hand and mental and physical skills on the other, we next argue and show that the obesity penalty in fact is completely explained by other factors than obesity in itself. This leaves little room for explanation such as discrimination of obese people on the labour market. We show this by expanding Model C by these other factors one by one (Model D – G) and finally by including them together (Model H). In the row denoted “Reduction (%) in original (Model C) obesity penalty”, we show how much the estimated obesity penalty decreases, in each of the Models D through H in comparison with Model C.

We start by controlling for cognitive skills, which reduces the obesity penalty by one fifth, or from 15.3 percent to 12.2 percent (Model D). Cognitive skills are also clearly related to earnings, as a one standard deviation increase in the score is associated with 10.5 percent higher earnings. When we control for non-cognitive skills, however, the obesity penalty is reduced by more than 50 percent, to 7.2 percent. In fact, non-cognitive skills are in themselves an even more important predictors of earnings than cognitive skills and a one standard deviation increase in non-cognitive skills increases earnings with 13.3 percent (Model E). If we include both cognitive and non-cognitive skills at the same time, the obesity penalty is reduced by 58 percent (not shown).

The results so far thus suggests that it is not only obesity per se that explains why obese teenagers are doing worse on the labour market as adults compared to their non-obese counterparts and that part of the story is that that they simply bring worse cognitive and non-cognitive skills to the market. We will next show, however, that while these mental skills are important in explaining the obesity penalty, there is another factors that may be of even of greater importance; physical fitness.

Our main measure of physical fitness, and thus long-run health, is cardiovascular fitness. In Model F, we show that controlling for it virtually wipes out the estimated obesity penalty, which is now only 0.1 percent. Note also this variable is a significant and important predictor of earnings in itself, where a one standard deviation increase in physical fitness scores increases earnings by 4.1 percent. As discussed in Background section, this could reflect part of the market reward to good health and physical fitness

The fact that controlling for physical fitness wipes out the obesity penalty merits some further discussion. First of all, it should be remembered that the result is obtained while deliberately not controlling for cognitive and non-cognitive skills. If the bicycle test is related to motivational factors, the test result may therefore obviously partly pick up such factors. Moreover, performing well at the test requires some discipline, endurance, and perhaps some competitive spirit. These factors remind very much to some of the factors tested for in the test of non-cognitive skills. If the physical test score picks up such non-cognitive factors, one would therefore expect the coefficient of the bicycle test score to decrease in magnitude as one controls for the non-cognitive test score. This is indeed what we find and the coefficient decreases from 7.7 percent to 2.6 percent, when including the non-cognitive test score (not shown but available on request). The coefficient of the bicycle test score in column F should therefore be interpreted as picking up the combined influence of physical fitness and some non-cognitive factors.

Second, the result relate to the discussion about participation in social activities that build skills and human capital. The strong link between obesity and fitness suggests that obese teenagers are unlikely to participate in most sport activities, at least with any success. Physical fitness may partly proxy for sport participation in sports, which is an activity that may yield rewards on the labour market, as argued by Persico et al. (2004) for instance.

Another worry is that obese persons will exhibit a very limited range of test values on the physical fitness test, so that the scores of obese persons essentially measures the same as being obese. The raw correlation between BMI and physical fitness score is only -0.4, however. Moreover, a histogram of the test scores in the obese group reveal that there is substantial variation in test scores in the obese group and that the scores range from bottom to the top (Appendix B).

What about other physical measures? As we show in Model G, muscular strength does not affect the obesity penalty to any important extent. This is not all too surprising, however, given the low correlation between handgrip strength and BMI shown in the earlier figures. In fact, when we control for handgrip strength, the obesity penalty slightly increases to 16.2 percent. Since handgrip strength seems to be positively rewarded on the labour market, and since there is a weak positive association between handgrip strength and BMI, the result is not that surprising.

In model H, we then bring all the personal supply side characteristics together (last column of table 3.1). The estimated obesity penalty now shrink to 2.7, a decline by 82 percent. This is less than the reduction in the obesity penalty obtained in Model F, but we now also account for muscle strength, which somewhat increases the obesity penalty. To sum up, about four fifths of the observed obesity penalty in earnings could be explained by supply side characteristics measured at age 18.

***** Table 4.1 *****

4.1.2 Results for siblings

The results presented so far do not take into account that, apart from parental earnings and education, our included control variables may reflect the influence of certain omitted and unobserved variables that are correlated with these controls. Both mental and physical skills may for instance be related to resources at the family or neighbourhood level that are not picked up by observed parental schooling and earnings. As we showed in the descriptive statistics, obese persons comes disproportionally from families with less income and schooling compared to non-obese persons and it is therefore not farfetched to assume that obese persons also differ in other aspects from non-obese persons. Moreover, it is possible that some of the skills that we consider are more associated with family background than others.

Our data provides us with an excellent opportunity to test for such unobserved influences at the family level, through the sibling linkages. The sample of siblings is also very large, 145,193, ensuring that we will be able to precisely estimate the coefficients despite relying on sibling-variation in obesity. By imposing sibling fixed effects in our analysis, we net out the influence of all confounding influences at the family level, such as family wealth and parental characteristics.

Before embarking on our analyses using family fixed effects, we want to be sure that our sibling sample is comparable to our main sample. We therefore start by estimating the raw obesity penalty, without imposing any sibling fixed effects. As we show in Model A of Table 4.2, the resulting estimate, 17 percent, is very similar to the corresponding estimate obtained for the full sample. This is reassuring and expected, since there is no reason to believe that our sample of sibling should be very different from our main sample.

Before including our skills measures, we next proceed by introducing sibling fixed effects (see Model B in table 4.2). This if of interest in its own right, since the resulting change in the obesity penalty shows how much of the penalty is explained by factors shared by the siblings. Model B shows that accounting for sibling fixed effects reduce the obesity penalty by almost 50 percent, 9 percent. This illustrates the importance of factors operating at the family-level and also suggests that the skills that explained such a large portion of the obesity penalty in the previous section may to some extent reflected the influence of unobserved factors at the family level.[22]

We next move on to add the various controls to our fixed effects regressions. As in the main sample, adding height (Model C) to the regression leaves the obesity premium unaltered. In model D, we then add cognitive skills, which again reduces the obesity penalty but this time only by about one sixth to 7.6 percent. Non-cognitive skill (Model E) reduces the obesity penalty by more than 40 percent, to 5.2 percent. When we account for both cognitive and non-cognitive skills, the obesity penalty is reduced by 46 percent, which is somewhat less compared to the 58 percent reduction obtained for the full sample. The main result, that non-cognitive skills explain substantially more of the obesity penalty than cognitive skills, remain, however.

In Model F, we then includes our measure of cardiovascular fitness, which again in essence eliminates the obesity penalty, which now amounts 0.2 percent. This implies that these penalties are reduced by about 98 percent when cardiovascular fitness is controlled for. As in the full sample, we again find that muscular strength does not reduce the obesity penalty in earnings.

Finally, in model H, we include all the controls simultaneously. The obesity penalty is now reduced to 1.5 percent and is insignificant. We are thus now able to explain the entire obesity penalty by supply-side factors that vary between sibling within families. These results also in general confirm the results obtained for the full sample. Next, in order to further check the robustness of our results, we turn to a number of different sensitivity analyses.

***** Table 4.2 *****

4.2 Sensitivity analysis

[22] Although it is well known that imposing sibling fixed effects exaggerates the downward bias resulting from classical measurement errors in an explanatory variable, we believe that this is unlikely to be the whole explanation, since height and weight are not self-reported but measured by the staff at the enlistment sites.

4.2.1 Sensitivity analysis of the impact of different earnings definitions

We start our sensitivity analysis by considering to what extent the results are sensitive to outliers in earnings and to the definition of earnings. In particular, we examine whether or not the results are sensitive to the existence of extreme earnings and low earnings (below a 100' SEK). In these analyses, we use the sibling sample and compare the results for the obesity penalty to those obtained in models C and H of Table 4.2. The results are presented in Table 4.3.

***** Table 4.3 *****

Top coded earnings

In the first column (i) of Table 4.3, we first replicate the estimates from Table 4.2 (Model C and H) are replicated in order to make comparisons easy. In the second column (ii), we then show the corresponding estimates when we top code annual earnings to 500' SEK.[23] The BMI gradients in earnings resulting from this restriction are strikingly similar to the original ones, indicating that a skewed distribution of extremely high earnings towards people of normal weight is not driving the results of Section 4.2.

Hourly wage or hours worked?

Since our measure of earnings does distinguish between the hourly wage rate and hours of work, we are not able to directly assess to what extent the obesity earnings penalty originates from variations in wage or hours of work. In order to say something about this, we draw on previous results by Antelius and Björklund (2000). They show that by excluding earnings below a threshold value of 100,000 SEK (approximately 10,000 euro) when analyzing annual earnings based on tax records in Sweden, one receives a return to education similar to the one obtained from analyzing hourly wages. If this result can be generalised to the present study, estimating the models including only those whose earnings are above 100,000 SEK should give us a weight penalty that more closely reflects the corresponding penalty in the wage rate. Under this presumption we conducted

[23] This corresponds to about 50,000 Euros.

a sensitivity analysis, where we excluded those with earnings below 100,000 SEK (12,312 individuals, or 8 percent, of the sample, see column (iii) of Table 4.5). As shown in model C, the obesity penalty now becomes less pronounced and shrinks from 9.1 to 4.8 percent.

The smaller obesity penalty may be interpreted in two ways. First, it may indicate that part of the obesity penalty in earnings is due to larger fractions of obese men spending relatively fewer hours working. Part of the obesity penalty in earnings would then be explained by obese men working less, due to their lower mental and physical skills. Second, it may suggest that the association between obesity and earnings is more pronounced for low earners. While we are not able to directly distinguish between these two explanations, it should be noted that we are still able to explain the entire obesity by our supply-side characteristics, as shown in Model H.

Enlistment "fakers"

We next address the possibility that some people may deliberately underperform during the various enlistment tests. One reason for such underperformance to occur would be if the recruits believe that they will be able to escape from certain positions in the army by performing poorly on the tests. For instance, those scoring above average on the cognitive test were also evaluated on leadership skills and therefore ran the risk (or chance) of serving more months in a leadership position. Hence, in order to minimize the risk of being appointed to a higher rank and longer duty, a strategy could be to deliberately score low on the cognitive test. Remember, however, that performing poorly would not make it possible for the individual to skip military service and would only affect the positions reached in the army, where poorer test scores in general leads to less qualified positions. In that sense, we believe that the incentives to underperform are rather weak. If the propensity to underperform does vary with BMI, however, our results may be biased.

To address these concerns, we checked the sensitivity of our results by excluding those with very low test scores on the tests for cognitive ability, non-cognitive ability, and physical fitness. Thus, we excluded every enlistee scoring a 1 or a 2 on the cognitive and non-cognitive test, which means excluding those 5-10 percent with the lowest scores, who also were among the bottom 5 percent at the physical fitness test. It should be stressed that the distribution of expected test scores do cover the full range of possible value and it is obviously not so that very low scores need to reflect deliberate underperformance. Compared with column (i), the results of column (v) for both model C and H indicate that the obesity penalty increases somewhat, from 9.1 percent to 11.1 percent (Model C) and from 1.5 percent to 6.2 percent (Model H). While the obesity penalty in Model H remains insignificant it is not surprising that the magnitude of the coefficient increases, since many obese people with low scores on mainly the physical fitness test are now take out.

Misclassified individuals

When one uses BMI in order to categorise people into obese, overweight, etc., there is always a risk that some people will get misclassified. Some people with a BMI above 25 may be classified as overweight, although their BMI rather reflects a large muscle mass.[24] Such misclassifications could be assumed to lead to a downward bias in the estimated obesity penalty, since a large muscle mass is something that should not affect labour market outcomes in a negative manner, but rather then opposite. We addressed this by excluding individuals from our analysis with an unusually large muscle mass and or exactly those who had a measured handgrip strength one standard deviation above the average handgrip strength. As shown in column (vi) of Table 4.3, this did not change the estimated obesity penalty. This is not very surprising, however, since most misclassified individuals are likely to be found in the overweight category. This is indeed what our findings suggest, as the penalty for being overweight increases somewhat, which is what one would expect, since some previously misclassified persons with large muscle mass are now taken out.

Do obese people face lower returns to schooling?

[24] It has been shown that athletes and body builders, such as Arnold Schwarzenegger, are often classified as being obese based on their BMI, despite apparently not being so (McKay 2002).

Even though our results suggest that there no obesity penalty remains after accounting for the lower skills that obese people bring to the market, this result could still reflect indirect preference discrimination. This would occur, for instance, if obese people invest less in skills or schooling due to perceived future discrimination on the labour market. In other words, if preference discrimination exists on the labour market, obese people would face lower returns to schooling and thus face reduced incentives to invest in schooling. We can investigate this by studying whether or not the returns to schooling in fact are less for obese people. We therefore ran models with interactions between our BMI-classifications and years of schooling. The coefficient of the interaction between obesity and schooling was small and insignificant, however, in both the total sample and the sibling sample.[25] We therefore do not believe that a smaller return to schooling for obese people is an important explanation for our findings.

Do the obesity penalty vary between sectors and line of work?

In the analyses above, we show that the obesity penalty mainly reflects variation in cognitive skills, non-cognitive skill, and physical fitness across obese and non-obese workers. We also shown that among these skills, non-cognitive and physical skills are of primary importance. This would suggest that if make the thought experiment of randomly assigning obese people to occupations were the requirements for these skills differ, we would expect the greatest obesity penalty in occupations were non-cognitive skills and physical skills matter the most. In practice, this type of thought experiment is difficult to implement, since obese and non-obese persons may self-select into different types of occupation. In particular, we would expect people to sort into occupations where their skills are rewarded the most. This means that estimating the obesity penalty within an occupation may give us a downward biased estimate. In our case, this can be illustrated by an obese person, who selects into an occupation that requires high non-cognitive skills. This person is likely to have higher-than-average non-cognitive skills compared to the average obese person, otherwise he who would not have selected into this occupation

[25] The estimate of the obesity*years of schooling interaction term is -0.003 (s.e.= 0.006) using the total data, and -0.018 (s.e.=0.012) using only siblings.

in the first place. He is therefore also likely a poor counterfactual for the average non-obese person in the non-cognitive-demanding occupation.

It could still be interesting to estimate the within-occupation obesity penalty, however, while keeping in mind that we are most likely getting a downward biased estimate. If the obesity penalty is greater in occupations that require higher levels of non-cognitive skills and physical skills, this would suggest that any selection effects would still be dominated by the within-occupation penalty. We therefore re-estimated the obesity penalty for four different occupations, where the work chores require varying levels of cognitive, non-cognitive, and physical skills. We classified farmers, blue collar workers in mining, construction and waste management and security personnel (fire fighters, prison guards etc.) as having *physically demanding* jobs. As *cognitively demanding* jobs, we selected mathematicians, statisticians, data specialists, physicists and chemists. We selected sales persons, under the assumption that such jobs require a good portion of interaction with customers and socialization skills, and managers and executives (*management*) as having jobs were non-cognitive skills are especially important.

In Table 4.4, we present the results of this exercise. In work chores classified as requiring relatively high levels of cognitive skills, the crude obesity penalty is only about 4 percent (column 2 of Table 4.4). This is in line with our earlier result that cognitive skills explained less of the obesity penalty than the other types of skills considered. We should therefore also expect a lower penalty in jobs where non-cognitive skills and physical skills are less important. What is perhaps more surprising is that the obesity penalty is only 8 percent in physically demanding jobs, see the third column of Table 4.4. This may of course, as discussed above, be due to positive sorting in which people who were obese in adolescence and still selected the physically demanding occupations are unusually able or physical capable. The results for occupations requiring non-cognitive skills are more in line what we expect, however, as shown in the fourth and fifth column. Here, the crude penalty is about 20, which is greater than in any of the other occupation groups considered. This may still be an underestimate of the within-sector penalty, since an obese person selecting into this sector is likely to have higher-than-average non-cognitive skills than what the average non-obese person in this sector would have if he was obese.

Our results thus suggest that the association between obesity and earnings is strong in fields requiring high social skills and weak in cognitively demanding occupations. When we simultaneously controlling for skills and physical capacity in all occupation groups, this leaves only small insignificant obesity penalty in the cognitively and physically demanding occupational sector categories. In sales and management, however, significant penalties of 9 and 13 percent respectively, remain. This could reflect that preference discrimination against obese workers are stronger in those sectors.

5 Is the effect of obesity at age 18 different from the effect at other ages? Further evidence using additional data

Most previous studies in the economic literature have found that adult males do not face an obesity wage penalty. Our results may therefore seem surprising but as discussed in the results section, a plausible explanation for the divergence is that we focus on the effects of obesity status during late adolescence on later life earnings, whereas most previous studies have focused on concurrent obesity status as an adult. We believe there are several reasons why the effect of obesity (or becoming obese) at different ages may vary. First of all, people who are obese at age 18 may be inherently different from people who become obese at older ages. Moreover, at later ages, some people may become obese as a *consequence* of their labour market outcomes. High-wage earnings may become obese because they fancy a lifestyle with good food and wines. Low-wage earners, on the other hand, may become obese partly because they can only afford fattening foods. For the group that is obese during their teens, such a reverse causality does not exist.

Second, being or becoming obese while still in school may have effects that are dissimilar from those of being or becoming obese as an adult. In particular, obese adolescents may be less likely to participate in activities that build social skills, such as sports. This is close to the argument put forth by Persico et al. (2004) for those with short stature. Moreover, being obese while in school may increase the risk of getting bullied, and as adolescence is as a sensitive period when it comes to identity formation, this may have long-lasting effects on senses of self-esteem and self-worth (see for instance Janssen et al. 2004; Gortmaker et al. 1993; Eriksson, 1959). Since obesity becomes more common as men age, it is also less of a deviation from norms and therefore also be less stigmatizing to become obese as an adult. Hence, for those reasons the negative effect of becoming obese may decrease with age from adolescence onwards. These arguments also suggest a mechanism through which obesity as a teenager may affect future earnings: being obese as a teenager has an adverse impact on the formation of skills and in particular on non-cognitive skills, which in turn affects future earnings. While we are unable to show this causal chain, it would imply potentially great returns to policies that aim at decreasing obesity rates among teenagers.

Since we only have access to a measure of height and weight when the subjects are 18 in our military enlistment data, we are not able to test in the same data whether the obesity penalty depends on which age at which obesity is measured. One could also not exclude the possibility that there is something in the Swedish context that punishes obese men more heavily at all ages compared to other countries. For this purpose, we bring in some additional data sets from Sweden, UK, and the U.S.

Does Swedish men face an adult obesity penalty?

To start with, we want to establish if Swedish men also face an adult obesity penalty and thereby differ from obese men in most other countries. For this purpose, we bring in two additional Swedish data sets, where we for a subsample observe several measurements of obesity. In the first one, the Swedish Level of Living Survey (LNU), we measure earnings in 2000 but observe the obesity status of about 600 men in 2000 and when they were between 16-34 in 1991. As we show in the first column of Table 5.1, there is no significant association between current obesity and earnings in 2000. Looking at the second column, however, there is a significant a large negative association, where men who were obese during ages 16-34 earned 20 percent less 10 years later. This result then holds up when accounting for both obesity in 1991 and 2000, as shown in the third column. In our second data source, the ULF-data, we find very similar results, when using both current and lagged measures of obesity. The third column shows that there is no significant association between current obesity and earnings when the respondents were 26-45. The fourth column then confirms our previous finding, as lagged obesity status, when the respondents were between 16-37, is associated with about 17% lower earnings.

The LNU and ULF data also allow us to investigate the relationship between obesity and earnings also for women, whereas the military data only concerns men. Interestingly, our analyses based on the LNU data show a reverse pattern for women compared to men. As shown in columns 4-6 of Table 5.1, women face a significant earnings penalty for current obesity, whereas there is no significant association between obesity at ages 16-26 and later earnings. This pattern is similar in the ULF, even there is less precision in the estimates. These results suggest that the mechanisms behind the obesity penalty indeed look very different for men and women.

Obesity and earnings in the UK

We next turn our attention to another country and an alternative data set: the British National Child Development Study (NCDS), which includes several measures of obesity at different ages as well as information on earnings. With these data, we are able to investigate if the effect of obesity does differ according to the age at which a person is obese also in other countries than Sweden, as it includes information on height and weight at ages 16, 23, 33, and 42. The NCDS is a longitudinal study on around 17,000 individuals born in Great Britain in the week of March 3-9, 1958, who have been followed up on several instances, the latest being 2004, when they were 46 years old. In addition to data on height and weight, the NCDS contain data on cognitive skills, non-cognitive skills, health, and parental characteristics. For details about the study see for instance Lundborg et al. 2010.

We start by investigating the fraction of obese males in the different waves of the NCDS and the relationship between obesity at various ages and earnings at age 42. In all our analysis on the NCDS data, we only include individuals who have non-missing information on height, weight in all waves.[26] As seen in the first column of Table 5.2, only 1 percent of the males were obese at age 16, which is the age closest to the age we consider in our Swedish data. At age 23, the figure has doubled to about 2 percent but the large increase comes later, at ages 33 and 42. At these ages, 10 and 15 percent were obese respectively. Only a fraction of those could obviously also have been obese at age 16. This is illustrated in the second column of Table 5.2, where it is revealed that only 8 and 5 percent of those who were obese at age 33 and 42, respectively, were also obese at age 16. The corresponding figure for age 23 is 26 percent. These results confirm our suspicion that people who are obese at older ages may be quite a separate group compared to those who are obese at younger ages. On the other hand, it is reasonable to assume that a high fraction of those who were obese at age 16 were also obese at older ages, since there is usually great persistence in health behaviours over time. In line with this, several studies have indeed shown that BMI at the age of 18 serves as good proxy for overweight and obesity at age 30-40 (e.g. Guo and Chumlea, 1999). This is also confirmed in the third column of Table 5.2, where the fractions of those who were obese at age 16 who were also obese at ages 23, 33, and 42 were 47, 76, and 71 percent respectively.

Next, we exploit the NCDS data and examine the effect of obesity at various ages on wages at age 42.[27] Table 5.3 shows regressions on the same BMI classification as we used for the Swedish data on earnings. We start by studying the obesity penalty when measuring obesity at different ages and one age at a time. As revealed in the first column, there is a large and significant relationship between obesity at age 16 and log wages,

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[26] In the 1981 and 2000 waves, when the subjects were 23 and 42 years old respectively, weight and height were self-reported, while they were measured by interviewers in the other waves. being obese. Since the definition of obesity varies for children and teenagers, we use age-specific thresholds of obesity and overweight at age 16, as provided by Cole et al. (2000). Previous research has shown substantial measurement errors in self-reported height and weight (e.g. Rowland 1989) and therefore correct for such errors in self-reported height and weight in the 1981 and 2000 waves by using the results from Burkhauser and Cawley (2008), where prediction equations for actual weight and height were provided. The results from Burkhauser and Cawley (2008) were obtained by comparing self-reported weight with measured weight in the NHANES data in the US. It should be noted that the relation between self-reported weight and measured weight may differ between the UK and the US.

[27] We construct a measure of the gross hourly wage rate at age 42 by using information on payment intervals, actual payment, and hours worked. First, the individual was asked to state in which intervals he/she was paid. Second, it was asked how much the gross amount was, excluding any overtime. Third, information was given on the weekly number of contractual hours of work, excluding any overtime hours. From this information we calculated the hourly gross wage. We excluded observations with a hourly wage rate below the minimum wage of £3.60 and above £100, resulting in a loss of 219 observations.

where being obese is associated with 39 percent lower earnings at age 42. The magnitude of the association is thus even greater than the corresponding association in the Swedish sample. When we then consider obesity at older ages, it is apparent that the relationship gets weaker and weaker by age, as we speculated above. In fact, the relationship is only significant for being obese at age 16, which is, again, close to the age at which we measured obesity in the Swedish data. When we include the individual's obesity status at different ages simultaneously, as in the last column, the picture is confirmed. Only being obese at age 16 is significant. This again confirms our suspicion that the zero findings for males obtained in most studies reflects that the focus has been on adult obesity. With the NCDS data, we are also able to confirm that the picture looks very different for women. Again, we only obtain a small and insignificant association between obesity at age 16 and later earnings (results not shown but available on request).

Since we find a strong relation between adolescent and later earnings also in the UK data, we next set out to examine if this penalty is partly explained by some of the same factors as in the Swedish data. Unfortunately, the NCDS lacks clear-cut measures of non-cognitive skills and physical fitness, but does include some measures that resembles tests of cognitive ability. To capture at least some elements of non-cognitive ability, we use the scores obtained at age 7 and 11 at the respondents Bristol Social Adjustment Guide (BSAG) test. This is more of a test of social maladjustment, however, but it may capture some elements of non-cognitive ability, such as social skills and motivation. Instead of physical fitness, we use a range of health measures taken at age 7.[28] Table 5.4 shows the results, where we the various control variables are first introduced one at a

[28] Cognitive skills at early ages are measured through test scores on math and reading tests at ages 7 and 11. In the math test, which was designed for the NCDS, the score ranges from 0 to 10. Prior studies have established that test scores at the age of 7 show a significant impact on later education attainments and labor market outcomes (Currie and Thomas 2001). Reading skills were assessed by the Southgate Reading Test. The BSAG consists of a large number of behavioral items, such as `attitudes to teacher', `attitudes towards other children', evaluated by the child's teacher. Higher scores indicate higher maladjustment. To measure the family's socioeconomic status, we include information on the number of years of education of the mother and the father, a measure of permanent family income at age 16, and a measure of financial problems in the family at ages 7, 11, and 16. As to family income, the NCDS only records it when the child is 16. Since this measure might not reflect living standards earlier in childhood or persistent poverty problems, the data holders have developed a measure of family income, which we will make use of. Since the permanent income measure is dependent on the estimation technique and data availability, however, we will use this measure in combination with the measures of whether or not the family had serious financial difficulties when the child was aged 7, 11, and 16. The health measures include indicators of things such as having allergies, asthma, chronic conditions, or other sources of ill health.

time and then included at the same time. First, as shown in the first column, we note that accounting for height and parental characteristics, such as parental education and income, does not alter the wage penalty. Accounting for cognitive skills reduces the penalty only by 9 percent, which is substantially less than the corresponding reduction in the Swedish data. Both social maladjustment and health factors reduces the penalty even less, by about 7 percent and adding all factors at the same time gives a 20 percent reduction of the wage penalty. It should be noted that the NCDS does not include any pure tests of cognitive skills and non-cognitive skills and these tests were taken at ages 7 and 11, whereas such tests were taken at the same ages as for the measure of height in the Swedish data. If obesity affect those skills more strongly during the teenage years, one should not expect a strong decrease in obesity penalty if one account for child skills. Also, the NCDS lacks a measure of physical fitness at a teenager, which showed up as very important variable in explaining the obesity penalty in the Swedish data.

We have now showed that there is a large and significant penalty for being obese as a teenager, but not as an adult, in both Sweden and the UK. Does this relationship also hold up in the U.S., the country were the increase in obesity has been most dramatic among adults, children, and teenagers? To investigate we finally conduct a brief analysis on the U.S. NLSY data, which has been subject to several analyses on obesity before. None, however, have investigated the association between obesity at ages 16-24 and earnings much later in life, at ages 39-49. To be more specific, in our analysis of the NLSY data, our sample of interest is those who were interviewed in 1979, when the survey started, and who were also present at later waves. In particular, we are interested in the association between being obese in 1981, when the respondents were between 16 and 24, and earnings in 2004, when the respondents were between 39 to 49 years of age on indicators of being obese between ages 16-24.

In the first column of Table 5.5, we show a significant and negative association between being obese at ages 16-24 and earnings at ages 39-49. In the regression, we only control for age and race. The coefficient, 0.195, is remarkable similar to the one obtained in the Swedish sample and suggests that people who were obese at ages 16-24 earned almost 20 percent less later in life. In column 2 of the table, we instead only include current obesity, i.e. being obese at ages 39-42. Interestingly, there is now a significant and positive association between obesity and earnings, where obese people earn about 11 percent more than people of normal weight. We believe that this association most likely reflects reverse causality where people who earn more also indulge more in weight-gaining activities. We then finally include both current obesity status and obesity status at ages 16-24 in the regression, as shown in the third column. The results are now strikingly similar to the results obtained in the UK and Sweden and show that early life obesity is associated with 21 percent lower earnings at ages 39-49, whereas obesity at the same ages is associated with 12 percent higher earnings.

We have now shown a similar relationship between obesity early in life and adult earnings in three different contexts, Sweden, UK, and the U.S. This is despite the fact that the labour markets look rather different in these countries. Moreover, the fraction of obese young people is much higher in the U.S. The latter fact also means that the associations that we estimated for a Swedish context, where rather few teenagers were obese, also seems to hold up in an environment were more people are obese.

6. Summary and discussion

By using large-scale Swedish enlistment register data, we provided new evidence on the obesity earnings penalty and its origins. In particular, and in contrast to most previous research, we showed that there is a large penalty among males for being obese on their later life earnings. This penalty, however, was only present for those men who are obese when they were teenagers, whereas being obese as an adult did not associate with earnings. We confirmed this pattern using additional data sets from Sweden, UK, and the U.S.

We then went on to show that the obesity penalty is linked to supply-side characteristics being associated with both earnings and obesity. Based on recent research showing links between obesity on the one hand and cognitive skills, non-cognitive skills, and physical fitness on the other hand, we showed that accounting for such skills explained the entire wage penalty of 18 percent in our Swedish data. We interpreted this as showing that is it not obesity in itself that makes obese teenagers earn less when they enter the labour market, but rather the skills that they bring to the market. We also suggested that social effects may be responsible for this result, where being obese as an teenager may have detrimental effects on the formation of various types of skills that are valued on the labour market. Obese teenagers are perhaps less likely to participate in sports activities that may build social skills and social relations. Obese teenagers are also more likely to be bullied, which may have an adverse impact on self-esteem and thus non-cognitive skills.

Our results show that the "obesity epidemic" should clearly be of interest to economists interested in the determinants of labor market performance among men. We obtain a raw adolescence obesity penalty in later life earnings of about 18 percent. To put this into perspective, the estimated Swedish gender earnings gap is 16 percent (Kumlin 2007) and the earnings gap for men born outside Europe 15 percent (le Grand and Szulkin, 2002). Moreover, the obesity penalty corresponds to about three years of additional schooling, equivalent to an ordinary university bachelor degree.

While we suggested that the social effects of being obese as an teenager may be partly responsible for our results, there are obviously other interpretations for our findings as well. For policy purposes, it is of course important to have knowledge about the correct interpretation. An alternative interpretation of our results is that obesity mainly picked up the influence of such skills, but that there is no causal links between these skills and obesity. This would suggest that there is some third omitted variable that relates to skills, earnings, and obesity. A natural candidate would be parental characteristics or other family-level endowments. We were able to rule out the influence of factors at the family level, however, by exploiting our sibling data. Even within the family, one cannot rule out that parents allocate resources to their children partly based on traits such as weight and various types of skills. If parents systematically disfavor children who are obese this could explain part of our findings. Moreover, since siblings only share half of their genes, the results could also reflect the influence of some gene candidates that affect all our variables of interest at the same time. Having access to twin data on males could shed some light on this.

Our analyses raise a number of interesting questions for further research. Why is there an association between teenage obesity and adult earnings for males but not for females? And on the contrary, why is there an adult obesity penalty for women but not for men? Moreover, what kind of social effects may lie behind the association between obesity and various types of skills during boys' teenage years? What are the causal links between obesity on the one hand and cognitive skills, non-cognitive skills, and physical fitness on the other? Our analyses were conducted in a context were relatively few adolescents were obese, though it should be noted that the association between early life obesity and later life earnings was also obtained in the U.S., where more young people were obese. Still, if social effects are important for understanding the results, will the adverse impact of obesity become less, as more teenagers are obese in the present context and the social stigma may be less severe? It may be useful to relate these questions to the common belief that technological change have made the populations of Western countries fatter, through lower the price of caloric intake and increasing the "price" of caloric expenditure through more sedentary work tasks (Lakdawalla et al. 2005).[29] To the best of our knowledge, there is no simultaneous technological change that would explain why we would also expect declining cognitive skills and non-cognitive skills. This may provide an indication that the lower skills faced by obese people are partly caused by the their obesity. If such a causal story is correct, obesity prevention in childhood and adolescence may have substantial effects on adult earnings and wellbeing, as well as on overall productivity and economic growth. More research is clearly need before such a conclusion could be convincingly made.

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[29] The "price" of caloric expenditure refers to the monetary costs and the time costs involved in getting rid of calories, through spending time at the gym and engaging in sport activities, for instance. In an industrial society, the individual in principle got "paid" to exercise at work, through physically demanding job tasks, whereas today's jobs are mostly sedentary. The price of expending calories has thus gone up, since the individual now has to pay, both in terms of time and money, in order to expend calories.

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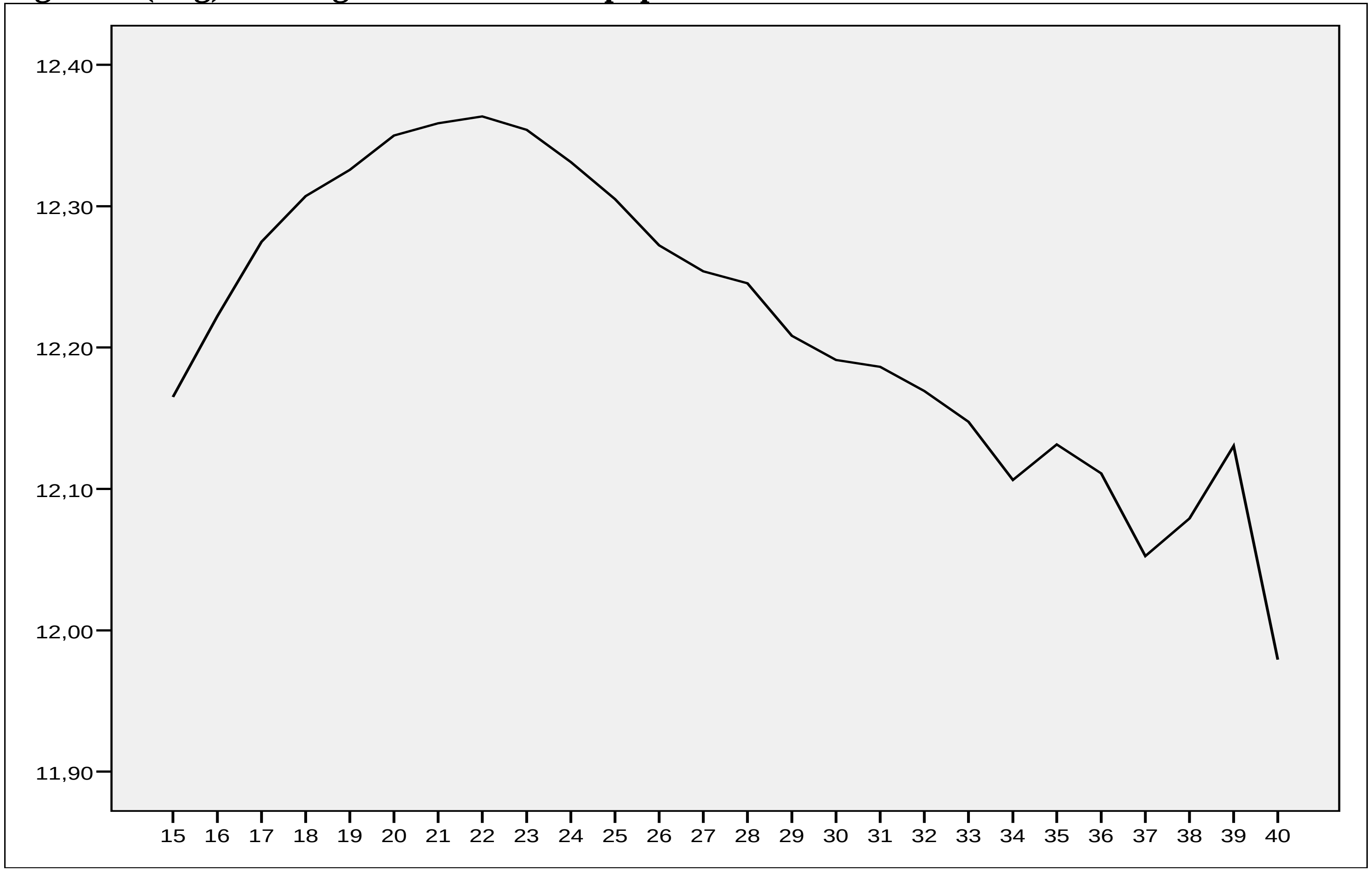
Figures:

Figure 1. (Log) Earnings and BMI. Total population.

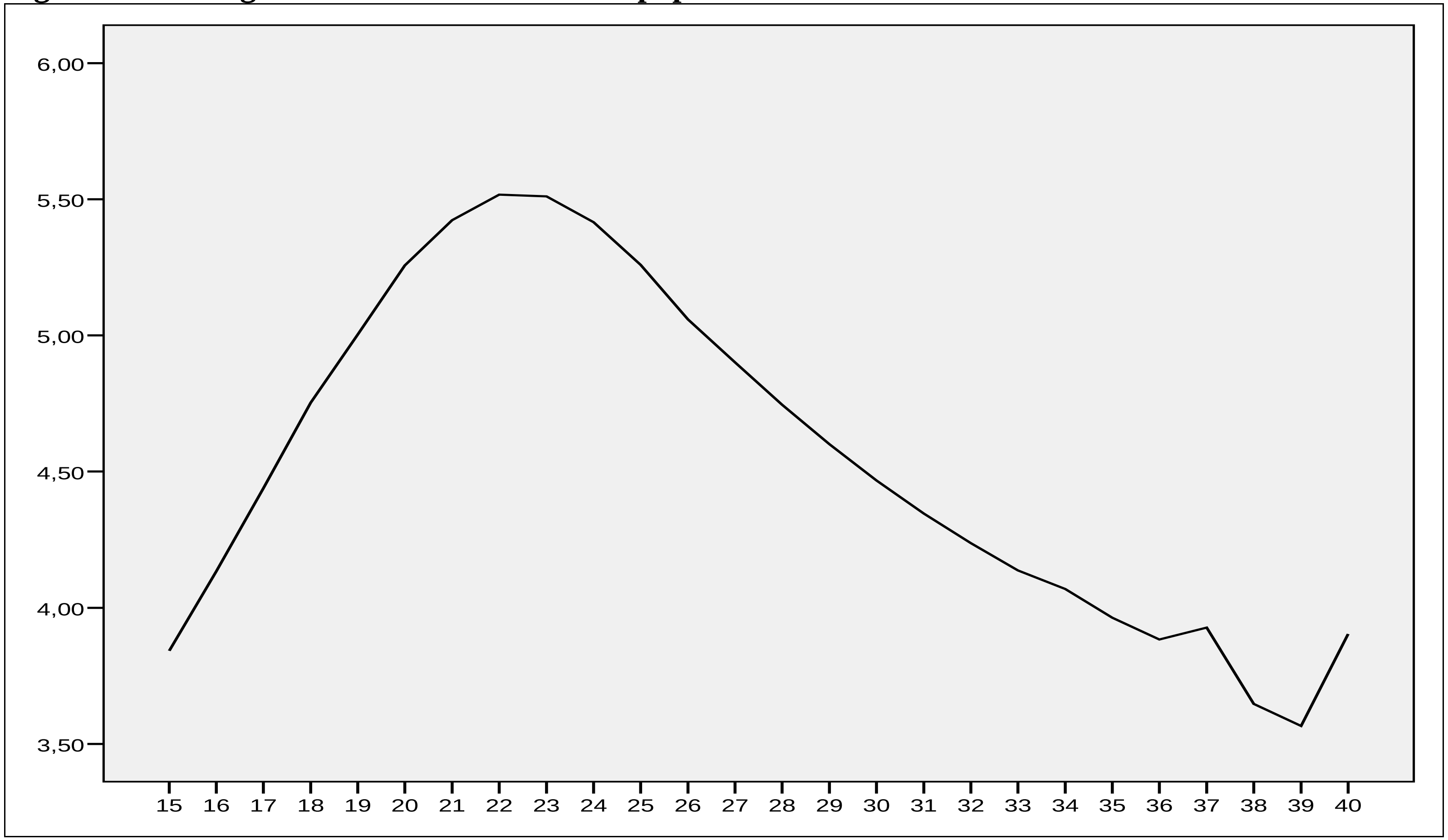


Note: The dependent variable is the mean for everyone with the integer value of the independent variable, being truncated at 15 and 40

Figure 2. Cognitive skill and BMI. Total population.

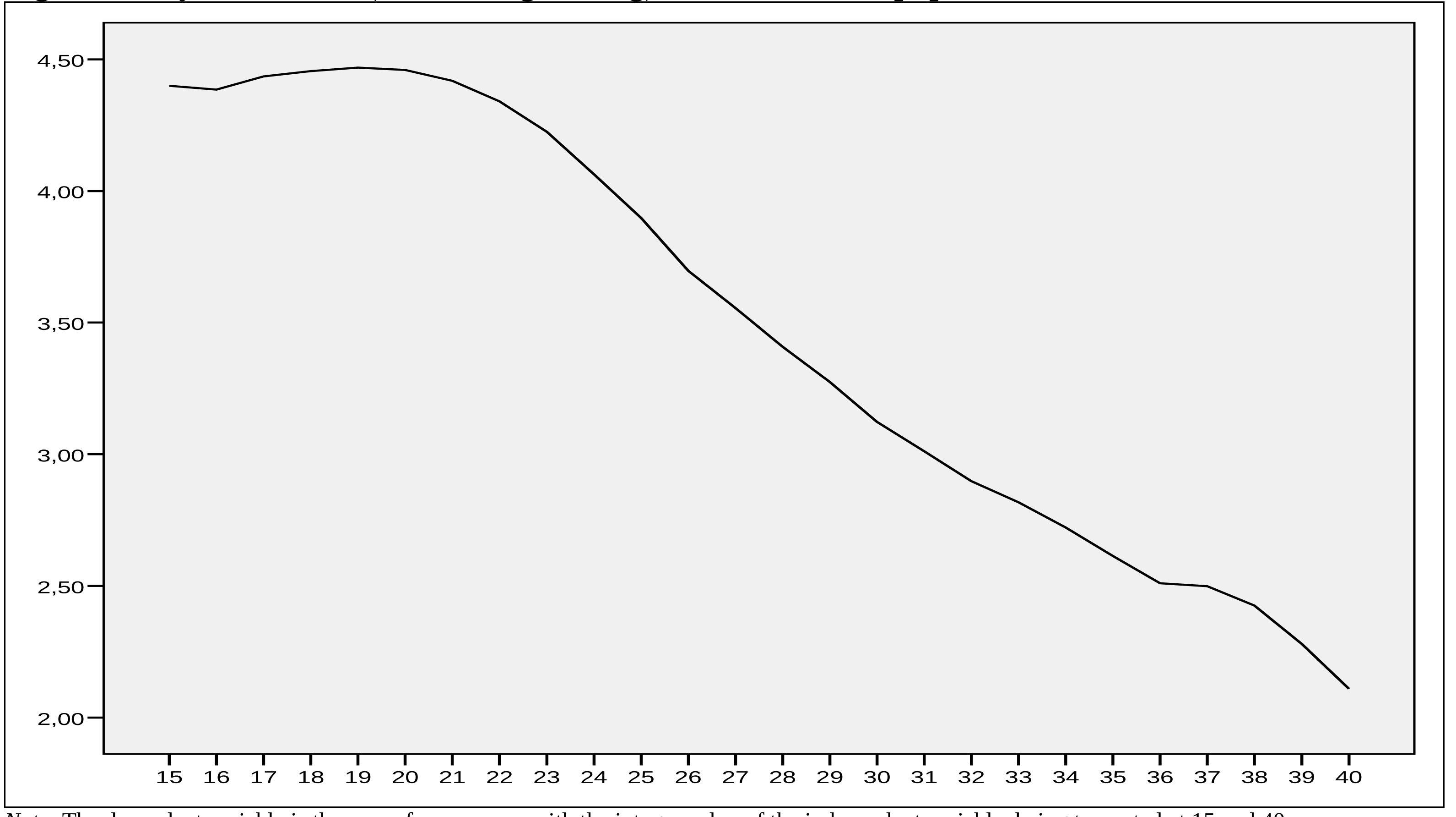
Note: The dependent variable is the mean for everyone with the integer value of the independent variable, being truncated at 15 and 40.

Figure 3. Non-cognitive skill and BMI. Total population.



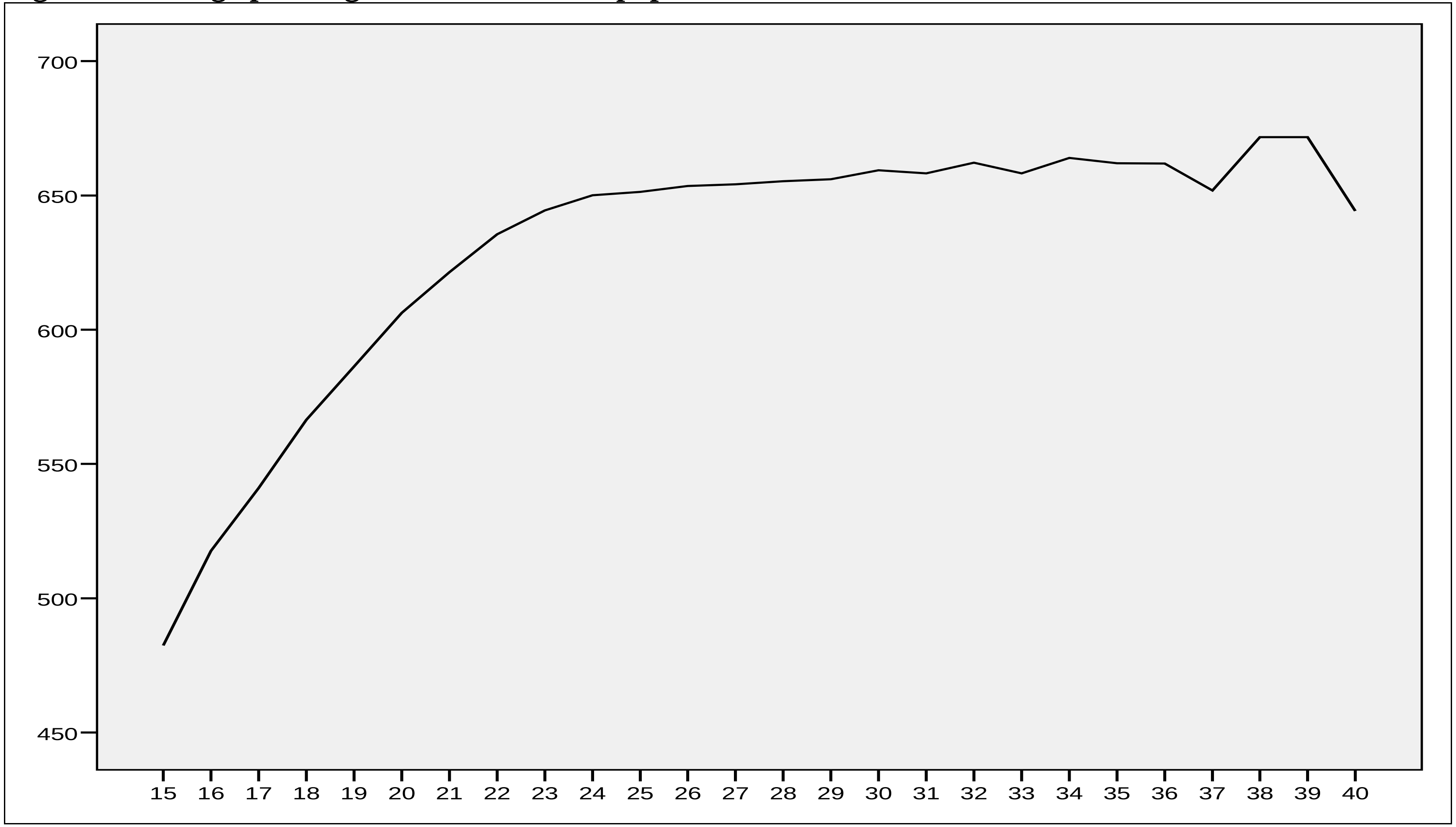
Note: The dependent variable is the mean for everyone with the integer value of the independent variable, being truncated at 15 and 40.

Figure 4. Physical fitness (wmax/weight in kg) and BMI. Total population.



Note: The dependent variable is the mean for everyone with the integer value of the independent variable, being truncated at 15 and 40.

Figure 5. Handgrip strength and BMI. Total population.



Note: The dependent variable is the mean for everyone with the integer value of the independent variable, being truncated at 15 and 40.

Tables:

Table 3.1. Descriptives of the population divided at BMI<20, 20<BMI<25, 25<BMI<30, and BMI>30. Men 28-38 years old, 2003. Total population.

Variable	<20		20-25		25-30		>30	
BMI	18.9	(0.9)	22.0	(1.3)	26.7	(1.3)	32.9	(2.9)
Logarithm annual earnings	12.31	(0.81)	12.35	(0.78)	12.27	(0.78)	12.16	(0.84)
Age	33.3	(3.1)	33.1	(3.2)	32.9	(3.2)	32.6	(3.2)
Parental characteristics:								
Fathers' (log) earnings	11.07	(0.50)	11.07	(0.50)	11.01	(0.48)	10.95	(0.46)
Mothers' (log) earnings	9.81	(1.26)	9.86	(1.23)	9.80	(1.25)	9.76	(1.27)
Fathers years of schooling	11.4	(2.3)	11.3	(2.3)	10.9	(2.0)	10.6	(1.7)
Mothers years of schooling	11.4	(2.2)	11.4	(22)	11.0	(2.0)	10.6	(1.8)
Cognitive skill:	5.2	(2.0)	5.2	(1.9)	4.8	(1.9)	4.4	(1.9)
Enlistment test score								
Non-cognitive skill:	4.8	(1.5)	5.4	(1.6)	5.0	(1.6)	4.2	(1.5)
Psychological evaluation								
Physical fitness:	4.46	(0.68)	4.35	(0.65)	3.68	(0.63)	2.89	(0.56)
Cardiovascular fitness								
Muscular strength	571.9	(86.4)	626.4	(92.6)	653.1	(101.7)	659.6	(108.4)
Height	179.8	(6.6)	179.5	(6.4)	179.2	(6.5)	179.4	(6.7)
No of observations	110,859		285,913		43,117		8,778	

Notes: Standard deviations in parentheses. The variables on cognitive skill, non-cognitive skill and physical fitness are standardized when used in the empirical analysis.

Table 4.1. Earnings and BMI. Men 28-38 years old, 2003. Logarithm of annual earnings. Total population data.

Variable	A	B	C	D	E	F	G	H
BMI ≤ 20:	-0.050***	-0.052***	-0.052***	-0.049***	-0.003	-0.064***	-0.036***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
BMI > 20 & ≤ 25	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
BMI > 25 & ≤ 30	-0.074***	-0.072***	-0.056***	-0.041***	-0.033***	0.013***	-0.064***	-0.010**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
BMI > 30	-0.183***	-0.183***	-0.153***	-0.122***	-0.072***	0.001	-0.162***	-0.027***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Cognitive skill:	-	-	-	0.105***	-	-	-	0.069***
Enlistment test score				(0.001)				(0.001)
Non-cognitive skill:	-	-	-	-	0.133***	-	-	0.103***
Psychological evaluation					(0.001)			(0.002)
Physical fitness:	-	-	-	-	-	0.077***	-	0.023***
Cardiovascular fitness						(0.001)		(0.001)
Muscular strength	-	-	-	-	-	-	0.027***	0.011***
							(0.001)	(0.001)
Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Height	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parental characteristics	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Reduction (%) in original (Model C) obesity penalty				*20*	*53*	*100*	*-5*	*82*
R2	0.01	0.02	0.03	0.04	0.05	0.04	0.03	0.06
No of cases	448,667	448,667	448,667	448,667	448,667	448,667	448,667	448,667

Notes: This table reports estimates from the (2) regression model: Log Earnings = a + b*BMI_class+ c*X + d*Missing info + e. Model A only includes BMI categories and age and is estimated using OLS. Model B adds height and Model C also adds the parental variables. Model D adds cognitive skill, Model E adds non-cognitive skill, while Model F and G add the physical fitness variables. Model H adds all variables.

Table 4.2. Earnings and BMI. Men 28-38 years old, 2003. Logarithm of annual earnings. Siblings data.

Variable	A	B	C	D	E	F	G	H
BMI ≤ 20:	-0.044***	-0.025***	-0.026***	-0.023***	-0.003	-0.036***	-0.015**	-0.006
	(0.005)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
BMI > 20 & ≤ 25	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
BMI > 25 & ≤ 30	-0.073***	-0.040***	-0.039***	-0.031***	-0.030***	-0.001	-0.045***	-0.012
	(0.007)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
BMI > 30	-0.171***	-0.090***	-0.091***	-0.076***	-0.052***	-0.002	-0.099***	-0.015
	(0.016)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Cognitive skill:	-	-	-	0.099***	-	-	-	0.075***
Enlistment test score				(0.003)				(0.003)
Non-cognitive skill:	-	-	-	-	0.092***	-	-	0.066***
Psychological evaluation					(0.003)			(0.004)
Physical fitness:	-	-	-	-	-	0.050***	-	0.023***
Cardiovascular fitness						(0.003)		(0.003)
Muscular strength	-	-	-	-	-	-	0.024***	0.013***
							(0.003)	(0.003)
Age	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Height	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Reduction (%) in original (Model C) obesity penalty				*16*	*43*	*98*	*-9*	*84*
Sibling fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.01	0.01	0.02	0.04	0.05	0.03	0.02	0.05
No of cases	145,193	145,193	145,193	145,193	145,193	145,193	145,193	145,193

Notes: This table reports estimates from the (2) regression model: Log Earnings = a + b*BMI_class + c*X + d*Missing info + f + e.
Model A only includes BMI categories and age and is estimated using OLS for the sibling sample. Model B adds siblings fixed effects and Model C height. Model D adds cognitive skill, Model E non-cognitive skill, while Model F and G add the physical fitness variables. Model H adds all variables.

Table 4.3. The BMI estimates and different outcome measures. Siblings. Men 28-38 years old, 2003. Logarithm of annual earnings.

	(i)	(ii)	(iii)	(iv)	(v)
Modell C:					
BMI < 20:	-0.026***	-0.024***	-0.017***	-0.019***	-0.028***
	(0.007)	(0.007)	(0.003)	(0.008)	(0.008)
BMI > 20 & ≤ 25	Ref.	Ref.	Ref.	Ref.	Ref.
BMI > 25 & ≤ 30	-0.039***	-0.038***	-0.017***	-0.031***	-0.050***
	(0.010)	(0.010)	(0.005)	(0.012)	(0.012)
BMI > 30	-0.091***	-0.091***	-0.048***	-0.111***	-0.090***
	(0.021)	(0.020)	(0.010)	(0.042)	(0.027)
Modell H:					
BMI < 20:	-0.006	-0.005	-0.007	-0.004	-0.005
	(0.007)	(0.007)	(0.003)	(0.008)	(0.008)
BMI > 20 & ≤ 25	Ref.	Ref.	Ref.	Ref.	Ref.
BMI > 25 & ≤ 30	-0.012	-0.012	0.001	-0.012	-0.020
	(0.010)	(0.010)	(0.005)	(0.012)	(0.013)
BMI > 30	-0.015	-0.017	-0.001	-0.062	-0.010
	(0.021)	(0.021)	(0.010)	(0.042)	(0.027)
Sibling fixed effects	Yes	Yes	Yes	Yes	Yes
No of cases	145,193	145,193	132,881	121,367	123,512

Notes: Column (i) is the BMI estimates from Model C in Table 4.2, while Column (ii) and (iii) shows the BMI estimates for those with top coded earnings and earnings above 100' SEK, respectively. Column (iv) gives the BMI estimates when excluding potential enlistment "fakers". Finally, Column (v) gives the BMI estimates when especially strong individuals are withdrawn from the sample, that is, those 1 standard deviation above average hand grip strength. It has been proposed that BMI might be a bad measure for individuals with a great muscular mass.

Table 4.4. Earnings and BMI. Men 28-38 years old, 2003. Logarithm of annual earnings. Total population data, and different work categories*

	Reference	Line of work			
	Total Pop. (fr.om table 4.1)	Cognitively demanding	Physically demanding	Non-cognitively demanding	
		Mathematicians Data specialists etc.	Farm hands Construction Mining etc.	Sales	Management
Obesity penalty (%)					
Crude	-15	-4	-8	-19	-22
Controlling for:					
Cognitive skill: Enlistment test score	-12	-5	-7	-17	-21
Non-cognitive skill: Psychological evaluation	-7	2	-2	-8	-15
Physical capacity: Cardiovascular fitness and muscular strength	***0*****	9	3	-7	-11
Skills and physical capacity combined	-3	3	0	-9	-13
R2					
No of cases					

Notes: all estimations include age, height and parental characteristics as control.

Table 5.1. LNU: log wages at 26-45 years old in 2000 and obesity at 16-36 years old in 1991. ULF: log earnings 26-45 years old related to current and 8 year pre weight status.

	LNU							ULF					
	Män			Kvinnor				Män			Kvinnor		
	(1)	(2)	(3)	(1)	(2)	(3)		(1)	(2)	(3)	(1)	(2)	(3)
Obese in 1991		-0.194***	-0.240***		-0.070	0.025	Obese -8 years		-0.166	-0.156		-0.169	-0.146
		(0.074)	(0.086)		(0.072)	(0.081)			(0.078)*	(0.084)		(0.104)	(0.107)
Obese in 2000	-0.050		0.057	-0.143***		-0.141**	Obese current	-0.082		-0.023	-0.100		-0.085
	(0.047)		(0.060)	(0.046)		(0.058)		(0.065)		(0.071)	(0.092)		(0.098)
Overweight 1991		-0.070**	-0.079**		-0.075**	-0.017	Overweight -8		-0.066	-0.057		-0.011	0.015
		(0.030)	(0.037)		(0.032)	(0.038)			(0.034)	(0.037)		(0.051)	(0.053)
Overweight 2000	-0.032		-0.010	-0.065***		-0.063**	Overweight cur.	-0.036		-0.021	-0.0562		-0.069
	(0.026)		(0.028)	(0.025)		(0.028)		(0.036)		(0.034)	(0.044)		(0.046)
Underweight 1991		-0.085*	-0.082		-0.004	-0.014	Underweight -8		-0.114	-0.080		-0.055	-0.062
		(0.050)	(0.053)		(0.037)	(0.040)			(0.054)*	(0.059)		(0.039)	(0.047)
Underweight 2000	-0.063		-0.023	-0.045		-0.036	Underweight cur.	-0.164		-0.126	-0.036		-0.001
	(0.079)		(0.083)	(0.065)		(0.070)		(0.069)*		(0.074	(0.044)		(0.047
Observations	615	615	615	584	584	584		2860	2860	2860	2695	2695	2695

Notes: The regressions on the ULF and LNU data control for age and age squared.

Table 5.2. Fraction of people who were obese at a certain ages who were also obese at other ages. Data from the NCDS.

Age	Fraction obese at various ages	Fraction of those who were obese at age 16 who were also obese at older ages	Fraction of those who were obese at older ages who were also obese at age 16
Age 16	0.011	-	-
Age 23	0.019	0.471	0.258
Age 33	0.098	0.765	0.083
Age 42	0.153	0.706	0.049

Table 5.3. Earnings and obesity at ages 16, 23, 33, and 42. Logaritm of wages at age 42. Data from the NCDS. Only BMI classification included.

Variable	A	B	C	D	E
BMI < 20 (age 16)	0.027	-	-	-	0.009
	(0.030)				(0.033)
BMI > 25 & < 30 (age 16)	0.046	-	-	-	0.081
	(0.081)				(0.084)
BMI > 30 (age 16)	-0.388***	-	-	-	-0.345**
	(0.144)				(0.152)
BMI < 20 (age 23)	-	-0.043	-	-	-0.069
		(0.047)			(0.052)
BMI > 25 & < 30 (age 23)	-	-0.074*	-	-	-0.057
		(0.040)			(0.048)
BMI > 30 (age 23)	-	-0.097	-	-	-0.037
		(0.110)			(0.121)
BMI < 20 (age 33)	-	-	0.052	-	0.097
			(0.090)		(0.097)
BMI > 25 & < 30 (age 33)	-	-	-0.047	-	-0.066*
			(0.031)		(0.039)
BMI > 30 (age 33)	-	-	-0.058	-	-0.036
			(0.052)		(0.062)
BMI < 20 (age 42)	-	-	-	-0.000	-0.029
				(0.261)	(0.270)
BMI > 25 & < 30 (age 42)	-	-	-	-0.015	0.024
				(0.032)	(0.038)
BMI > 30 (age 42)	-	-	-	-0.020	0.055
				(0.042)	(0.051)
R2	0.005	0.004	0.004	0.000	0.011
No of cases	1597	1597	1597	1597	1597

Notes: This table reports estimates from the regression model: Log Earnings = a + b*BMI_class+ e. Model A-D reports results from BMI categories at ages 16, 23, 33, and 42. Model D includes BMI categories all these ages simultaneously. Only BMI classification is included. No controls for age are necessary, since all respondents are born in same week of 1958.

Table 5.4. Earnings and BMI at age 16. Logaritm of wages at age 42. Data from the NCDS. Controlling for skills.

Variable	A	B	C	D	E	F	G
BMI < 20 (age 16)	0.027	0.046	0.041	0.030	0.036	0.025	0.019
	(0.030)	(0.030)	(0.029)	(0.027)	(0.028)	(0.029)	(0.027)
BMI > 25 & < 30 (age 16)	0.046	0.036	0.098	0.104	0.112	0.095	0.099
	(0.081)	(0.080)	(0.078)	(0.073)	(0.076)	(0.080)	(0.075)
BMI > 30 (age 16)	-0.388***	-0.404***	-0.402***	-0.353***	-0.378***	-0.374***	-0.326**
	(0.144)	(0.142)	(0.138)	(0.130)	(0.134)	(0.140)	(0.132)
Height	No	Yes	Yes	Yes	Yes	Yes	Yes
Parental characteristics	No	No	Yes	Yes	Yes	Yes	Yes
Cognitive skills	No	No	No	Yes	No	No	Yes
Social maladjustment	No	No	No	No	Yes	No	Yes
Health	No	No	No	No	No	Yes	Yes
R2	0.005	0.028	0.097	0.206	0.145	0.095	0.216
No of cases	1597	1597	1597	1597	1597	1597	1597

Notes: This table reports estimates from the regression model: Log Earnings = a + b*BMI_class+ c*X + d*Missing info + e. Model A only includes BMI categories. Model B adds height and Model C also adds the parental variables. Model D adds cognitive skills, Model E adds social maladjustment, while Model F adds the health variables. Model G adds all variables. No controls for age are necessary, since all respondents are born in same week of 1958.

Table 5.5. Earnings at ages 39-49 and obesity at ages 16-24 and 39-49. Logaritm of earnings. Data from the NLSY.

	A	B	C
BMI < 20 (age 16-24)	-0.201***		-0.149***
	(0.052)		(0.054)
BMI > 25 & < 30 (age 16-24)	-0.052		-0.066
	(0.043)		(0.046)
BMI > 30 (age 16-24)	-0.195**		-0.207**
	(0.084)		(0.088)
BMI < 20 (age 39-49)		-0.424**	-0.393**
		(0.165)	(0.166)
BMI > 25 & < 30 (age 39-49)		0.178***	0.162***
		(0.045)	(0.046)
BMI > 30 (age 39-49)		0.111**	0.118**
		(0.048)	(0.054)
Observations	2905	2905	2905
R-squared	0.071	0.074	0.078

Notes: This table reports estimates from the regression model:
Log Earnings = a + b*BMI_class+ c*X + e. Model A reports results from BMI categories at ages 16-24. Model B concerns BMI categories at ages 39-49. Model C includes BMI categories at ages 16-24 and 39-49.

Appendix:

Table A1. Variable List

Variable	Definition of the variable
BMI	Measured at age 18 when enlisting. Calculated as a persons weight in kg divided by the square of his length in meters.
Logarithm annual earnings	Annual earnings in 2003 from work or self-employment. Including subsidies.
Age	In 2003. 28-38 years old.
Parental characteristics:	
Fathers' (log) earnings	Annual earnings in 1980 from work or self-employment
Mothers' (log) earnings	Annual earnings in 1980 from work or self-employment
Fathers years of schooling	Years of schooling, taking values from 9-18. Measured in 1999.
Mothers years of schooling	Years of schooling, taking values from 9-18. Measured in 1999.
Cognitive skill:	Measured at age 18 when enlisting. The enlistment test score on a scale 1-9.
Non-cognitive skill:	Measured at age 18 when enlisting. Evaluated by a psychologist, on a scale 1-9.
Physical fitness:	
Cardiovascular fitness	Measured at age 18 when enlisting. During a 5-10 minute exercise it was measured the highest watts attained when riding on a stationary bike. This measure is then divided by the individuals weight in kilograms.
Muscular strength	Measured at age 18 when enlisting. Handgrip strength of strongest hand.
Height	Measured at age 18 when enlisting.
Missing information on:	
Fathers' (log) earnings	Takes a 1 if missing information on fathers' log earnings and zero otherwise. If missing the mean of fathers' log earnings is imputed.
Mothers' (log) earnings	Takes a 1 if missing information on mothers' log earnings and zero otherwise. If missing the mean of mothers' log earnings is imputed.
Fathers years of schooling	Takes a 1 if missing information on fathers years of schooling and zero otherwise. If missing the mean of fathers years of schooling is imputed.
Mothers years of schooling	Takes a 1 if missing information on mothers' years of schooling and zero otherwise. If missing the mean of mothers' years of schooling is imputed.
Maximum watts on stationary bike	Takes a 1 if missing information on maximum watts on stationary bike and zero otherwise. If missing the mean of maximum watts on stationary bike is imputed.
Handgrip strength	Takes a 1 if missing information on handgrip strength and zero otherwise. If missing the mean of handgrip strength is imputed.

Figure A1. Frequency distribution of physical fitness test scores in the obese group.