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OBESITY AND SKILL ATTAINMENT IN EARLY CHILDHOOD

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ABSTRACT

This paper investigates the association between obesity and skill attainment in early childhood (aged 2-4 years). Data from the German Socio-Economic Panel Study are used to estimate models of developmental functioning in four critical areas (verbal skills, activities of daily living, motor skills, and social skills) as a function of various measures of weight (including body mass index and obesity) controlling for a rich set of child, parent, and family characteristics. The findings indicate that, among boys, obesity is associated with reduced verbal skills, social skills, motor skills, and activities of daily living. Among girls, obesity is associated with reduced verbal skills. Further investigations show that the correlations exist even for those preschool children who spend no time in day care, which implies that it cannot be due solely to discrimination by teachers, classmates, or day care providers.

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Introduction

In developed countries, obesity tends to be associated with worse labor market outcomes; in particular, lower wages or earnings (Cawley, 2004; Cawley et al. 2005; Brunello and d'Hombres 2007; Lundborg et al. 2007), less wealth (Zagorsky 2005), and a lower probability of employment (Paraponaris et al. 2005; Lundborg et al. 2007; Morris, 2007; Burkhauser and Cawley, 2008). Several papers have found evidence that the relationship is causal (e.g. Cawley, 2004; Cawley et al. 2005; Morris 2007).

Obesity may worsen labor market outcomes for several reasons, including discrimination by employers or lower productivity due to worse health. Another possibility is that childhood obesity, which is a strong predictor of adult obesity[1], leads to less skill formation and therefore lower productivity in adulthood (Sabia 2007; Lobstein et al. 2004). An obese child might attain fewer skills for several reasons; e.g. obesity-related illness may impair skill acquisition, there may be discrimination by teachers, day care providers, or classmates, or high-ability parents may be better producers of both skills and health in their children.

This paper tests whether childhood obesity is associated with lower skill attainment, at younger ages (2-4 years) than previously examined. This research question is timely because the prevalence of childhood obesity has risen rapidly in many countries (Lobstein et al. 2004; Kurth and Schaffrath Rosario 2007; Ogden et al. 2002; WHO 2005), which has led some to describe childhood obesity as a pandemic (Malecka-Tendera 2006; Kimm 2002). This research is also timely because it contributes to the

[1] Roughly 20% of obese adults were obese as children (estimates range from 5-44%) and the probability of becoming an obese adult is roughly 400% greater for obese children than non-obese children (estimates range from 200% to 650%); see Freedman et al. (2005) and Serdula et al. (1993).

growing literature on early-childhood health and skill formation (e.g. Heckman 2008; Heckman 2007; Cunha et al. 2005).

Previous studies of whether childhood overweight is associated with lower skill attainment have focused largely on children of elementary school age (Datar and Sturm 2006; Cairney et al. 2006; Datar et al. 2004; Graf et al. 2004; Mo-suwan et al. 1999) or those about to enter elementary school (Mond et al., 2007). To our knowledge, this is the first study of obesity and skill attainment to study children as young as 2 to 4 years old. Studying pre-school children is informative because if obesity is associated with skill attainment prior to school entry, it suggests that it cannot solely be due to discrimination by schoolteachers or classmates.

Several studies have examined how childhood obesity correlates with academic outcomes. A study of nationally representative U.S. data on kindergarten children found a negative correlation between overweight status and test scores on math and reading exams, but these differences tended to become insignificant after controlling for socioeconomic and behavioral characteristics (Datar et al., 2004). A study of children and adolescents in Thailand found that overweight was associated with significantly lower grade point average among young adolescents (grades 7-9) but not younger children (grades 3-6) (Mo Suwan et al. 1999). A study of nationally representative Icelandic data of 14- and 15-year old schoolchildren found that body mass index (BMI) was significantly and negatively correlated with grades in three language classes and mathematics (Sigfusdottir et al. 2007). Among older youths (aged 14-17) in the U.S., a negative relationship between BMI and grade point average has been documented among white girls, but not nonwhite girls or males (Sabia 2007). A large literature has

documented discrimination against obese students by classmates, teachers, and administrators; see the reviews in Puhl and Latner (2006) and Puhl and Brownell (2001).

Other research has examined the relationship between childhood overweight and motor skills. A study of first-grade children in the Cologne region of Germany found that obesity was associated with impaired motor development for both boys and girls (Graf et al., 2004). A study of elementary school children aged 9-14 years in a city in Ontario, Canada found that Developmental Coordination Disorder is a risk factor for overweight and obesity for boys but not girls (Cairney et al., 2005). A study of children aged 4.4 – 8.6 years in Lower Bavaria in Germany found that obese male (but not obese female) children were more likely to have impaired gross motor skills (Mond et al. 2007).

This paper tests whether childhood obesity is associated with lower skill attainment on four dimensions: verbal skills, activities of daily living, motor skills, and social skills. To our knowledge, our sample of children (between the ages of two and four years) is younger than that used in any previous study of this question. In contrast to previous studies based on German data (Graf et al. 2004; Mond et al. 2007), a nationally representative data set is used.

Data and Methods

Data: German Socio-Economic Panel Study (SOEP)

The sample consists of children aged between the ages of 26 and 44 months who are the offspring of respondents to the German Socio-Economic Panel Study (SOEP). The SOEP is a wide-ranging nationally representative longitudinal study of private households that includes information on all household members and includes Germans

living in West and East Germany, foreigners, and recent immigrants (Wagner et al. 2007); for more information see the SOEP webpage at: http://www.diw-berlin.de/english/soep/soepoverview/27908.html. The SOEP was started in 1984 and in 2006 it included more than 20,000 individuals in nearly 11,000 households. SOEP data are collected in varying ways from respondents: oral interviews, written questionnaires, and computer-assisted interviews; the way in which the mother-child questionnaire data (which are the main source of this study) were collected is not indicated.

Child Body Mass Index, Overweight, and Obesity

Since 2002 the SOEP has included questions on the health (including weight) of adult respondents (see e.g. Cawley et al. 2005 and Heineck 2006). In addition, mother's reports of the weight and height of children have been collected since 2003. A substantial body of research has studied the accuracy of parental reports of child weight; in general, this literature finds that parents tend to underreport the weights of relatively heavy children and therefore obesity is underestimated (Scholtens et al. 2007; Wing et al. 1980; Davis and Gergen, 1994). Huybrechts et al. (2006) finds no difference in the accuracy of parental reports across the gender of the preschool child. Several studies conclude that parental reports of child weight are sufficiently accurate to be used in research (Garcia-Marcos et al. 2006; Sekine et al. 2002; Goodman et al. 2000).

Reporting error by mothers in Germany may be less than in other samples because, in Germany, preventive medical check-ups for very young children are offered on a regular basis starting at birth and are free of charge. Weight and height at each check-up are documented in a medical record booklet that is kept by the family. 98% of SOEP children had such check-ups, so to the extent that mothers referred to these

booklets when reporting child weight and height to the SOEP, reporting error in mother's report of child weight and height are presumed to be small.

Clinical weight classifications were defined using the standard reference values for German children (Kromeyer at al., 2001): overweight is above the historic 90th percentile, and obesity is above the historic 97th percentile, of BMI. These reference values are those used by major German studies of childhood overweight (e.g. Kurth and Schaffrath Rosario 2007). As a robustness check we also use the international thresholds for overweight and obesity (Cole et al. 2000). We do not include among the regressors an indicator variable for underweight for the two reasons stated by Cole et al. (2000): standardized cutoffs for underweight tend to result in "unacceptably high" percentages of children classified as underweight, and underweight lacks validation as a measure of disease risk in children. As a result, the reference category is having a BMI less than the overweight threshold.

Skill Attainment

The outcomes are measures of skill attainment. Collectively they are a modification of the German Vineland scale (Tietze, 1998; Sparrow et al., 1984) that has been developed and used by researchers studying child development in Germany (Tietze, 1998; Coneus and Pfeiffer 2007). In each of four areas -- verbal skills, activities of daily living, motor skills, and social skills -- mothers were asked to rate their child's ability to perform five skills as either yes, to some extent, or no. Yes was scored as two points, to some extent was scored as one point, and no was scored as 0 points. Scores were summed across the five tasks to create an index that ranged from 0 to 10 indicating the child's skill attainment in each of the four areas. The Appendix provides the full text

(English translation) of these SOEP questions and also provides information about the skills that were most and least commonly exhibited by the children.[2]

As these measures of skill attainment are reported by the mother, they represent noisy measures of true skill attainment. The extent of maternal error in this measure is unknown, but in related work Furnham and Bunclark (2006) conclude that parents are accurate in assessing both male and female children's overall intelligence, and that it is not clear that parents are more accurate at assessing it for one gender relative to the other.

Regression Models

Ordinary least squares regression models were used to examine the association between skill attainment and either BMI or indicator variables for clinical weight classification (overweight and obese), while controlling for the following characteristics: age of child in months (linear and squared), age of mother in years, household income (thousands of Euros per month, reported by the household head), number of other children in the household, and indicator variables for: whether in day care four or more hours a week, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, whether mother migrated to Germany (i.e. was foreign-born), living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year.

Models are estimated separately by gender because the mechanisms for the association (e.g. discrimination, parental investments) may vary by child gender. For

[2] This study uses data from the questionnaires on child development that were administered in 2005 to the parents of the "2003 cohort" of newborns and those administered in 2006 to the parents of the "2004 cohort" of newborns. (The cohort year refers to when the mother was interviewed, not necessarily the year that the child was born.)

example, Thomas (1994) finds that parents' resource allocations can result in differentials in height that vary by the gender of the child.

Various sensitivity analyses and extensions are conducted. Ordered probit models rather than ordinary least squares models are estimated. In order to explore mechanisms for the correlations, we also estimate our models for children who spend no time in day care. In order to determine whether results are driven by differences between the immigrant and native-born population, we estimate models for families who speak only German at home, child who are German citizens, children whose mothers are German citizens, and children whose mothers are native born Germans. All analyses were conducted using STATA version 9.2 (StataCorp, College Station, TX, USA).

Weight and height were missing for 28 observations, and an additional three observations were dropped because the child BMI was implausible – either below 10 (one observation) or above 36 (two observations). Four additional observations were dropped because of missing data on mother's age or whether the mother had migrated to Germany. Subtracting these 35 observations from the total of 479 children in the 2005 and 2006 waves with valid data from the SOEP mother questionnaire leaves us with a sample of 444.

Results

Table 1 lists the summary statistics by gender. By the thresholds developed for the German population of children, 7.9% of boys and 6.0% of girls are overweight but not obese, and 7.4% of boys and 9.8% of girls are obese. Scores on the verbal skills, social skills, and motor skills developmental scales are high; the mean score (out of 10)

on these tests ranges between 8.1 and 8.7 for boys and between 8.2 and 9.0 for girls. The average score on activities of daily living is lower: 5.8 for boys and 6.7 for girls. For both genders combined, the correlation coefficients between any two of the four measures of skill attainment from .39 (activities of daily living and social skills) to .55 (verbal and social skills).[3] These correlations are higher for obese than non-obese children.

Associations between skill attainment and BMI are shown in Table 2. For the sake of brevity the main tables in this paper present only the coefficients or marginal effects associated with the weight variables. Full regression results are available upon request, and as an example Appendix Tables 1A (boys) and 1B (girls) provide full results for one set of regressions (those corresponding to Table 2).

Table 2 indicates that, among boys, higher BMI is associated with significantly lower verbal skills ($P<0.10$), social skills ($P<0.05$), and motor skills ($P<0.05$). The magnitudes of the point estimates are such that weighing 12.8 units of BMI more than the average is associated with scoring one point lower on the verbal skill index, weighing 9.2 BMI units above average is associated with scoring one point lower on the social skills index, and weighing 11 BMI units above average is associated with scoring one point lower on the motor skills index. To put this in context, scoring one point lower on any of these indices is equivalent to the difference between fully having a skill (such as speaking in complete sentences) and partly having the skill, or between partly having the skill and not having the skill at all. Among girls the point estimates on BMI are always less than

[3] The correlation between mother with vocational training and the four measures of child skills range from .02 (social skills) to .05 (verbal skills), and the correlation between mother with university degree and the four measures of child skills range from .04 (social) to .12 (verbal).

half those for boys, and in no case is BMI significantly correlated with a measure of skill attainment.

Nonlinearities in the association between skill attainment and BMI are explored in Table 3. Obesity among boys is associated with significantly lower developmental functioning on each scale: verbal skills ($P<0.01$), social skills ($P<0.01$), motor skills ($P<0.10$) and activities of daily living ($P<0.05$). The magnitude of the associations are substantial; relative to healthy weight, obesity is associated with between a 1.2 and 1.6 unit deficit on a ten-unit scale for three of the four measures of development. Overweight is not associated with significantly lower skill attainment for boys.

To put these magnitudes into perspective, obesity is associated with a decrement in verbal skills more than 9 times larger than that associated with the household having 1,000 Euros lower monthly income. Also relative to the household earning 1,000 fewer Euros per month, the association of obesity is almost 8 times larger for social skills, almost 6 times larger for motor skills, and more than 8 times larger for activities of daily living.

Among girls, obesity is associated with lower developmental functioning on only one scale: verbal skills ($P<0.10$). As was the case for BMI, the point estimate for girls is less than half that for boys, implying that obesity is associated with scoring slightly more than half a point lower on the ten-point scale. Still, the conditional difference in verbal skills between girls who weigh less than the overweight threshold and those who are obese is only slightly smaller than the gap in verbal skills between girls whose fathers did, and whose fathers did not, attain a university degree.

Sensitivity Analyses and Extensions

As a sensitivity analysis, overweight and obesity were defined using the international thresholds (Cole et al. 2000) rather than the thresholds tailored to the German child population (Kromeyer at al., 2001). The international threshold results in a lower prevalence of obesity than that associated with the German threshold for both boys and girls. The international threshold also results in a prevalence of overweight that is lower than that based on the German threshold for boys, but higher than that based on the German threshold for girls. Table 4 presents results for regression models that use the international thresholds, but which are otherwise comparable to the results in Table 3, which are based on the German thresholds. Use of the international threshold generates interesting differences in results; in particular, it is overweight rather than obesity that is associated with lower verbal skills and activities of daily living among boys. Both overweight and obesity are associated with lower social skills among boys. The results for boys' motor skills are largely unaffected by using the international rather than the German thresholds; in both cases obesity is associated with scoring 0.8 to 0.9 units lower. For girls, the coefficient on obesity defined using the international threshold is two-thirds the size of that defined using the German threshold, and is not statistically significant. An explanation for the difference in results is that using the international rather than the German thresholds moves some children out of the obese category and into the overweight category, increasing the average BMI among the overweight children and therefore strengthening the association between overweight and skill attainment. The difference in results by threshold is a specific example of the general point that the measure of fatness one uses, and where one draws the line for overweight and obesity can

have important implications for one's research findings (Burkhauser and Cawley 2008). For the purposes of this paper, it is more appropriate to use the German than the international thresholds because they were developed for precisely this population of children (Kromeyer at al. 2001). For the extensions and sensitivity analyses described below, the German thresholds are used.

The finding that obese boys attain fewer skills prior to school entry is informative about the mechanisms of the association. For example, it suggests that the association cannot solely be due to discrimination by schoolteachers or classmates. However, one might argue that it is due to discrimination by day care providers. To test this possibility, we estimated our models using only the children who spend zero hours per week in day care; such children represent 61.3 percent of the total sample used to estimate the models described earlier in this paper. The results are presented in Table 5. For boys, obesity is associated with at least a 1.2-unit decrease on each of the four measures of skills; in each case the coefficient is statistically significant at the 10 percent level or better. For girls, obesity is associated with a 0.97 unit decrease on the index of motor skills, which is statistically significant at the 10 percent level. For girls, the association of obesity with verbal skills is not significant in this subsample, but the point estimate is slightly larger than that for the full sample. In summary, this extension confirms that the association of obesity with lower skill attainment cannot be due solely to discrimination by day care providers (or, for that matter, by schoolteachers or classmates) – it is found even among preschool children who spend no time in day care.

Our dependent variables are ordinal indices, so as another sensitivity analysis we estimate ordered probit regressions rather than ordinary least squares regressions. (The

pattern of statistically significant coefficients is very similar in each case regardless of whether ordered probit or OLS is used, so given the ease of interpretation OLS are presented as the primary results in this paper.) Marginal effects associated with the ordered probit coefficients are listed in Table 6. For boys, obesity is associated with a 25.9% lower probability of scoring a perfect 10 on verbal skills, a 28.0% lower probability of a perfect score on social skills, an 11.1% lower probability of a perfect score in motor skills, and a 3.9% lower probability of a perfect score on activities of daily living. Among girls, obesity was associated with a 21.7% lower probability of a perfect score on verbal skills, but was not significantly associated with the probability of a perfect score on the other skill indices. To put these associations into context, the difference in verbal skills between obese and less-than-overweight children is approximately that equal to the difference in verbal skills between children whose fathers did not and did attain a university degree. For boys, the decrement in social skills associated with obesity is five times larger than that associated with the household earning 1,000 fewer Euros per month.

In order to determine whether results are driven by differences between the immigrant and native-born population, we estimated our models for various subsamples: children who speak only German at home (N=364), children who are German citizens (N=416), children whose mothers are German citizens (N=398) and children whose mothers are native born (i.e. did not migrate to Germany) (N=375). These results for each of these subsamples are extremely similar to those for the sample as a whole (for the sake of brevity we do not include tables of these results but the results are available from the authors upon request). This implies that the results for the full sample are not driven

by differences in weight and skill attainment between native-born and immigrant children.

Discussion

This paper contributes to the growing literature on early-childhood health and skill formation (e.g. Heckman 2008; Heckman 2007; Cunha et al. 2005) by providing new evidence on the association between early-childhood obesity and skill attainment. We find that obesity is associated with lower skill attainment at ages two to four years - younger than previously appreciated. Moreover, the magnitude of the association is substantial; on three out of four measures, obesity in boys is associated with more than a one-unit deficit on a ten-unit scale, which is equivalent to a shift from "to some extent" to "no" on one of the five skills in that domain. This difference in development cannot be attributed to discrimination by day care providers; the gap is found even among children who spend zero hours per week in day care.

These findings are significant because skill attainment at one stage of the life cycle raises skill attainment at later stages of the life cycle, a process called "self-productivity" (Heckman 2007; Cunha et al. 2005). As a result of this process, the skill attainment of young children is correlated with subsequent educational and labor market outcomes (Heckman 2008; Heckman 2007; Cunha et al. 2005; Currie and Early, 2001). In particular, our finding that obesity is associated with skill attainment among boys may explain why youth obesity is associated with lower eventual educational attainment in men (Karnehed et al., 2006).

Our findings also indicate that the association between obesity and skill attainment is stronger for boys than girls. This is consistent with two previous studies that found that obesity was associated with worse academic performance in boys but not girls (Datar et al. 2004; Mond et al. 2007). Some previous studies found different patterns across gender. One study found that BMI was associated with impaired motor skills in both boys and girls in Germany (Graf et al. 2004) and one study found that excess weight is associated with worse academic performance among teenage girls but not teenage boys in the U.S. (Sabia 2007). Resolving and better understanding gender differences in such associations are important areas for future research.

The labor market penalty for obesity tends to be greater for women than men (Averett and Korenman 1996; Cawley, 2004; Lundborg et al. 2007), and the decrement in wealth associated with obesity is also greater for women than men (Zagorsky 2005). One explanation is that obesity lowers human capital accumulation more for women than men; however, this paper finds the opposite pattern – the skill deficits associated with obesity are greater for boys than for girls. Future research should explore what other factors may be responsible for these disparities in adulthood.

A strength of this study is that it is the first to study the association between overweight and skill attainment in children as young as 2-4 years of age. The youngest children previously examined in this context were aged 4.4 – 8.6 years (Mond et al. 2007). By examining children aged 2-4 who spend no time in day care this paper is able to rule out discrimination by day care providers, teachers, or classmates as an explanation for the gap. Another strength of the analysis is the range of skills considered – verbal

skills, activities of daily living, motor skills, and social skills. Furthermore the results are based on a nationally representative sample.

Three of the four measures of skill attainment had high mean scores (above 8 out of 10 for each gender, pooling all ages). In addition, average scores rise with age. The skills in question were generally not sufficiently difficult or rare to create a lot of variation, especially for the children closer to 4 than 2 years old. For this reason, the variation being explained by the regression models is among younger children who lag the norm for their age. It is not possible to say how the associations would have differed if the measures of skill attainment had more variation at the high end.

The study has the following limitations. The measures of skill attainment are assessed by the mother rather than a professional; however, the measures are designed to be answered by non-professionals. These measures of developmental functioning are a modification of the Vineland scale (Sparrow et al. 1984) that has been used by other researchers studying child development in Germany (Tietze 1998; Coneus and Pfeiffer, 2007).

Another limitation is that weight and height are reported by parents. Although several studies conclude that parental reports of child weight are sufficiently accurate to be used in research (Garcia-Marcos et al. 2006; Sekine et al. 2002; Goodman et al. 2000), and although maternal reporting error of child weight is expected to be small in the SOEP because virtually all children had recent medical check-ups and therefore a recent measured weight and height in their medical booklets, such reporting error is likely to bias coefficient estimates so future studies on this topic should seek to collect data that include measured weight and height.

Another limitation is that body mass index is a poor measure of fatness, as it does not distinguish fat from lean body mass (Burkhauser and Cawley, 2008). More accurate measures of fatness include total body fat or percent body fat, which can be assessed using methods such as Bioelectrical Impedance Analysis (Ibid). However, BMI is the only measure of fatness available in the SOEP. A direction for future research is to find data that include the more accurate measures of fatness and use them to test the robustness of this paper's findings.

Finally, we are unable to make causal inferences; obesity may cause developmental delays, slow development may result in obesity, or both obesity and developmental delays may be caused by unobserved factors. For example, boys who are stigmatized for being obese may lack opportunities to develop their social skills. Cramer and Steinwert (1998) find that even among three year olds, overweight peers are seen as undesirable playmates. Alternatively, it may be that boys with poor social skills have a hard time finding playmates and therefore play less, raising the risk of obesity. A third possibility is that unobserved physical health problems led to both obesity and impaired social skills. One possible candidate is Prader-Willi syndrome, which is associated with both early onset of obesity and emotional and behavior problems (Curry and Early, 2001). Another possibility is that mothers who are more able in unobserved ways are better at producing skills and healthy weight in their children.

Despite these limitations, this paper contributes to the literature by establishing that the association of childhood obesity with lower skill attainment exists at younger ages (2-4 years) than previously appreciated, that the association is greater for boys than

girls, and that it cannot be due solely to discrimination by teachers, classmates, or day care providers.

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References

Averett, S., Korenman, S., 1996. The economic reality of the beauty myth. Journal of Human Resources 31, 304-330.

Brunello, G., D'Hombres, B., 2007. Does body weight affect wages? Evidence from Europe. Economics and Human Biology 5 1-19.

Burkhauser, R., Cawley, J., 2008. Beyond BMI: The value of more accurate measures of fatness and obesity in social science research. Journal of Health Economics 27, 519-529.

Cairney, J., Hay, J., Faught, B., Hawes, R., 2005. Developmental coordination disorder and overweight and obesity in children aged 9-14y. International Journal of Obesity 29, 369-372.

Cawley, J., 2004. The impact of obesity on wages. Journal of Human Resources 39, 451-474.

Cawley, J., Markus G., Lillard, D., 2005. A comparison of the relationship between obesity and earnings in the US and Germany, Schmollers Jahrbuch 125, 119-129.

Cole, T.J., Bellizi, M.C., Flegal, K.M., Dietz, W.H. 2000. Establishing a standard definition for child overweight and obesity worldwide: international survey. British Medical Journal 320: 1-6.

Coneus, K., Pfeiffer, F., 2007. Self-productivity in early childhood. ZEW Discussion Paper Number 07-053, 2007, Mannheim.

Cramer, P., Steinwert, T., 1998. Thin is Good, Fat is Bad: How Early Does it Begin? Journal of Applied Developmental Psychology, 19 (3): 429-451.

Cunha, F., Heckman, J.J., Lochner, L., Masterov, D.V. 2005. Interpreting the Evidence on Life Cycle Skill Formation. NBER Working Paper #11331.

Currie J., Early, T., 2001. Test scores, socioeconomic status, school quality, and future outcomes. Research Labor Economics 20, 103-132.

Datar, A., Sturm, R., Magnabosco, J., 2004. Childhood overweight and academic performance: National study of kindergarteners and first-graders. Obesity Research 12, 58-68.

Datar, A., Sturm, R., 2006. Childhood overweight and elementary school outcomes. International Journal of Obesity 30,1449-1460.

Davis, H., Gergen, P., 1994. Mexican-American mothers' reports of the weights and heights of children six months through 11 years old. Journal of the American Dietetic Association 94,512-516.

Freedman, D. et al., 2005. The Relation of childhood BMI to adult adiposity: The Bogalusa heart study. Pediatrics 115, 22-27.

Furnham, A., Bunclark, K. 2006. Sex differences in parents' estimations of their own and their children's intelligence. Intelligence. 34(1): 1-14.

Garcia-Marcos, L., et al.2006. Validity of parent-reported height and weight for defining obesity among asthmatic and non-asthmatic schoolchildren. International Archives of Allergy Immunization 139, 139-145.

Goodman, E. et al., 2000. Accuracy of teen and parental reports of obesity and body mass index. Pediatrics. 106, 52-58.

Graf, C. et al., 2004. Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-Project). International Journal of Obesity 28, 22-26.

Heckman, J. J., 2007. The economics, technology, and neuroscience of human capability formation. PNAS, 104(33): 13250-13255.

Heckman, J.J. 2008. Schools, Skills, and Synapses. NBER Working Paper #14064.

Heineck, G., 2006. Height and weight in Germany, evidence from the German Socio-Economic Panel, 2002. Econ. Hum. Biol. 4 (3), 359-382.

Karnehed, N.et al. 2006. Obesity and attained education: Cohort study of more than 700,000 Swedish men. Obesity 14,1421-1428.

Kimm, S., Obarzanek, E., 2002. Childhood obesity: A new pandemic of the new millennium. Pediatrics 110, 1003-1007.

Kromeyer-Hauschild, K. et al. 2001. Perzentile für den body-mass-index für das kinder- und jugendalter unter heranziehung verschiedener deutscher stichproben. Monatsschr Kinderh 149, 807-818.

Kurth, B., Schaffrath Rosario, A. 2007. Die Verbreitung von Übergewicht und Adipositas bei Kindern und Jugendlichen in Deutschland, in: Bundesgesundheitsblatt – Gesundheitsforschung – Gesundheitsschutz 50, 736-743.

Lobstein, T. et al., 2004. Obesity in children and young people: A crisis in public health. Obesity Review 5(Supplement 1), 4-85.

Lundborg, P. et al., 2007. Obesity and occupational attainment among the 50+ of Europe. In: Bolin, K., Cawley, J. (Eds.). The Economics of Obesity, Advances in Health Economics and Health Services Research. 219-252.

Malecka-Tendera, E., Mazur, A., 2006. Childhood obesity: A pandemic of the twenty-first century. International Journal of Obesity. 30, S1-S3.

Miller, J., et al. 2006. Neurocognitive findings in Prader-Willi Syndrome and early-onset morbid obesity. Pediatrics. 149, 192-198.

Mo-suwan, L. et al., 1999. School performance and weight status of children and young adolescents in a transitional society in Thailand. International Journal of Obesity, 23, 272-277.

Mond, J. et al., 2007. Associations between obesity and developmental functioning in pre-school children: A population-based study. International Journal of Obesity,. 31**,** 1068–1073.

Morris, S., 2007. The impact of obesity on employment. Labour Economics 14, 413-433.

Ogden, C., et al., 2002. Prevalence and trends in overweight among US children and adolescents: 1999-2000. Journal of the American Medical Association 14, 1728-1732.

Paraponaris, A., et al. 2005. Obesity, weight status, and employability: empirical evidence from the French national survey. Economics and Human Biology 3, 241-258.

Puhl, R.M., Brownell, K.D., 2001. Bias, Discrimination, and Obesity. Obesity Research 9(12): 788-805.

Puhl, R.M., Latner, J.D., 2006. Stigma, obesity, and the health of the nation's children. Psychological Bulletin. 133(4): 557-580.

Sabia, J., 2007. The effect of body weight on adolescent academic performance. Southern Economic Journal 73, 871-900.

Scholtens, S., et al. 2007. Reported versus measured body weight and height of four-year-old children and the prevalence of overweight. European Journal of Public Health 17, 369-375.

Sekine, M., et al. 2002. Accuracy of the estimated prevalence of childhood obesity from height and weight values reported by parents: Results of the Toyama Birth Cohort study. Journal of Epidemiology 12, 9-13.

Serdula, M., et al. 1993. Do obese children become obese adults? A Review of the Literature. Preventive Medicine 22, 167-177.

Sigfusdottir, I. et al. 2007. Health behavior and academic achievement in Icelandic school children. Health Education Journal 22, 70-80.

Sparrow, S, et al.1984. The vineland adaptive behavior scales. American Guidance Service, Circle Pines, MN.

Thomas, D. 1994. Like father, like son; like mother, like daughter: Parental resources and child height. Journal of Human Resources, 29(4): 950-988.

Tietze, W., (Ed.) 1998. Wie gut sind unsere Kindergärten? Eine Untersuchung zur pädagogischen Qualität in deutschen Kindergärten. Weinheim, Beltz.

Wagner, G. et al., 2007. The German socio-economic panel study (SOEP) – scope, evolution and enhancements, Schmollers Jahrbuch 127, 139-169.

Wing, R. et al., 1980. Accuracy of parents' reports of height and weight. Journal of Psychopathology Behavior 2,105-110.

World Health Organization, 2005. The Challenge of Obesity in the WHO European Region. Fact sheet EURO/13/05.

Zagorsky, J.L., 2005. Health and wealth: the late-20th Century obesity epidemic in the U.S. Econ. Hum. Biol. 3: 296-313.

Table 1: Descriptive Statistics by Gender

Variable	Boys (N=229)		Girls (N=215)	
	Mean	**Std. dev**	**Mean**	**Std. dev**
Verbal Skills	8.725	1.693	9.005	1.480
Social Skills	8.526	1.689	9.023	1.363
Motor Skills	8.128	1.712	8.170	1.935
Activities of Daily Living	5.765	2.486	6.730	2.388
Body Mass Index	15.998	2.586	15.892	3.252
Overweight – German definition	7.860%	0.270	6.047%	0.239
Obese - German definition	7.424%	0.263	9.767%	0.298
Overweight – International Definition	6.987%	0.255	6.512%	0.247
Obese - International definition	5.240%	0.223	9.302%	0.291
Age of child (in months)	33.686	4.070	32.916	3.637
Age of child (squared)	1152.214	274.531	1096.647	241.786
Number of other children in the household	0.900	0.979	0.981	0.976
Child in day care center (more than 4 hours per week)	36.245%	0.482	34.419%	0.476
Age of mother (in years)	32.943	5.859	33.219	5.042
Mother completed vocational training	62.882%	0.484	71.628%	0.452
Mother completed university	21.834%	0.414	20.465%	0.404

degree				
Father completed vocational training	56.332%	0.497	56.279%	0.497
Father completed university degree	20.524%	0.405	24.186%	0.429
Single Parent Household	9.170%	0.289	10.233%	0.304
Net monthly income (in 1,000 Euro)	2.614	1.636	2.628	1.533
Mother has migration backbround	17.031%	0.377	15.349%	0.361
Household in West Germany	76.856%	0.423	77.209%	0.420
Household in urban area	31.441%	0.465	33.953%	0.475
Household in rural area	21.834%	0.414	20.930%	0.408
Survey year 2006	44.541%	0.498	47.907%	0.501
Education of mother missing	4.367%	0.205	2.326%	0.151
Education of father missing	18.341%	0.388	19.070%	0.394
Income missing	3.930%	0.195	4.186%	0.201

Notes:

1) Data: German Socio-Economic Panel Study (SOEP)

Table 2: Regressions of Skill Attainment on Child BMI

	Boys	**Girls**
	BMI	**BMI**
Verbal Skills	-.078* (-.043)	-.035 (-.029)
Social Skills	-.108** (-.043)	-.021 (-.029)
Motor Skills	-.091** (-.041)	-.029 (-.039)
Activities of Daily Living	-.080 (-.057)	.037 (-.045)

Notes:

1) Figures in the table represent estimates of the association between skill attainment and BMI, controlling for child and family characteristics.
2) Table cells list OLS coefficient and the associated standard errors in parentheses.
3) Asterisks indicate statistical significance: * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
4) Results are shown only for BMI. The regression models also included the following controls: age of child in months (linear and squared), age of mother in years, household income, number of other children in the household, and indicator variables for whether in day care 4 or more hours a week, net monthly income, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, mother has a migration background, living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year. Full regression results are available upon request.

Table 3: Regressions of Skill Attainment on Child Clinical Weight Classification

	Boys		Girls	
	Over-weight	**Obese**	**Over-weight**	**Obese**
Verbal Skills	-.315 (-.403)	-1.330*** (-.440)	-.276 (-.381)	-.535* (-0.314)
Social Skills	-.139 (-.405)	-1.593*** (-.442)	-.040 (-.384)	-.295 (-.318)
Motor Skills	.268 (-.396)	-.823* (-.433)	-.221 (-0.511)	-.423 (-.422)
Activities of Daily Living	-.225 (-.543)	-1.190** (-.593)	.318 (-.601)	.216 (-.496)

Notes:

1) Figures in the table represent estimates of the association between skill attainment and clinical weight classification (defined using German thresholds), controlling for child and family characteristics.
2) Table cells list OLS coefficient and the associated standard errors in parentheses.
3) Asterisks indicate statistical significance: * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
4) Results are shown only for clinical weight classification. The regression models also included the following controls: age of child in months (linear and squared), age of mother in years, household income, number of other children in the household, and indicator variables for whether in day care 4 or more hours a week, net monthly income, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, mother has a migration background, living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year. Full regression results are available upon request.

Table 4: Regressions of Skill Attainment on Child Clinical Weight Classification Using International Rather than German Thresholds for Overweight and Obese

	Boys		Girls	
	Over-weight	**Obese**	**Over-weight**	**Obese**
Verbal Skills	-1.174*** (-.427)	-.555 (-.510)	-.526 (-.369)	-.366 (-.318)
Social Skills	-.930** (-.434)	-.975* (-.517)	-.260 (-.373)	-.146 (-.322)
Motor Skills	-.193 (-.420)	-.909* (-.501)	-.425 (-.496)	-.284 (-.428)
Activities of Daily Living	-.975* (-.576)	-.443 (-.686)	.234 (-.583)	.273 (-.503)

Notes:

1) Figures in the table represent estimates of the association between skill attainment and clinical weight classification (defined using international thresholds), controlling for child and family characteristics.
2) Table cells list OLS coefficient and the associated standard errors in parentheses.
3) Asterisks indicate statistical significance: * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
5) Results are shown only for clinical weight classification. The regression models also included the following controls: age of child in months (linear and squared), age of mother in years, household income, number of other children in the household, and indicator variables for whether in day care 4 or more hours a week, net monthly income, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, mother has a migration background, living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year. Full regression results are available upon request.

Table 5: Regressions of Skill Attainment on Child Clinical Weight Classification
Sample Limited to Children Who Spend Zero Hours Per Week in Day Care (141 Boys, 134 Girls)

	Boys	**Girls**
	Obese	**Obese**
Verbal Skills	-1.219**	-.676
	(-.568)	(-.452)
Social Skills	-1.407**	-.421
	(-.577)	(-.476)
Motor Skills	-1.231**	-.968*
	(-0.589)	(-.566)
Activities of Daily Living	-1.498*	-.192
	(-.779)	(-.720)

Notes:

1) Figures in the table represent estimates of the association between skill attainment and clinical weight classification (defined using German thresholds), controlling for child and family characteristics.
2) Table cells list OLS coefficient and the associated standard errors in parentheses.
3) Asterisks indicate statistical significance: * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
4) Results are shown only for the clinical weight classification of obesity. The regression models also included the following controls: indicator variable for overweight, age of child in months (linear and squared), age of mother in years, household income, number of other children in the household, net monthly income, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, mother has a migration background, living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year. Full regression results are available upon request.

Table 6: Ordered Probit Regressions of Skill Attainment on Clinical Weight Classification
Marginal Effects Refer to Probability that Dependent Variable = 10

	Boys		Girls	
	Over-weight	**Obese**	**Over-weight**	**Obese**
Verbal Skills	-.136 (.093)	-.259*** (.077)	-.078 (.135)	-.217** (.099)
Social Skills	-.059 (.094)	-.280*** (.055)	-.050 (.129)	-.087 (.107)
Motor Skills	.036 (.083)	-.111** (.055)	-.066 (.077)	-.022 (.075)
Activities of Daily Living	-.010 (.022)	-.039*** (.0144)	.050 (.067)	.021 (.046)

Notes:

1) Figures in the table represent estimates of the association between skill attainment and clinical weight classification (defined using German thresholds), controlling for child and family characteristics.
2) Table cells list marginal effects and the associated standard errors in parentheses.
3) Asterisks indicate statistical significance: * = significant at 10%, ** = significant at 5%, *** = significant at 1%.
4) Results are shown only for clinical weight classification. The regression models also included the following controls: age of child in months (linear and squared), age of mother in years, household income, number of other children in the household, and indicator variables for whether in day care 4 or more hours a week, net monthly income, mother has completed vocational training, mother has completed university degree, father has completed vocational training, father has completed university degree, single parent household, mother has a migration background, living in West Germany, living in urban area, living in rural area, missing income data, missing education data, and year. Full regression results are available upon request.

Appendix

Below is the full text (English translation) of the SOEP questions that were used to create the measures of developmental functioning used in this paper.

For parents, it is always a big event when their child learns something new.

Please tell us what those new things in the case of your child.

(Rate child's ability to perform each task as either "Yes", "To Some Extent" or "No")

Verbal Skills:

V.1. Understands brief instructions such as "go get your shoes"

V.2. Forms sentences with at least two words

V.3. Speaks in full sentences (with four or more words)

V.4. Listens attentively to a story for five minutes or longer

V.5. Passes on simple messages such as "dinner is ready"

Activities of Daily Living:

ADL.1. Uses a spoon to eat, without assistance and without making a mess

ADL.2. Blows nose without assistance

ADL.3. Uses the toilet to do "number two"

ADL.4. Correctly puts on pants and underpants

ADL.5. Brushes teeth without assistance

Motor Skills:

M.1. Walks forwards down the stairs

M.2. Opens doors with the door handle

M.3. Climbs up playground climbing equipment and other high playground structures

M.4. Cuts paper with scissors

M.5. Paints/draws recognizable shapes on paper

Social Skills:

S.1. Calls familiar people by name; for example, says “mommy” and “daddy”

S.2. Participates in games with other children

S.3. Gets involved in role-playing games (“playing pretend”)

S.4. Shows a particular liking for certain playmates or friends

S.5. Calls own feelings by name, e.g. “sad”, “happy”, “scared”

Among the verbal skills, the most commonly-achieved skills are V.1. and V.2. (over 90% Yes) and the least-achieved skills are V.3. and V.4. (between 60-70% Yes).

Among the activities of daily living, the most commonly-achieved skill is ADL.1. (60% Yes) and the least-achieved skill is ADL.3. (30% Yes).

Among the motor skills, the most commonly-achieved skill is M.2. (95% Yes) and the least-achieved skill is M.5. (39% Yes).

Among the social skills, the most commonly-achieved skill is S.1. (99% Yes) and the least-achieved skill is S.3. (67% Yes).

Average scores on each of the four indices rise with age.

Appendix Table 1A: Full Regressions Results for Boys

	Verbal Skills	Social Skills	Motor Skills	Activities of Daily Living
Body Mass Index	-.078* (-.043)	-.108** (-.043)	-.091** (-0.041)	-.080 (-0.057)
Age of child (in months)	.386 (-.392)	-.108 (-.385)	.018 (-.372)	.809 (-.511)
Age of child (squared)	-.004 (-.006)	.003 (-.006)	0.002 (-0.006)	-.008 -.008
Number of other children in the household	-.259** (-0.126)	-.180 (-.127)	.163 (-.122)	.078 (-.169)
Child in day care center (more than 4 hours per week)	.037 (-.290)	.158 (-.290)	.273 (-.280)	.315 (-.386)
Age of mother (in years)	.015 (-.024)	.005 (-.024)	-.009 (-.023)	-.092*** (-.032)
Mother completed vocational training	.475* (-0.265)	.192 (-0.267)	.134 (-0.258)	-.118 (-.354)
Mother completed university degree	.080 (-.369)	.047 (-.371)	.529 (-0.360)	.111 (-.493)
Father	.230	.163	-.220	-.180

completed vocational training	(-.316)	-.316	(-.309)	(-.420)
Father completed university degree	.487 (-.393)	-.019 (-.395)	-.573 (-.384)	-.299 (-.524)
Single Parent Household	.586 (-.519)	.490 (-.522)	1.210** (-.502)	1.994*** (-.693)
Net monthly income (in 1,000 Euro)	.148* (-.088)	.193** (-.089)	.140 (-.085)	.153 (-.118)
Mother has migration background	.240 (-.321)	.365 (-.321)	-.484 (-.310)	-.396 (-.427)
Household in West Germany	-.437 (-.329)	-.770** (-.331)	-.316 (-0.321)	-1.377*** (-.440)
Household in urban area	-.181 (-.259)	-.123 (-.261)	.157 (-.254)	-.687** (-.346)
Household in rural area	.256 (-.284)	.386 (-.286)	.277 (-.276)	-.195 (-.380)
Survey year 2006	-.042 (-.226)	-.147 (-.227)	-.162 (-.222)	-.187 (-.301)
Education of mother missing	.170	.726	-.724	-1.710**

	(-.575)	(-.579)	(-.557)	(-.768)
Education of father missing	-.045 (-.475)	-.123 (-.477)	-.812* (-.462)	-.792 (-.634)
Income missing	-.017 (-.650)	.384 (-.654)	-.085 (-.630)	-.074 (-.868)
N	228	229	225	229

Appendix Table 1B: Full Regressions Results for Girls

	Verbal Skills	Social Skills	Motor Skills	Activities of Daily Living
Body Mass Index	-.035 (-.029)	-.021 (-.029)	-.029 (-.039)	.037 (-.045)
Age of child (in months)	.799** (-.383)	.461 (-0.386)	.677 (-.513)	.763 (-.602)
Age of child (squared)	-.010* (-.006)	-.006 (-.006)	-.008 (-.008)	-.007 (-.009)
Number of other children in the household	.352*** (-.105)	.330*** (-.106)	.481*** (-.141)	.419** (-.165)
Child in day care center (more than 4 hours per week)	.110 (-.244)	.313 (-.246)	.233 (-.327)	.560 (-.384)
Age of mother (in years)	-.0532** (-.022)	-.013 (-.022)	-.059** (-.030)	-.061* (-.035)
Mother completed vocational training	.600** (-.248)	-.012 (-.250)	-.081 (-.333)	.004 (-.390)
Mother completed university degree	1.188*** (-.293)	.315 (-.295)	.577 (-.393)	-.255 (-.461)

Father completed vocational training	.554** (-.270)	.348 (-.271)	.466 (-.361)	.665 (-.424)
Father completed university degree	.585* (-.299)	.251 (-.301)	.581 (-.400)	.393 (-.469)
Single Parent Household	-1.371*** (-0.463)	-1.127** (-.466)	-.350 (-.620)	-.522 (-.727)
Net monthly income (in 1,000 Euro)	-.101 (-.080)	-.080 (-.080)	.125 (-.107)	.073 (-.125)
Mother has migration background	-.334 (-.270)	-.491* (-.272)	-1.035*** (-.362)	-.003 (-.424)
Household in West Germany	.182 (-.277)	.168 (-.278)	.154 (-.371)	-.908** (-.435)
Household in urban area	-.062 (-.212)	-.236 (-.214)	.217 (-.285)	-.006 (-.334)
Household in rural area	.050 (-.248)	-.110 (-.249)	.122 (-.332)	-.011 (-.389)
Survey year 2006	.222 (-.188)	.055 (-.190)	-.132 (-.251)	.139 (-.295)
Education of	1.039	.120	-.144	.190

mother missing	(-.644)	(-.648)	(-.863)	(-1.012)
Education of father missing	.865** (-.411)	.852** (-.414)	1.071* (-.551)	1.809*** (-.646)
Income missing	-.732 (-.523)	.054 (-.526)	.033 (-.700)	-.828 (-.821)
N	215	215	215	215