Bodyweight and human capital development: Assessing the impact of obesity on socioemotional skills during childhood in Chile.

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Abstract

This article analyzes the effect of bodyweight on socioemotional skills for children aged two to 12 years in Chile. Using an instrumental variable approach and a representative survey, we show that both BMI and obesity are causality related to children's socioemotional development, even after assuming that our instrument is imperfect. Although we did not find significant differences between boys and girls, we do identify heterogeneous effects by age: the weight penalty for girls starts earlier than for boys. Our findings suggest that early interventions for childhood obesity not only might generate positive impacts on children's health, but also a greater accumulation of non-cognitive human capital in the future.

JEL classification: I10, I12, I30

Keywords: childhood development; instrumental variable; obesity; socioemotional skills; Chile.

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1 Introduction

Between 1990-2016, the number of overweight or obese children aged 0-5 years increased from 32 million to 41 million worldwide, making it one of the most serious public health problems of the last three decades and the new epidemic in the modern era (WHO, 2020). These figures are worrisome not only because obesity has a direct impact on health outcomes (Deckelbaum and Williams, 2001), which in turn increases costs in the public health sector (Cawley, 2000, 2010), but also because of the unintended and long-lasting consequences in human capital accumulation. For example, childhood obesity is associated with lower academic performance and cognitive development (Sabia, 2007; Cawley and Spiess, 2008; Averett and Stifel, 2010; Scholder et al., 2012; Palermo and Dowd, 2012; Black et al., 2015; Afzal and Gortmaker, 2015; Murasko, 2015; Segal et al., 2021).

The negative association between childhood obesity and human capital is concerning for at least three reasons. First, the theory of skill formation developed by Heckman and his colleagues states that gaps in both cognitive and non-cognitive skills between individuals and across socioeconomic groups open up at early ages (Carneiro and Heckman, 2003; Heckman, 2007; Cunha and Heckman, 2007, 2008). Thus, human capital investments in early childhood (especially at the preschool age) might produce greater returns than investments at later ages (Carneiro and Heckman, 2003; Cunha and Heckman, 2008; Coneus et al., 2012). Second, it has also be documented that a third of obese preschool children, and half of obese school-age children are likely to be obese adults (Serdula et al., 1993). Third, there is a vast literature showing that obese adults have lower wages (Cawley, 2004), are less likely to be promoted (Pagan and Davila, 1997), and face greater problems finding job (Lindeboom et al., 2010). One possible mechanism by which obesity may affect economic success (in addition to productivity and/or discrimination) is through the fewer acquisition of cognitive and non-cognitive skills during childhood (Cawley and Spiess, 2008; Currie, 2009; Lundborg et al., 2014). Under this reasoning, effective interventions for childhood obesity may not only generate positive impacts on children's health, but also a large payoff in terms of future human capital accumulation and hence improve labor outcomes during adulthood (Cawley, 2010; Palermo and Dowd, 2012; Lundborg et al., 2014).

In this context, we add to the literature on child bodyweight and human capital development in three ways. First, we focus on the socioemotional development, which is considered an important non-cognitive skill (Cohen et al., 2005; Humphries and Kosse, 2017; Black and Kassenboehmer, 2017; Cawley and Spiess, 2008).[1] Early cognitive and non-cognitive development is crucial for long-term outcomes in children. For example, both skills are important predictors for labor market outcomes, education and social behavior (Heckman

[1]The socioemotional development of children in early childhood includes the experience, expression, and management of the child's emotions, and the ability to establish positive and rewarding relationships with others, encompassing both intra and interpersonal processes, in addition to measuring adaptation and socialization skills that allow adaptation to the environment that surrounds them (Cohen et al., 2005).

et al., 2006; Carneiro et al., 2006; Cunha et al., 2010; Polemis, 2020). However, some recent findings indicate that non-cognitive skills are as important as, or even more important than, cognitive skills (Cunha et al., 2006; Heckman et al., 2006; Gutman and Schoon, 2016). For example, the empirical evidence suggests that a potential remediation for the lack of skill of disadvantaged adolescent is fostering non-cognitive rather than cognitive skills (Cunha et al., 2010; Kautz et al., 2014). This recommendation is supported by research indicating that non-cognitive skills are more important than test scores or schooling in securing employment for youth who dropped out of school (Bowles and Gintis, 2002). There is also evidence that non-cognitive skills are more malleable than cognitive skills, which suggests that there may be greater scope for policy interventions in early childhood (Carneiro et al., 2007; Cunha and Heckman, 2008; Hoeschler et al., 2018).

Second, most of what is currently known about the relationship between obesity and non-cognitive skills among children come from studies from developed countries (for a deeper review see Segal et al., 2021). Most of the empirical studies in the US show that obese children (especially girls) have more socioemotional problems (Datar and Sturm, 2004; Judge and Jahns, 2007), less self-esteem (Palermo and Dowd, 2012; Sabia and Rees, 2015), and less development of social skills (Rouse and Hunziker, 2020). Similar results have been found using data from children in the UK (Griffiths et al., 2011), Germany (Cawley and Spiess, 2008), and Australia (Black and Kassenboehmer, 2017).

We fill this gap by providing evidence of the effect of body weight on socioemotional development using a Chilean national representative sample of children at ages between two and 12. Chile is a developing country with high levels of childhood obesity. According to JUNAEB (2020), 64 percent of the children in fifth grade were overweight or obese, whereas 12 and 11 percent of children in pre-kindergarten and kindergarten, respectively, had severe obesity in 2020. Moreover, the trend is on the rise despite all the public policies that have been carried out by the Chilean government to reverse this situation (Vio et al., 2008). In addition, Chileans tend to associate slimness with the ideal body size as in western societies. For example, some qualitative findings reveal a high degree of stigmatization of the fat body by young Chileans (Sprovera et al., 2017) and adult women (Robinovich et al., 2018). Quantitative studies have also shown the detrimental effect of obesity in Chilean adults. Sarrias and Iturra (2022) find that women in Chile are penalized for being obese in the labor market: an obese woman earns on average ten percent less than a similar qualified but more healthy-weight woman. Similarly, Sarrias (2021), find that bodyweight and mental health are causally and negatively related when considering a representative Chilean sample.

Third, previous research studying the effect of obesity on children's non-cognitive development was relied mostly on ordinary least squared (OLS) and fixed effect (FE) estimators.[2] While FE estimation adjust for unobserved time invariant child's characteristics,

[2]Unlike non-cognitive skills, there are studies that analyze the causality between obesity and cognitive skills (such as educational attainment) using instrumental variables as an identification strategy (see for

it is unable to control for time variant unobserved factors determining both the stock of socioemotional skills and children's body weight or to address reverse causality (low socioemotional development may result in obesity). To disentangle the effect of bodyweight on children's socioemotional development we use the instrumental variables (IV) estimator. We instrument the endogenous children's weight variables with the lagged BMI of their biological mother. Since the validity of this instrument has been questioned (Scholder et al., 2012), we further explore the robustness of the results assuming that our instrument is imperfect and violate key assumptions such as independence and exclusion restriction. To this end, we use Nevo and Rosen (2012)'s approach which allow us to provides bounds of the weight penalty in the presence of imperfect instrument, making assumption about the sign and the maximum strength of the correlation of the instruments with the error term. To the best of our knowledge, we are the first using these procedures to analyze the sensitivity of weight penalty to violations of the IV assumptions.

The remainder of the article is organized as follows. The next section presents the survey and the main variables used in this study. Section 3 presents our empirical framework. The results are presented in Section 4. Section 5 contextualizes our results in the literature. Finally, section 6 concludes.

2 Data

The data used in this work comes from three available waves (2010, 2012, 2017) of the Longitudinal Survey of Early Childhood (ELPI), which is a representative survey of children in Chile. Its objective is to characterize and analyze the development of successive cohorts of boys and girls throughout their childhood, considering home characteristics, access to services (education, health, housing, among others) and parents' information. The information is collected in two steps. First, information about child's development, home environment and parents is obtained through face-to-face interviews with child's primary caregiver at home. In a second interview, different instruments are applied to both the main caregiver and the selected child to evaluate cognitive, socioemotional and physical aspects.[3]

The first round of the survey in 2010 was carried out by the Ministry of Education and the sample was randomly drawn from the official administrative records of the birth of children born between January 2006 and August 2009, with a sample size of 15,175 children from zero to four years old. The same participants were part of the 2012 sample, which at that period were two to six years old. This wave also considers the incorporation of a new sample made up of 3,135 boys and girls between zero and two years old, who were born between September 2009 and December 2011. This round was carried out by the Ministry of Labor

example Sabia, 2007; Averett and Stifel, 2010; Kaestner and Grossman, 2009; Scholder et al., 2012).

[3]The raw data is publicly available http://observatorio.ministeriodesarrollosocial.gob.cl/elpi-tercera-ronda and follows the subject confidentiality and statistical protection guidelines established in Chilean law 17,347 and 19,628.

and Social Welfare. The third and last round carried out in 2017 has a sample of 18,310 boys and girls from 2012 plus 4,500 cases from a refreshment sample of children between zero and two years old. Thus the total number of children in the survey corresponds to 22,810 boys and girls, from 0 to 12 years old.

The sample used in this study consists of an unbalanced panel of children who have non-missing values on the main outcome variable and covariates (see Table 1). To obtain reliable measures of our instrument, we keep those children whose biological mother was part of the second interview. Since we use the lagged weight of the mother as instrument, we loose the first round of the wave. Thus, our final sample corresponds to 5,407 girls and 5,484 boys between the ages of two and 12 years.[4]

(Insert Table 1 about here)

2.1 Socioemotional development and weight measures

Our dependent variable for early socioemotional development comes from the results of the Child Behavior Check List (CBCL) test, which allows the evaluation of children's behavior and emotional problems (Achenbach and Ruffle, 2000). The validity of this instrument in the Chilean context has been verified by Ivanova et al. (2007) and Ivanova et al. (2010). Both studies show that the CBCL test is a reliable measure to capture socioemotional patterns through a sample of 19,106 children between 18 and 71 months of age from 23 countries. Furthermore, it has been widely used in various international (Katsuki et al., 2020; Guerrera et al., 2019; Rishel et al., 2005) and national research (Reynolds et al., 2018; Fritsch et al., 2007; Cova et al., 2016; Berthelon et al., 2020; Ugarte et al., 2021).

Two versions of the test were applied to the children depending on their age and the questions were answered by the main caregivers (biological mothers in our sample) in each wave. The first one is the CBCL1 and was applied to children in the age-range of 18 to 71 months and 30 days. It is composed of 99 questions applied to the child's main caregiver and is evaluated on seven scales: i) emotional reactivity, ii) anxiety / depression, iii) somatic complaints, iv) self-absorption, v) sleep problems, vi) attention problems, and vii) aggressive behavior. The second one, known as the CBCL2, was applied to children from 72 months on-wards and consists of 112 questions evaluated on eight scales: i) anxiety / depression, ii) self-absorption, iii) somatic complaints, iv) social problems, v) thinking problems, vi) attention problems, vii) disruptive behaviors and viii) aggressive behaviors. The questions in both questionnaires have response categories in terms of periodicity: i) not true, ii) in a certain way or sometimes, and iii) very true or often true, with an associated score of zero, one, and two points, respectively. These scales, in turn, are organized into three problem factors: Total, internalization, and externalization factors. The internalization factor is mainly related

[4]The summary statistics of our main variables using the full sample are provided in Table A.1 in Appendix A.

to problems such as anxiety, depression, somatic complaints without apparent medical cause, and withdrawal from social relationships. The externalization factor represents disruptive behaviors and aggressive behaviors (Achenbach and Rescorla, 2000).

In both tests, the total raw-score for each of the scales and factors is obtained by adding the score of all the corresponding items, thus a higher general raw score implies less social-emotional development.

We used two variables as bodyweight measures for children. First, and following the Centers for Disease Control and Prevention, we use the age and sex standardized body mass index (z-BMI).[5] We also use a dummy variable indicating whether the child is obese ($>$ 95th percentile in the age and gender specific BMI distribution). Both, weight and height are measured in each wave by a trained interviewer, thereby eliminating the possibility of measurement error bias.

According to Table 1, the average BMI for children is approximately 20, whereas only 5 percent of them are obese.

2.2 Instrument and covariates

To find a causal relationship between weight and children's socioemotional development, we use the mother's lagged BMI to separate the exogenous variation in child's weight. Both the mother's weight and height are also measured by the trained interviewer at the second visit. Table 1 shows that mothers in our sample have an average BMI equal to 28, which falls within the overweight range using the international classification ($25 \leq BMI \leq 30$).

In all our specifications, we control for child, geographical and maternal characteristics that are presumably exogenous. We also include a wave dummy for 2012. As controls for children's characteristics, we include age (in months) and its square, the number of older and younger siblings. As mothers' characteristics, we include their marital status, age, and a dummy equal to one if they are the head of the household. All our specifications include region fixed effects.

3 Methods

To test the negative association between childhood weight and socioemotional development (also known as the weight penalty), we estimate several models based on the following socioemotional-skill production function (Averett and Stifel, 2010):

$$\ln s_{it} = \beta w_{it} + \mathbf{x}_{it}' \boldsymbol{\delta} + \epsilon_{it}, \tag{1}$$

where $\ln s_{it}$ is a measure of socioemotional skills for child i in wave $t = \{2012, 2017\}$; w_{it} is a measure for child i's weight; $\mathbf{x}_{it}$ is a set of presumably exogenous inputs that may influence socioemotional development; and ϵ_i is the error term. To maintain the idea that higher s_i

[5] The BMI is computed as the weight in kilograms divided by the square of height in meters.

represents better socioemotional development, we use the negative of the logarithm of the CBCL score in all our specifications.

Our main interest is the sign and magnitude of β in Equation (1). Following the empirical evidence, we postulate a weight penalty on socioemotional skills, $\beta < 0$, which may rise from different pathways. Obesity may have an impact on human capital because it deteriorates children's health, which in turns may affect the development of non-cognitive skills (Averett and Stifel, 2010). Discrimination has also been suggested as a potential mechanism explaining the relationship between obesity and human capital in childhood. Obese children might be discriminated against by parents, peers or teachers which produces social isolation and therefore reduce self-esteem (Datar and Sturm, 2004; Strauss, 2000). Thus, an estimate of β might be considered, at best, as the total effect of obesity on socioemotional skills.

Regardless of the mechanism through which obesity impact non-cognitive skills, there exist several unobserved factors correlated with the error term that might bias the OLS estimate of β, and hence invalidating causal claims. For example, children with higher motivation, better self-esteem, and high ability tend to have healthier lifestyles, less likely to be obese, and hence better childhood development (Scholder et al., 2012; Black et al., 2015; Black and Kassenboehmer, 2017). Similarly, some parents might have less unobserved preferences for investing in children development (Bhalotra and Clarke, 2020) and hence being less concerned about a healthy diet. Additionally, a flexible or permissive parenting style may result in positive socioemotional outcomes, but also in an increase of fat and/or sugar intake during childhood (Gahagan, 2012; Vollmer and Mobley, 2013). The OLS estimate of the weight penalty may also be biased due to reverse causality; a child might overeat and become obese in response to a socioemotional state.

To deal with endogeneity arising through unobserved heterogeneity and reverse causality, we propose an IV approach. In this case, the model becomes:

$$\ln s_{it} = \beta w_{it} + \mathbf{x}'_{it}\boldsymbol{\delta} + \epsilon_{it}, \quad (2)$$

$$w_{it} = \pi z_{it-1} + \mathbf{x}'_{it}\boldsymbol{\lambda} + \upsilon_{it}, \quad (3)$$

where z is the instrument (mother's lagged BMI) for children's bodyweight, Equation (2) is the structural equation and Equation (3) is the first-stage equation.[6]

Mother's BMI in previous wave must comply with some assumptions to be a valid instrument. First, it must be relevant. That is, it must be partially and highly correlated with children's current weight once the other exogenous variables have been netted out (i.e., $\pi \neq 0$), otherwise the IV estimator will be severely biased resulting in a weak-instruments

[6]Previous research focusing on children's cognitive development have used the weight of a biological relative (often the mother's weight) (e.g., Sabia, 2007; Averett and Stifel, 2010; Scholder et al., 2012; Black et al., 2015; Shi and Li, 2018), genetic markets (Scholder et al., 2012), and past weight status of the child (e.g., Kaestner and Grossman, 2009; Scholder et al., 2012) as instruments for child's weight.

problem. This assumption is supported by empirical studies showing that roughly half of the variation in weight is genetic in origin (Comuzzie and Allison, 1998), thus mother's weight should be a strong predictor of children's weight through shared genes (Cawley, 2000). Moreover, this assumption can be tested using the first-stage regression. An F test can be performed on the (conditional) regression of children's weight on mother's weight. Stock et al. (2002) suggest that if the first-stage F-statistic is larger than ten, then we can be confident that the relevance assumption holds.

Although this instrument has been widely used in other studies, its validity has been criticized (see Scholder et al., 2012). In particular, it has been questioned that it is completely exogenous (that is, it is correlated with the unobservables of the children's socioemotional-skill production function). For example, there exists at least two potential explanations of why the mothers' weight might be related to inputs on child development equation (Scholder et al., 2012; Black et al., 2015). First, if the link between mother's and child's weight is through genetics, then genetic factors determining childhood weight might also be correlated with unobserved genetic factors determining cognitive and non-cognitive development. Second, unobserved household factors common to mothers and children might also affect parental and child weight. Specifically, mothers' weight is likely to be correlated with other variables that are inputs in a childhood development such as family income, preferences or choices, and habits/life style (Scholder et al., 2012).

On the other hand, there exists different studies that validate using the weight of a relative as an instrument. For example, some studies indicate that genetics plays a more important role in determining body weight than family environment (see for example Stunkard et al., 1986; Cawley, 2000, 2004; Sabia, 2007). Studies based on twins indicates that approximately two-thirds of the variability in weight can be attributed to genetic factors (Ravussin and Bogardus, 2000). Similarly, Cawley (2004) and Sabia and Rees (2015) based on studies of adopted children and twins argue that living in the same household during childhood generates less similarity in weight than expected from genetics.

Given the concern of a certain degree of correlation between our instrument and the error term, we also provide bounds of the weight coefficient using Nevo and Rosen (2012)'s partial identification strategy. Specifically, we assume that our instrument is imperfect and hence correlated with the unobservables affecting children's socioemotional skills. Following Nevo and Rosen (2012), we rely on two assumption to identify the set of weight penalty values: (1) the correlation between the mother's lagged BMI and the unobservables affecting child's socioemotional skills has the same sign as the correlation between children's weight and the error term, and (2) the mother's lagged BMI is less correlated to the error than child's weight.

4 Results

4.1 Is there an effect of bodyweight on socioemotional skills?

We begin our analysis by asking if there is evidence of a negative association between bodyweight and socioemotional skills among Chilean girls and boys. Table 2 presents some preliminary estimates for this association using different body-size measures across columns and different econometric specifications across panels. For sake of brevity, the main tables in this article present only the coefficients associated with the bodyweight variables.[7] All specifications report clustered standard errors at the child level in parentheses.

(Insert Table 2 about here)

Panel A displays the point estimates for the unconditional OLS associations between z-BMI, being obese and weight (controlling for height) and the (negative of) logarithm of the CBCL test for girls (columns 1-3) and boys (columns 4-6). Looking at the results for girls, column 1 shows that the unconditional (OLS) estimate of z-BMI is negative but small: an increase of one standard deviation of BMI (approximately 4 points in the age-sex specific BMI distribution) decreases CBCL score in about 2.8 percent ($p < 0.01$). The estimate for obesity is also negative implying that obese girls score, on average, 7.3 percent less than non-obese girls on the CBCL test ($p < 0.01$). Column (3) displays the results for weight (in kilograms) controlling for height (in centimeters). The results are in line to those using previous measures of bodyweight. The point estimate indicates that an one-kilogram increase in weight is correlated with a decrease of 0.4 percent ($p < 0.01$) of socioemotional score. The results for boys are qualitatively similar and consistent with the results for girls. However, the estimates for girls on each measure of bodyweight are about twice as negative as for boys.

Associations between bodyweight and socioemotional attainment holding potentially exogenous covariates fixed are shown in Panel B of Table 2. In general, the magnitudes of the associations for both girls and boys are insensitive to the inclusion of these controls. Furthermore, the precision of the obesity estimate for boys and girls slightly increases compared to that in panel A.

The previous OLS estimates cannot be interpreted as causal if bodyweight is correlated with unobserved factors affecting children's socioemotional skills. Panel C shows the IV estimates using mothers' lagged BMI as exogenous variation for children's body size.[8] Our identification is based on some critical assumptions about the validity of mother's weight as an instrument. The fist key assumption is that mother's weight explains a large part of the children's propensity to be obese through genetic transmission, after exogenous factors have been netted out. This assumption is supported by the first-stage F-statistics from Table 2:

[7] Table A.2 of appendix A presents the estimates of Table 2 with the full set of baseline controls.

[8] The first-stage estimates are presented in Table A.3 of appendix A.

all F-statistics are substantially above the traditional cut-off of ten, and hence a potential week-instruments problem is precluded (Staiger and Stock, 1997; Stock et al., 2002).

A second important assumption is monotonicity. This assumption implies that the instrument only moves the endogenous regressor in one direction. Although monotonicity cannot be tested, we provide some evidence in Figure 1. It can be observed that the predicted relationship between mother's lagged BMI and our measures of child's bodyweight is positive for both boys and girls, but slightly decreasing for higher values of mother's BMI; a higher mother's BMI in previous wave predicts an increase in current BMI, z-BMI, the probability of being obese and weight (controlling for height) among children. A third and more critical assumption is that mother's weight is uncorrelated with the unobservables of the non-cognitive skills formation equation. We further explore this issue in the following sections.

(Insert Figure 1 about here)

We find that the IV estimates for girls are statistically significant and more negative than the conditional OLS estimates for all bodyweight measures (Panel C of Table 2). For example, the IV estimate for z-BMI is about twice as negative as the conditional OLS estimate ($\widehat{\beta}^{\text{ols}}_{\text{z-BMI}} = -0.028$ vs $\widehat{\beta}^{\text{iv}}_{\text{z-BMI}} = -0.067$). Similarly, column 2 of Panel C shows that obese girls score, on average, 62 percent less than non obese girls ($p < 0.01$). This estimate is approximately 9 times more negative than the conditional OLS estimate ($\widehat{\beta}^{\text{ols}}_{\text{obese}} = -0.072$ vs $\widehat{\beta}^{\text{iv}}_{\text{obese}} = -0.622$). The estimates for boys show a similar pattern. All IV estimates for the bodyweight measures are significant and more negative than the conditional OLS estimates.

An important finding is that, unlike the OLS estimators, there appear to be no significant differences in the IV-magnitudes between boys and girls. To further test gender differences, we estimate pooled IV models with gender interactions for each bodyweight measure. As instrument for the endogenous interaction, we use the interaction between mothers' lagged BMI and children's gender. The results are presented in Table 3. Since none of the interaction terms are significant, we conclude that there is not sufficient evidence of differential effects of bodyweight on socioemotional skills by gender. This result also suggests that gender-differences are potentially due to endogeneity issues.

(Insert Table 3 about here)

The fact that the IV coefficient for obesity is relatively high (compared to the other measures of bodyweight) could indicate that the weight penalty is largely caused by children who are in the upper tail of the BMI distribution. We shed some light in terms of nonlinearities of the association by computing IV estimates and considering the relative position of each child in the age and gender specific BMI distribution. That is, we consider that a child is obese if her BMI is equal to or above the τth percentile of age-gender-BMI distribution. This helps us to mitigate the potential heterogeneity of the body fat distribution across groups of children. The results are shown in Figure 2. It is clearly noticeable that the weight penalty is much higher in children who are in the 95th percentile of their respective distribution. For example, the IV estimator for the 95th percentile is about twice as large as for the 90th percentile. These results show that the weight penalty is somewhat homogeneous in the middle of the distribution, but increasing as we consider a more rigorous definition of obesity. Despite the fact that the confidence intervals are wider as we consider a higher percentile, all the estimates are significant at the 5% error.

(Insert Figure 2 about here)

In sum, the benchmark results show that, regardless of the bodyweight measure used in the specifications, the relationship is negative and significant for both genders. Another important finding is that the IV estimates are always more negative than OLS estimates. This finding may be explained by three non-exclusive factors. First, if mother's BMI is exogenous, IV estimates indicate the direction of the bias of $\widehat{\beta}^{\text{OLS}}$. In this scenario, the OLS estimate would point to the existence of positive correlation between children's bodyweight and the error term resulting in a underestimation of the weight-penalty. This could be caused by omitted factors that simultaneously increase children's weight and their socioemotional skills. For instance, a flexible or permissive parenting style may result in positive socioemotional outcomes (Berthelon et al., 2020), but also in an increase of fat and/or sugar intake during childhood (Gahagan, 2012; Vollmer and Mobley, 2013). Reverse-causality might also be a serious problem in the current framework. For example, a child might overeat and become obese in response to a socioemotional state.[9]

Second, the IV estimate delivers the local average treatment effect (LATE) rather than the average treatment effect (ATE). In other words, IV provides a consistent estimate of the average treatment effect only for the subgroup of children whose weight is affected by mothers' weight known as the compliers (Imbens and Angrist, 1994). In our context, the compliers are the sub-population of children who would increase weight if they were genetically disposed to being heavier but would not increase weight if they are not so disposed. Thus, the difference

[9]To further assess the role of reverse causality, we estimate the following IV specifications:

$$\begin{aligned} \ln s_{i,2017} &= \beta w_{i,2012} + \mathbf{x}'_{i,2012}\boldsymbol{\delta} + \epsilon_{i,2012}, \\ w_{i,2012} &= \pi z_{i,2010} + \mathbf{x}'_{i,2012}\boldsymbol{\lambda} + \upsilon_{i,2012}. \end{aligned}$$

By including the children's weight in the previous wave, we mitigate to some extent the effect running from $\ln s$ to w. Note that we also used as instrument the mother's BMI in 2010. The results are presented in Table A.4 of the Appendix A. The sample is considerably reduced since we need children who are present in the three waves of the ELPI and who do not have missing values in all the variables used. The first-stage F-statistics when obesity is the endogenous variable are very low. Thus, we only comment the results for z-BMI. It can be seen that, for both boys and girls, the IV estimator of z-BMI is more negative than the OLS estimator. If our instrument is valid, these results suggest that reverse causality is not driving the discrepancies between OLS and IV estimates.

between OLS and IV estimate may be suggesting heterogeneous treatment and/or instrument effects.[10]

A third and more worrisome possibility is that mothers' weight is not exogenous and hence correlated with the unobserved factors affecting children's socioemotional skills. In this case, and depending on the degree of correlation, the IV estimate is inconsistent exacerbating the negative impact of bodyweight on children's socioemotional development. We explore this issues in the following sections.

4.2 Extensions

Our previous estimates show that children's bodyweight has an impact on their socioemotional development. In the following sections, we try to provide further evidence regarding the robustness of our results.

4.2.1 Additional controls

As explained above, one of the fundamental assumptions of our identification strategy is that the mothers' weight is not correlated with the error term. If this assumption does not hold, then the inconsistency of $\widehat{\beta}^{\text{IV}}$ is:

$$\text{plim}\,\widehat{\beta}^{\text{IV}} - \beta = \frac{\sigma_\epsilon}{\sigma_w}\frac{\rho_{z,\epsilon}}{\rho_{z,w}}, \tag{4}$$

where $\rho_{z,\epsilon}$ is the correlation between the instrument and the error term, whereas $\rho_{z,w}$ is the correlation between the endogenous variable and the instrument. In previous section, we provided evidence that mother's weight and children's weight are positively correlated, $\rho_{z,w} > 0$. Therefore, the sign of $\rho_{z,\epsilon}$ will determine the inconsistency of the IV estimator: if $\rho_{z,\epsilon} > 0$ ($\rho_{z,\epsilon} < 0$), then $\widehat{\beta}^{\text{IV}}$ will underestimate (overestimate) the true negative weight penalty, $\text{plim}\,\widehat{\beta}^{\text{IV}} > \beta$ ($\text{plim}\,\widehat{\beta}^{\text{IV}} < \beta$). In this section, we try to remove these correlations by adding additional sets of variables potentially confounded with mother's bodyweight.[11]

For example, we have claimed that the relationship between mother's and children's

[10] The IV estimate is very sensitive to the proportion of compliers in the sample. The higher the complier rate, the closer the LATE will be to the ATE. In this regard, Greve (2016) argues that, since the mechanism is through genetics, then one should expect that the group of compliers consist of children with average characteristics and not people belonging to certain ethnic or socioeconomic groups. In addition, Sarrias (2021) analyzes the heterogeneous effects of bodyweight on satisfaction with life using an instrumental variable latent class approach for binary outcomes. He shows that the instrument (whether the respondent's closer relatives have diabetes), although is heterogeneous in terms of its magnitude, it is positively related to weight for all estimated classes. This evidence, along with our results in Figure 1, suggests that the proportion of noncompliance may be low.

[11] Most of the additional regressors used in this section are also potentially endogenous. This is one of the reasons why these variables were not previously included in our baseline estimates of Table 2. A second reason is that the BMI of the mother may be correlated with these (potentially) endogenous regressors, resulting in inconsistent IV estimates for the child's bodyweight (Huntington-Klein, 2021). Thus, these estimates should be interpreted with caution.

weight is through genetic transmission. However, if the relationship is purely genetic, then there are reasons to think that shared genetic factors related to excess weight could also be related to factors that determine socioemotional skills. In columns (2) and (7) of Table 4, we test this possibility by including as proxies of the mother's socioemotional state two dichotomous variables that indicate: (1) if the mother currently has depression and, (2) if the mother had postpartum depression. The full set of previous covariates are also included in all specifications. Columns (1) and (6) shows baseline IV results to facilitate comparisons. We only report the results for z-BMI (panel A) and obesity dummy (panel B).[12] Panel A shows that both variables have a negative relationship with the CBCL test among girls (columns 2); and only current maternal depression impairs socioemotional development among boys. Including these variables reduces the magnitude of the LATE of the weight penalties; the estimated coefficients decrease by approximately 18 and 24 percent for girls and boys, respectively. Looking at Panel B, we observe that the obesity penalties decreases in a similar percentage.[13]

(Insert Table 4 about here)

Another potential bias can result if the mother's weight may be related to her preferences, habits and therefore her effort to invest in her children's development. For example, mothers with higher rate of time preferences are less willing to forego current utility in exchange for long-run benefits, resulting in unhealthy behaviors at home and less effort to invest in their children's human capital (Cawley and Ruhm, 2011). In columns (3) and (8) of Table 4 we control for mother's risky behaviors during pregnancy (smoking, drug used, and drinking alcohol). According to Lindeboom et al. (2010), these variables are likely to be good proxies for parent's preferences to invest in their child. The IV estimates for z-BMI (panel A) and obesity (panel B) are almost invariant for both groups when including these additional controls.

In columns (4) and (9), we add the logarithm of household income and mother's education as additional controls. These variables are very likely to be highly correlated with both childhood development and mother's obesity (Cawley, 2010; Scholder et al., 2012; Black et al., 2015; Black and Kassenboehmer, 2017). Panels A and B shows that, overall, the weight penalty seems to be robust to the inclusions of these variables.[14] Finally, columns (5) and (10) show that the inclusion of all previous controls reduces the weight penalty for both girls

[12] The results for weight are displayed in Table A.5.

[13] The empirical covariance between mothers' socioemotional status and their body weight is positive, while its covariance with children's socioemotional development is negative (see Table 4). This results in a negative correlation between the lagged mothers' BMI and the error term $\rho_{w,\epsilon} < 0$, and therefore in an overestimation of IV estimate.

[14] Interestingly, the results from Table 4 show that household income is not an important determinant for socioemotional development. Although this result might be driven by the potential endogeneity of income, this finding resembles those of Khanam and Nghiem (2016) who found that family income is significantly associated with children's cognitive skills but not with non-cognitive skills.

and boys by a similar amount. Specifically, the IV estimate of z-BMI and obesity is reduced by 37 percent among girls, while for boys the reduction is approximately 41 percent.[15]

It is important to note that the first-stage F-statistics are not affected when including these additional covariates. Consistently with previous literature (Stunkard, 1986; Stunkard et al., 1986; Cawley, 2000, 2004; Sabia, 2007), these results tend to confirm that the intergenerational correlation in bodyweight is greatly due to genetic variation, whereas family environment plays a minor role.

4.2.2 Estimates assuming that the instrument is imperfect

Since it is almost impossible to control for all unobserved factors, we provide bound estimates for the weight penalty assuming the sign of the correlation between bodyweight and unobserved factors among children and using Nevo and Rosen (2012)'s imperfect IV procedure.

To understand Nevo and Rosen (2012)'s approach, note that the inconsistency of $\widehat{\beta}^{\text{OLS}}$ is given by:

$$\text{plim}\, \widehat{\beta}^{\text{OLS}} - \beta = \frac{\sigma_\epsilon}{\sigma_w} \rho_{w,\epsilon}, \tag{5}$$

where β is the true weight penalty, $\rho_{w,\epsilon}$ is the correlation between children's weight and the unobservables, whereas σ_ϵ and σ_w are the standard deviation of the error term and children's weight, respectively. Following Scholder et al. (2012), we assume that maternal weight has the same direction of correlation with the omitted error term as the children's weight. For example, unobserved family factors, unhealthy eating habits or stressful shocks common to the family environment can increase both the weight of the mother and her children. This implies that $\rho_{z,\epsilon} \cdot \rho_{w,\epsilon} \geq 0$, which is Nevo and Rosen (2012)'s Assumption 3 (hereinafter, A3). This assumption combined with the assumption about the relative magnitude of $\rho_{z,\epsilon}$ and $\rho_{w,\epsilon}$ allows to construct bound estimates. Since the correlation between children's and mother's weight is positive, we can only obtain one-side bounds (see Lemma 1 in Nevo and Rosen, 2012). To obtain two-side bounds, we follow Bhalotra and Clarke (2020)'s procedure and multiply our instrument by -1. Finally, we assume that the correlation between the error term and children's weight is positive.[16] This assumption is supported by Scholder et al. (2012). They provide suggestive evidence that BMI in mother and adiposity in children are both positively correlated with various (observed) child and family background characteristics such as deprivation and mother's locus of control.

Under above assumptions and considering Equations (4) and (5), Nevo and Rosen (2012) show that the true effect is bounded by:

[15]We also conduct a falsification test by regressing the non-biological mother's weight on the weight of an unrelated child. The results presented in Table A.6 of Appendix A show that both variables are not statistically associated, providing evidence that common home environment is not driving our results.

[16]Under the assumption that $\rho_{z,\epsilon} \cdot \rho_{w,\epsilon} \geq 0$, the statement $\rho_{w,\epsilon} > 0$ implies also that $\rho_{z,\epsilon} > 0$.

$$\beta^{\text{IV}} \leq \beta \leq \beta^{\text{OLS}},$$

which is not very informative in our case. Under Nevo and Rosen (2012)'s Assumption 4 (hereinafter, A4) that mother's weight is less endogenous than the children's weight, $|\rho_{z,\epsilon}| < |\rho_{w,\epsilon}|$, we can further tighten the upper bound such that:

$$\beta^{\text{IV}} \leq \beta \leq \beta^{\text{IV}}_{\kappa},$$

where $\beta^{\text{IV}}_{\kappa}$ is the IV estimator using as instrument a compound instrument based on the endogenous children's weight variable and the imperfect mother's weight instrument:

$$\kappa = (\sigma_w z - \sigma_z w).$$

The point and bound estimates, along with their 95% confidence interval, for z-BMI and obesity are given in Figure 3 and 4, respectively.[17] The OLS and IV point estimates include all previous controls and are added for comparison purposes.[18] As mentioned before, without assumption A4 (wo A4 in Figures) then the true weight penalty is bounded by the IV and the OLS estimates. When we add the assumption that the instrument is less endogenous than children's weight (A4), we further tighten the upper bounds.

Considering the effect of z-BMI (Figure 3), we observe that the bounds and their 95% confidence interval never include zero. This provides evidence that the null hypothesis of a zero effect is rejected for both boys and girls, even if there exists some degree of endogeneity of our instrument. Assuming Nevo and Rosen (2012)'s A4 we can say that among girls the impact of BMI lays between -0.045 and -0.029. Among boys, the range is similar: the negative impact of one additional standard deviation of BMI on the CBCL test is bounded between -0.037 and -0.017. Regarding to obesity (Figure 4), the effect size lies between [-0.42, -0.11] and [-0.36, -0.064] for girls and boys, respectively, which is much more informative than our preliminary estimates. In sum, all estimates are significant at the 5% error even assuming that mother's weight is positively correlated with unobserved factors affecting children's socioemotional development.[19]

[17]The Nevo and Rosen's procedure was computed using **imperfectiv** command in Stata (Clarke and Matta, 2017).

[18]The IV estimates correspond to those in columns (5) and (10) of Table 4.

[19]As an additional exercise, and as suggested by one of the reviewers, we also provide some bounds of the weight penalty without relying on the IV procedure. To do so, we use Kinky Least Squares (KLS) estimation (Kiviet, 2020) which analytically correct the bias of the OLS coefficient for all values of the correlation between the error term and children's bodyweight, $\rho_{w,\epsilon}$. Figure A.1 shows the KLS estimates of the weight penalty assuming different degree of correlation between the error term and children's weight in the interval $\rho_{w,\epsilon} \in (-0.7, 0.7)$. Under $\rho_{w,\epsilon} = 0$, the OLS estimates are the true weight penalty. It can be observed that the corrected OLS coefficient for each measure of bodyweight is positive (negative) if the true correlation between the error term and children's weight is less (higher) than -0.1. In other words, the sign of the coefficients is very sensitive to the sign of the covariance between the error term and weight. However, Nevo and Rosen's bound

(Insert Figure 3 about here)

(Insert Figure 4 about here)

4.2.3 Heterogeneous effects by age

The empirical literature has documented that the weight penalty on children's human capital development seems to be higher at older ages (see Segal et al., 2021). To corroborate this hypothesis, we include the interaction between children's bodyweight (z-BMI and obesity) and their age and run separately regressions for boys and girls. Figure 5 shows the IV-point estimates. Panel A presents the estimates for z-BMI, whereas panel B shows the IV estimates for obesity.[20]

Some interesting results emerge from the figure. First, the weight penalty appears to be greater for girls at earlier ages. But the gap gradually narrows as children get older. In particular, the magnitude of the weight penalty decreases and increases with age for girls and boys, respectively. Another important point is that there are differences regarding the age from which the effect is significant. For girls, the effect of z-BMI and being obese is significant starting at ages three and five, respectively. For boys, the significant effects start later; the effects of z-BMI and obesity are statistically different from zero when they turn eight years old. These results agree with previous findings showing that children with overweight or obesity at later ages have more often detrimental consequences on their human capital (Segal et al., 2021).

(Insert Figure 5 about here)

4.2.4 Additional specifications

We end this section by providing additional sensitivity analyzes suggested by the reviewers. Table A.7 in Appendix A contains additional IV estimates of the weight penalty using different specifications for the instrument. The full set of controls of Table 4 are used. Panel A shows the the point estimates using as instrument the contemporaneous (as opposed to the lagged) mother's BMI; panel B displays the estimates using as IV whether the mother is currently obese (BMI > 30); panel C uses as instruments the contemporaneous mother's BMI and its squared to capture nonlinearities in the first-stage regression; and Panel D uses the mother's obesity status in previous wave. The results reveal that, in general, the point estimates for girls are very similar to each other, regardless of the specification of the instrument. The magnitudes for boys have more variability, especially when current or

estimates are consistent with a degree of endogeneity between $0.01 < \rho_{w,\epsilon} < 0.2$. Thus, a very conservative conclusion is that our LATE estimates would be valid if the potential correlation between mother's weight and the error term is not higher than 0.2.

[20]Following Bun and Harrison (2019), we use as instrument the BMI of the mother and its interaction with children's age.

lagged maternal obesity is used as instrument. However, the results remain qualitatively and quantitatively very similar to those in Table 2 and 4.

The results controlling for child fixed effects (FE) are presented in Table A.8. Panel A shows the child FE estimates—which identify the average treatment effect on children who switched their weight—, whereas panel B shows the IV-FE estimates using contemporaneous mother's BMI as instrument. Among girls, the child FE estimates for z-BMI and obesity are slightly lower (in absolute value) than the OLS estimates (see Table 2), revealing that there might exist time-invariant unobserved factors correlated with the bodyweight measures. The lack of statistical significance of the obesity coefficient reflects the fact that there is not enough within-child variation in this variable for girls. The estimated coefficients for z-BMI and weight in the IV-FE model are more negative than the FE estimates and larger than the IV estimates (see Table 4). The results for obesity are inconclusive since the F-statistic is lower than the cut-off of ten. For boys, the child FE estimates are negative and statistically significant. However, the IV-point estimates controlling for child FE prevent us of extracting meaningful conclusions due to the lack of within-child variation in the first-stage regression, as evidenced by the F-statistics.

As described previously, the CBCL measures behaviors related to syndromes that can be classified into two broad categories of problems: internalization and externalization problems. We explore the effect of bodyweight on each of these categories and report our results in Table A.9 and find that the weight penalty is stronger for externalizing factors for both girls and boys. This finding suggests that the effect of bodyweight on socioemotional development may be driven by problems that involve attention problems and aggressive behavior, especially among boys.

4.3 The mediating role of scholar bullying, health and body-image

The previous estimates should be considered, at most, as the total LATE of bodyweight on children's socioemotional development. Thus, determining the pathways through which bodyweight reduces socioemotional skills can be useful for prevention and intervention among children with increased bodyweight (Cawley and Spiess, 2008). In this section, we explore potential mechanisms by which weight can cause worse socioemotional skills.

Table 5 suggest alternative IV estimations in which some mechanisms are added. By including these mechanisms, we are blocking the potential pathway of bodyweight to socioemotional development through these mediators. If the IV-point estimates for bodyweight are not longer significant, it suggests that the total detrimental effect of bodyweight on socioemotional development is driven by the indirect effect through our mediator variables.[21] Since most of these variables are available for 2017, and hence the sample is reduced, we present the IV estimates with this new sub-sample in columns (1) and

[21] It is important to highlight that this approach does not allows us to compute the effect of the mediator variables on socioemotional skills, since they might also be endogenous.

(6).[22] Again, the results for z-BMI are presented in Panel A, whereas the point estimates for being obese are shown in Panel B.

(Insert Table 5 about here)

One potential mechanism that might explain the link between obesity and socioemotional skills is peer victimization. Accordingly, the psychological consequences of obesity may be attributable to weight stigmatization and discrimination, which is mainly expressed through teasing and bullying among children and adolescents (Patte et al., 2021; Datar and Sturm, 2004). This is corroborated by many studies documenting that obese children are bullied, teased and socially excluded by their peers (see for example Feeg et al., 2014; Thompson et al., 2020). To test whether heavier children have less social-emotional development because they are bullied, we re-estimated the IV model including a measure of school bullying victimization.[23] The results are displayed in columns (2) and (7) for girls and boys, respectively. The weight penalties are still statistically significant and their magnitude, although reduced compared to columns (1) and (6), are not significantly altered.

Another suggested mechanism is obesity-related diseases. Accordingly, bodyweight has an impact on non-cognitive development because it deteriorates children's physical health and/or increases comorbidities (Reilly et al., 2003; Averett and Stifel, 2010). In columns (3) and (8) of Table 5, we include a dummy variable indicating whether the child has some obesity-related comorbidities such as sleep apnea, high blood pressure, elevated insulin levels, or type 2 diabetes mellitus. Again, the IV estimates for our two measures of bodyweight remain stable.

Finally, it has also been suggested that low socioemotional development in obese children and adolescents can be partly account for by dissatisfaction with one's body size and body-image concerns (Friedman et al., 2002; Allen et al., 2006). Especially in societies like the Chilean one, where the beauty premium plays an important role (Sprovera et al., 2017; Robinovich et al., 2018; Sarrias and Iturra, 2022). Columns (4) and (8) of Table 5 show the results when controlling for children's body-image (BI) satisfaction.[24] As expected, BI

[22] Although the sample is reduced, the IV-point estimates without controls (columns (1) and (6) of Table 5) are within the bounded estimators of Figures 3 and 4.

[23] This measure is based on the Social and School Climate Scale Test. It consists of five sub-scales, but only the bullying sub-scale was applied in the 2017 wave to boys and girls aged 7 to 12. The questionnaire consists of eight items that have response categories on a Likert scale related to periodicity (never, rarely, almost always, and always) with values from 1 to 4, respectively. The total score is obtained as the simple sum of the points assigned to each question. Thus, a higher score indicates a negative perception of school climate. The questions are presented in Appendix B.

[24] This variable is constructed based on some questions of the School Self-esteem Test (TAE in Spanish). In particular, our body-image satisfaction variable is computed as the sum of the points assigned to each of the following questions: (1) "My appearance bothers me, how I look", (2) "I am good-looking", and (3) "I have a nice face". Thus, the total score could reach a maximum of 3 points. The closer to the upper limit, the better the child's BI satisfaction.

satisfaction is associated with an increase in socioemotional development for both girls and boys, yet the IV estimates for the weight penalty, although reduced, remain negative and statistically different from zero.

In columns (5) and (10) we jointly control for our three mediator variables. According to the results, the weight penalty (for both z-BMI and obesity) is reduced in about 13% and 21% for girls and boys, respectively.

5 Discussion

We showed that conditional OLS estimates between bodyweight and socioemotional development among Chilean children was negative and statistically significant. This result was robust even when considering continuous or discrete measures of bodyweight. Among girls, the weight penalty was 2.8% and 7.1% when using z-BMI and obesity, respectively. The results for boys were slightly lower: an increase of one standard deviation of the BMI decreased the CBCL score in about 1.3%, whereas obese boys scored, on average, 3.4% less than non-obese peers. Although it is difficult to compare these magnitudes with previous studies—due to different measures of both body weight and non-cognitive abilities—they do support previous research in developed countries which found that bodyweight is related to non-cognitive skills using similar methods.

For example, Rouse and Hunziker (2020) using a sample of American children found that obese children were both more likely to have internalizing problems behaviors and had worse interpersonal skills even after controlling for child fixed effects. Palermo and Dowd (2012) using also a sample of American children aged five to 19 found that obese girls had significantly worse positive behaviors scores compared to normal weight girls in both OLS and FE models. Unlike Rouse and Hunziker (2020), Palermo and Dowd (2012) did not find evidence of a weight penalty on non-cognitive outcomes for boys. Sabia and Rees (2015) also found evidence that increases in bodyweight lead to reduced psychological well-being among adolescent American girls (aged 14-17), but provide little evidence that this relationship hold for boys. Closer to our results, but using a dynamic GMM approach on Australian children aged four to 13, Black and Kassenboehmer (2017) found that a one standard deviation increase in lagged BMI increases total and emotional problems by 0.10 and 0.08 standard deviations, respectively.

Next, we addressed the endogeneity of bodyweight by using an IV approach. We used the lagged mother's BMI as exogenous variation for child's bodyweight. Our baseline results suggested that the detrimental effect of bodyweight on CBCL score was stronger when the endogeneity of bodyweight was taken into consideration. This key finding echoes those reported for the weight penalty on children's cognitive skills. For example, Averett and Stifel (2010) and Scholder et al. (2012) found that the coefficients in their IV models are much negative than OLS and FE estimates when they used mother's past BMI as instrument. Sabia (2007), Black et al. (2015), Sabia and Rees (2015), Shi and Li (2018) and also reached a similar conclusion for the weight penalty on children's cognitive and non-cognitive development using parent's bodyweight as exogenous variation. We also showed that the weight-penalty IV estimates were robust to the inclusion of variables potentially confounded with mother's bodyweight such as: mother's depression, mother's behavior during pregnancy, mother's education and household income.

Since instruments based on relative's weight has been criticized (e.g., Scholder et al., 2012), we further assessed whether our results were reliable even assuming our instrument was imperfect. Since is almost impossible to control for all potential variables relegated to the error term, and potentially correlated with the instruments, we constructed bound estimates of the true weight penalty assuming the sign of the endogeneity and using Nevo and Rosen (2012)'s procedure. The bound estimates allowed us to elucidate that the weight penalty was robust in terms of sign. Considering the most conservative bounds, we can say that an additional standard deviation of BMI reduces CBCL score in [2.9%, 4.5%] and [1.7%, 3.7%] for girls and boys, respectively. Considering a more stringent measure of bodyweight such as being obese (>95th percentile in the age-sex BMI distribution) the bounds were [11%, 42%] and [6.4%, 36%].

In terms of heterogeneous effects, we did not observe distinguishable difference between boys and girls. In fact, the gender gap initially found by OLS was completely eliminated once we control for potential endogeneity issues. This finding differs from those that found greater effects for girls (e.g, Datar and Sturm, 2004; Judge and Jahns, 2007; Palermo and Dowd, 2012; Sabia and Rees, 2015) or boys (Cawley and Spiess, 2008), but it is consistent with those studies reporting negative associations for both (e.g., Black and Kassenboehmer, 2017; Rouse and Hunziker, 2020). One possible reason for these differences may be that the weight of girls, at least in our sample, is more correlated with the unobservables, and therefore the IV estimator corrects for these gender disparities in terms of endogeneity.

Our results for age also showed that the negative impact seems to start earlier for girls (four years), while for boys the negative impacts begins to be significant at age of six. Yet, the gender-gap of the weight penalty decreases as children get older. A similar result if found by Griffiths et al. (2011). They showed that obesity was associated with more emotional and behavioral problems at the age of five years than at age three. One possible explanation is that the weight penalty on human capital during childhood may be cumulative over time (Segal et al., 2021).

Finally, we assessed how much of the total effect of BMI and obesity can be explained by some suggested mechanisms in the literature: scholar bullying victimization, physical health, and body-image satisfaction. We found that bad health and scholar bullying victimization are the mediators that most explained the weight penalty among girls and boys, respectively. Furthermore, the effect remained negative and statistically significant even after controlling for these three pathways together. Additionally, these mechanisms explained approximately 33 (among girls) and 44 percent (among boys) of the total effect of the penalty suggesting that there might exists other mechanisms explaining this relationship and hence further research is needed.

6 Conclusions

This article contributes to the growing literature on childhood health and human capital by providing new evidence on the effect of childhood obesity on socioemotional skills for children aged two to 12 years in Chile.

Overall, both OLS and IV estimates suggests that bodyweight has negative consequences on the child's socioemotional skill acquisition. This corroborates previous findings in developed countries and provides more evidence on the human capital accumulation theory in developing countries such as Chile. If we assume that childhood obesity also requires parental investment, then our findings provide another mechanism by which parents could foster human capital (Heckman and Rubinstein, 2001; Carneiro and Heckman, 2003). Given that the formation of human capital is a dynamic process, and assuming the same level of parent investment in healthy habits, then the future returns for having a healthy bodyweight will be greater in those children whose investments were made in early childhood. Additionally, there is ample empirical literature showing a penalty for being obese in labor markets (e.g., Cawley, 2004; Lundborg et al., 2014). Our findings also support the idea that a potential mechanism through which obesity may affect economic success during adulthood is through the acquisition of fewer socioemotional skills during childhood.

Our IV estimates do not detect a significant difference between boy and girls, but we do find that heterogeneous effects by age. We identify the age of four and eight to be a sensitive period for girls and boys, respectively. The result resembles those found by studies focused on cognitive development on high-income countries (see for example the studies in Segal et al., 2021). Accordingly, detrimental effects of childhood obesity are mostly apparent when obesity is measured and assessed in later stages of childhood. This finding implies that the effects of childhood obesity are rather cumulative over time, and therefore interventions in early childhood could be reflected in better socioemotional skills in middle childhood (ages six to 12). This period is considered as a critical stage in which children not only develop foundational skills for building healthy social relationships but also become more aware of their body as puberty approaches (Murasko, 2015; Kautz et al., 2014).

Our results are also important considering the Chilean context. The figures for childhood overweight and obesity in Chile are discouraging. Despite the different public policies carried out by the government (such as "Choose healthy living" program), childhood obesity is one of the main public health problems in the country and affects one in four children. Our findings suggest that early treatment for childhood obesity not only might generate positive impacts on children's health, but also might generate positive externalities by improving children's non-cognitive skills. Additional results of our research support that victimization of bullying and body-image dissatisfaction should be the target of prevention and intervention programs for children with both obesity and increased BMI to improve internalizing and externalizing behaviors. In addition, interventions focusing on the school climate may also help to reduce stigmatizing behaviors towards children who are obese (Thompson et al., 2020). These interventions make sense in contemporary western societies, like the Chilean one, where larger body size is considered as an unattractive characteristic and where there exists a high degree of stigmatization of the fat body (Sprovera et al., 2017; Robinovich et al., 2018).

Our study findings should be interpreted considering some caveats. Although we provide some robustness checks about the validity of lagged mother's weight as an instrument, we cannot guarantee that it is completely exogenous. However, our results are consistent with the general empirical finding that OLS estimates of the weight penalty are generally underestimated. At best, the magnitude of our IV estimates should be considered as LATE estimates and hence they provide useful information of the sub-population composed by children who are genetically predisposed to lose or gain weight (the compliers). Further research is needed to determine if the proportion of compliers is representative of the population.

A second caveat is our measures for bodyweight. Although, weight and height for both children and mothers were measured using trained interviewers and standardized protocols, the use of BMI has been criticized as measure of excess of fat among children and adults. For example, BMI does not distinguish fat from muscle, bone, and other lean body mass and hence it is less accurate to reflect the true adiposity of individuals (Burkhauser and Cawley, 2008). Future work is needed to analyze the effect of bodyweight on socioemotional skills using more accurate measures of fatness.

References

Achenbach, T. and Rescorla, L. (2000). *Manual for the ASEBA Preschool Forms & Profiles.* An integrated system of Multi-formant Assessment. ASEBA.

Achenbach, T. and Ruffle, T. (2000). The child behavior checklist and related forms for assessing behavioral/emotional problems and competencies. *Pediatrics in Review*, 21(1):265–271.

Afzal, A. S. and Gortmaker, S. (2015). The relationship between obesity and cognitive performance in children: A longitudinal study. *Childhood Obesity*, 11(4):466–474.

Allen, K. L., Byrne, S. M., Blair, E. M., and Davis, E. A. (2006). Why do some overweight children experience psychological problems? the role of weight and shape concern. *International Journal of Pediatric Obesity*, 1(4):239–247.

Averett, S. L. and Stifel, D. C. (2010). Race and gender differences in the cognitive effects of childhood overweight. *Applied Economics Letters*, 17(17):1673–1679.

Berthelon, M., Contreras, D., Kruger, D., and Palma, M. I. (2020). Harsh parenting during early childhood and child development. *Economics & Human Biology*, 36:100831.

Bhalotra, S. and Clarke, D. (2020). The twin instrument: fertility and human capital investment. *Journal of the European Economic Association*, 18(6):3090–3139.

Black, N., Johnston, D. W., and Peeters, A. (2015). Childhood obesity and cognitive achievement. *Health economics*, 24(9):1082–1100.

Black, N. and Kassenboehmer, S. C. (2017). Getting weighed down: the effect of childhood obesity on the development of socioemotional skills. *Journal of Human Capital*, 11(2):263–295.

Bowles, S. and Gintis, H. (2002). Schooling in capitalist america revisited. *Sociology of education*, pages 1–18.

Bun, M. J. and Harrison, T. D. (2019). OLS and IV estimation of regression models including endogenous interaction terms. *Econometric Reviews*, 38(7):814–827.

Burkhauser, R. V. and Cawley, J. (2008). Beyond bmi: the value of more accurate measures of fatness and obesity in social science research. *Journal of health economics*, 27(2):519–529.

Carneiro, P., Crawford, C., and Goodman, A. (2006). *Which skills matter?*

Carneiro, P., Crawford, C., and Goodman, A. (2007). *The impact of early cognitive and non-cognitive skills on later outcomes.*

Carneiro, P. M. and Heckman, J. J. (2003). Human capital policy.

Cawley, J. (2000). An instrumental variables approach to measuring the effect of body weight on employment disability. *Health Services Research*, 35(5 Pt 2):1159.

Cawley, J. (2004). The impact of obesity on wages. *Journal of Human resources*, 39(2):451–474.

Cawley, J. (2010). The economics of childhood obesity. *Health affairs*, 29(3):364–371.

Cawley, J. and Ruhm, C. J. (2011). The economics of risky health behaviors. In *Handbook of health economics*, volume 2, pages 95–199. Elsevier.

Cawley, J. and Spiess, K. (2008). Obesity and skill attainment in early childhood. *Economics and Human Biology*, 5:388–397.

Chernozhukov, V., Lee, S., and Rosen, A. M. (2013). Intersection bounds: estimation and inference. *Econometrica*, 81(2):667–737.

Clarke, D. and Matta, B. (2017). Practical considerations for questionable ivs. *The Stata Journa*, 18(3):663–691.

Cohen, J., Ngozi, O., Clothier, S., and Poppe, J. (2005). Helping young children succeed strategies to promote early childhood social and emotional development.

Comuzzie, A. G. and Allison, D. B. (1998). The search for human obesity genes. *Science*, 280(5368):1374–1377.

Coneus, K., Laucht, M., and Reuß, K. (2012). The role of parental investments for cognitive and noncognitive skill formation—evidence for the first 11 years of life. *Economics & Human Biology*, 10(2):189–209.

Cova, F., Bustos, c., rincón, p., saldivia, s., inostroza, c., and grandón, p. (2016). Psychometric properties of the child behavior checklist and the caregiver /teacher report form in chilean preschoolers. *Terapia Psicologica*, 34(3):191–198.

Cunha, F. and Heckman, J. (2007). The technology of skill formation. *American Economic Review*, 97(2):31–47.

Cunha, F. and Heckman, J. (2008). Formulating, identifying and estimating the technology of cognitive and noncognitive skill formation. *The journal of human resources*, 43(4):738–782.

Cunha, F., Heckman, J. J., Lochner, L., and Masterov, D. V. (2006). Interpreting the evidence on life cycle skill formation. *Handbook of the Economics of Education*, 1:697–812.

Cunha, F., Heckman, J. J., and Schennach, S. M. (2010). Estimating the technology of cognitive and noncognitive skill formation. *Econometrica*, 78(3):883–931.

Currie, J. (2009). Healthy, wealthy, and wise: Socioeconomic status, poor health in childhood, and human capital development. *JoUrnal of economIc lIteratUre*, 47(1):87–122.

Datar, A. and Sturm, R. (2004). Childhood overweight and parent- and teacher-reported behavior problems.evidence from a prospective study of kindergartners. *Archives of pediatrics & adolescent medicine.*, 158:804–810.

Deckelbaum, R. J. and Williams, C. L. (2001). Childhood obesity: the health issue. *Obesity research*, 9(S11):239S–243S.

Feeg, V. D., Candelaria, L. M., Krenitsky-Korn, S., and Vessey, J. A. (2014). The relationship of obesity and weight gain to childhood teasing. *Journal of pediatric nursing*, 29(6):511–520.

Friedman, K. E., Reichmann, S. K., Costanzo, P. R., and Musante, G. J. (2002). Body image partially mediates the relationship between obesity and psychological distress. *Obesity research*, 10(1):33–41.

Fritsch, R., Montt, M., Solfs, J., Pilowsky, D., and Rojas, M. G. (2007). ¿how is the mental health of the children of depressed mothers consulting primary care services?psychopathology and social functioning among offspring of depressed women. *Revista medica de Chile*, 135:602–612.

Gahagan, S. (2012). The development of eating behavior-biology and context. *Journal of developmental and behavioral pediatrics: JDBP*, 33(3):261.

Greve, J. (2016). Why do people with higher body weight earn lower wages? In *The Oxford Handbook of Economics and Human Biology*.

Griffiths, L., Dezateux, C., and Hill, A. (2011). Is obesity associated with emotional and behavioural problems in children? findings from the millennium cohort study. *International Journal of Pediatric Obesity*, 6:e423—e432.

Guerrera, S., Menghini, D., Napoli, E., Di Vara, S., Valeri, G., and Vicari, S. (2019). Assessment of psychopathological comorbidities in children and adolescents with autism spectrum disorder using the child behavior checklist. *Frontiers in Psychiatry*, 10(535):1—8.

Gutman, L. M. and Schoon, I. (2016). A synthesis of causal evidence linking non-cognitive skills to later outcomes for children and adolescents. In *Non-cognitive skills and factors in educational attainment*, pages 171–198. Brill Sense.

Heckman, J. and Rubinstein, Y. (2001). The importance of noncognitive skills: Lessons from the ged testing program. *American Economic Review*, 91(2):145–149.

Heckman, J. J. (2007). The economics, technology, and neuroscience of human capability formation. *Proceedings of the national Academy of Sciences*, 104(33):13250–13255.

Heckman, J. J., Stixrud, J., and Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. *Journal of Labor economics*, 24(3):411–482.

Hoeschler, P., Balestra, S., and Backes-Gellner, U. (2018). The development of non-cognitive skills in adolescence. *Economics Letters*, 163:40–45.

Humphries, J. E. and Kosse, F. (2017). On the interpretation of non-cognitive skills–what is being measured and why it matters. *Journal of Economic Behavior & Organization*, 136:174–185.

Huntington-Klein, N. (2021). *The effect: An introduction to research design and causality.* Chapman and Hall/CRC.

Imbens, G. W. and Angrist, J. D. (1994). Identification and estimation of local average treatment effects. *Econometrica: Journal of the Econometric Society*, pages 467–475.

Ivanova, M., Achenbach, T. M., , Dumenci, L., Bilenberg, N., Bird, H., Rescorla, L. A., Almqvist, F., Broberg, A., Dobrean, A., Do¨pfner, M., Erol, N., Forns, M., Hannesdottir, H., Kanbayashi, Y., Lambert, M., Leung, P., Minaei, A., Mulatu, M., Novik, T., Ja Oh, K., Roussos, A., Sawyer, M., Simsek, Z., Steinhausen, H.-C., Weintraub, S., Metzke, C., Wolanczyk, T., Zilber, N., Zukauskiene, R., and Verhulst, F. (2007). The generalizability of the youth self-report syndrome structure in 23 societies. *Journal of Consulting and Clinical Psychology*, 75(5):729–738.

Ivanova, M. Y., Achenbach, T., Rescorla, L., Harder, V., Ang, R., Bilenberg, N., Bjarnadottir, G., Capron, C., De Pauw, S., Dias, P., Dobrean, A., Doepfner, M., Duyme, M., Eapen, V., Erol, N., Mohammad, E., Ezpeleta, L., Frigerio, A., Gonçalves, M., Gudmundsson, H., Jeng, S.-F., Jetishi, P., Jusiene, R., Kim, Y.-A., Kristensen, S., Lecannelier, F., Leung, P., Liu, J., Montirosso, R., Ja Oh, K., Plueck, J., Pomalima, R., Shahini, M., Silva, J., Simsek, Z., Sourander, A., Valverde, J., Van Leeuwen, K., Woo, B., Wu, Y.-T., and Zubrick, Stephen R.and Verhulst, F. C. (2010). Preschool psychopathology reported by parents in 23 societies: Testing the seven-syndrome model of the child behavior checklist for ages 1.5–5. *Journal of the american academy of child & adolescent psychiatry*, 49(12):1215–1224.

Judge, S. and Jahns, L. (2007). Association of overweight with academic performance and social and behavioral problems: an update from the early childhood longitudinal study. *Journal of School Health*, 77(10):672–678.

JUNAEB (2020). Mapa nutricional 2020. situación nutricional de los preescolares y escolares de establecimientos municipalizados y particulares subvencionados del país.

Kaestner, R. and Grossman, M. (2009). Effects of weight on children's educational achievement. *Economics of Education Review*, 28:651–661.

Katsuki, D., Yamashita, H., Yamane, K., Kanba, S., and Yoshida, K. (2020). Clinical subtypes in children with attention-defcit hyperactivity disorder according to their child behavior checklist profle. *Child Psychiatry & Human Development*, 51:969–977.

Kautz, T., Heckman, J. J., Diris, R., Ter Weel, B., and Borghans, L. (2014). Fostering and measuring skills: Improving cognitive and non-cognitive skills to promote lifetime success.

Khanam, R. and Nghiem, S. (2016). Family income and child cognitive and noncognitive development in australia: Does money matter? *Demography*, 53(3):597–621.

Kiviet, J. F. (2020). Testing the impossible: identifying exclusion restrictions. *Journal of Econometrics*, 218(2):294–316.

Kripfganz, S. and Kiviet, J. F. (2021). kinkyreg: Instrument-free inference for linear regression models with endogenous regressors. *The Stata Journal*, 21(3):772–813.

Lindeboom, M., Lundborg, P., and Van Der Klaauw, B. (2010). Assessing the impact of obesity on labor market outcomes. *Economics & Human Biology*, 8(3):309–319.

Lundborg, P., Nystedt, P., and Rooth, D.-O. (2014). Body size, skills, and income: Evidence from 150,000 teenage siblings. *Demography*, 51:1573–1596.

Murasko, J. E. (2015). Overweight/obesity and human capital formation from infancy to adolescence: evidence from two large us cohorts. *Journal of biosocial science*, 47(2):220–237.

Nevo, A. and Rosen, A. M. (2012). Identification with imperfect instruments. *The Review of Economics and Statistics*, 94(3):659–671.

Pagan, J. A. and Davila, A. (1997). Obesity, occupational attainment, and earnings. *Social Science Quarterly*, pages 756–770.

Palermo, T. M. and Dowd, J. B. (2012). Childhood obesity and human capital accumulation. *Social Science & Medicine*, 75(11):1989– 1998.

Patte, K. A., Livermore, M., Qian, W., and Leatherdale, S. T. (2021). Do weight perception and bullying victimization account for links between weight status and mental health among adolescents? *BMC public health*, 21(1):1–16.

Polemis, M. (2020). Personality traits as an engine of knowledge: a quantile regression analysis. *Journal of Economic Studies*.

Ravussin, E. and Bogardus, C. (2000). Energy balance and weight regulation: genetics versus environment. *British Journal of Nutrition*, 83(S1):S17–S20.

Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L., and Kelnar, C. J. (2003). Health consequences of obesity. *Archives of disease in childhood*, 88(9):748–752.

Reynolds, S., Fernald, L., Deardorff, J., and Behrman, J. (2018). Family structure and child development in chile: A longitudinal analysis of household transitions involving fathers and grandparents. *Demographic research*, 38(58):1777–1814.

Rishel, C., Greeno, C., Marcus, S., Shear, K., and Anderson, C. (2005). Use of the child behavior checklist as a diagnostic screening tool in community mental health. *Research on Social Work Practice*, 15(3):195–203.

Robinovich, J., Ossa, X., Baeza, B., Krumeich, A., and van der Borne, B. (2018). Embodiment of social roles and thinness as a form of capital: A qualitative approach towards understanding female obesity disparities in chile. *Social Science & Medicine*, 201:80–86.

Rouse, K. and Hunziker, B. (2020). Child bodyweight and human capital: Test scores, teacher assessments and noncognitive skills. *Economics of Education Review*, 79:102042.

Sabia, J. J. (2007). The effect of body weight on adolescent academic performance. *Southern Economic Journal*, pages 871–900.

Sabia, J. J. and Rees, D. I. (2015). Body weight, mental health capital, and academic achievement. *Review of Economics of the Household*, 13(1):653–684.

Sarrias, M. (2021). A two recursive equation model to correct for endogeneity in latent class binary probit models. *Journal of Choice Modelling*, page 100301.

Sarrias, M. and Iturra, V. (2022). The double burden of being a woman and obese: Evidence from the chilean labor market. *Feminist Economics*, 28(1):199–231.

Scholder, S. v. H. K., Smith, G. D., Lawlor, D. A., Propper, C., and Windmeijer, F. (2012). The effect of fat mass on educational attainment: examining the sensitivity to different identification strategies. *Economics & Human Biology*, 10(4):405–418.

Segal, A. B., Huerta, M. C., Aurino, E., and Sassi, F. (2021). The impact of childhood obesity on human capital in high-income countries: A systematic review. *Obesity Reviews*, 22(1):e13104.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., and Byers, T. (1993). Do obese children become obese adults? a review of the literature. *Preventive medicine*, 22(2):167–177.

Shi, H. and Li, C. (2018). Does weight status affect academic performance? evidence from australian children. *Applied Economics*, 50(29):3156–3170.

Sprovera, M. A. E., Gonzáles, E. A., Grancelli, F. B., and Paredes, M. H. (2017). Gordura, discriminación y clasismo: un estudio en jóvenes de santiago de chile. *Psicologia & Sociedade*, 29.

Staiger, D. and Stock, J. H. (1997). Instrumental variables regression with weak instruments. *Econometrica: journal of the Econometric Society*, pages 557–586.

Stock, J. H., Wright, J. H., and Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics*, 20(4):518–529.

Strauss, R. (2000). Childhood obesity and self-esteem. *Pediatrics*, 105(1):1–5.

Stunkard, A. J., Foch, T. T., and Hrubec, Z. (1986). A twin study of human obesity. *Jama*, 256(1):51–54.

Stunkard, A. J., S. T. I. A. H. C. T. T. W. C. R. S. W. J. (1986). An adoption study of human obesity. *New England Journal of Medicine*, 314(4):193–196.

Thompson, I., Hong, J. S., Lee, J. M., Prys, N. A., Morgan, J. T., and Udo-Inyang, I. (2020). A review of the empirical research on weight-based bullying and peer victimisation published between 2006 and 2016. *Educational Review*, 72(1):88–110.

Ugarte, E., Narea, M., Aldoney, D., Weissman, D. G., and Hastings, P. D. (2021). Family risk and externalizing problems in chilean children: mediation by harsh parenting and emotional support. *Child Development*, 92(3):871–888.

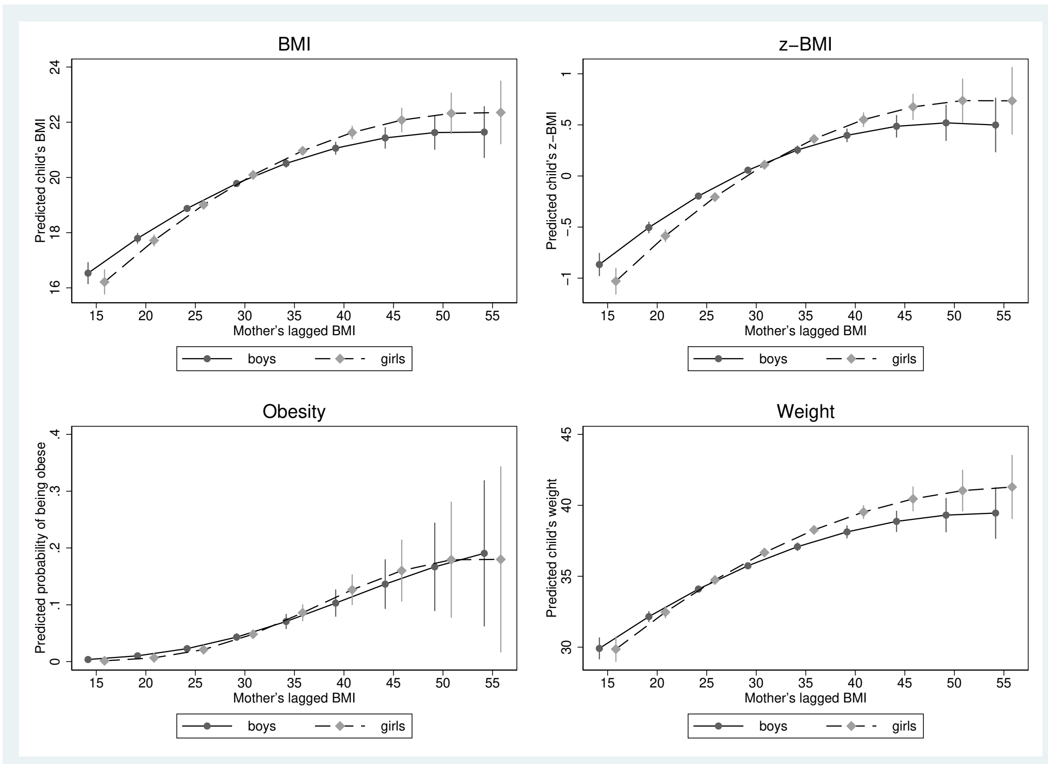
Vio, F., Albala, C., and Kain, J. (2008). Nutrition transition in chile revisited: mid-term evaluation of obesity goals for the period 2000–2010. *Public health nutrition*, 11(4):405–412.

Vollmer, R. L. and Mobley, A. R. (2013). Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. a review. *Appetite*, 71:232–241.

WHO (2020). Obesity and overweight. data and numbers.

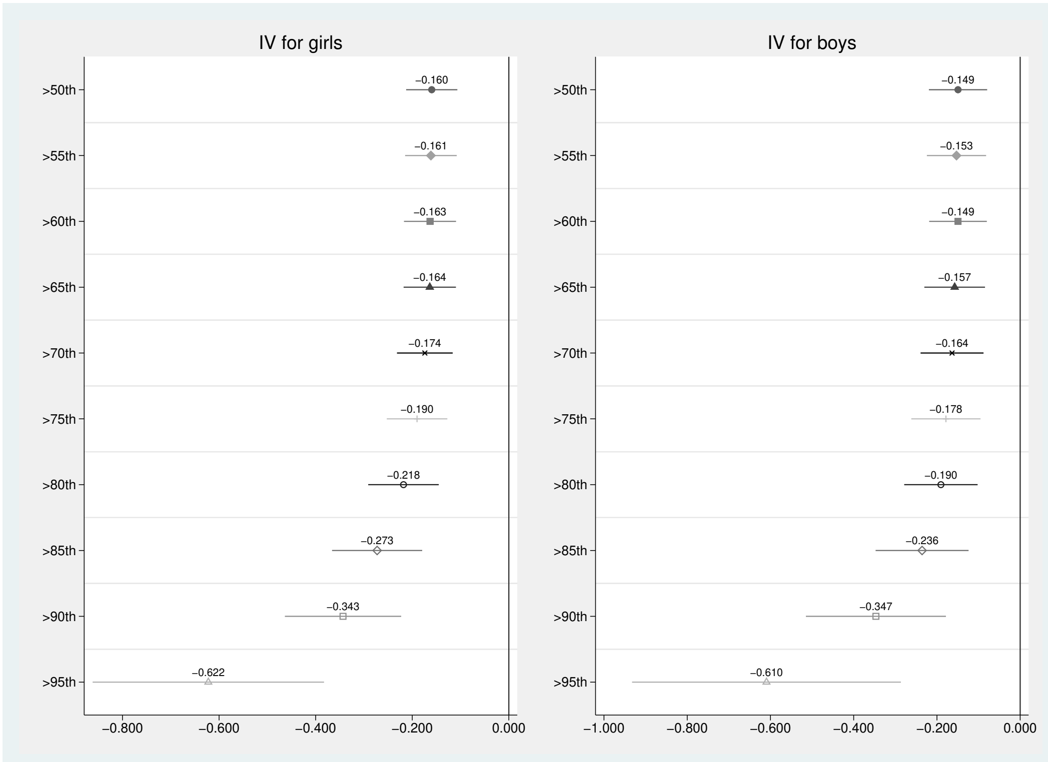
Figures

Figure 1: Predicted relationship between children's bodyweight and lagged mother's BMI: Estimates with 95% CI



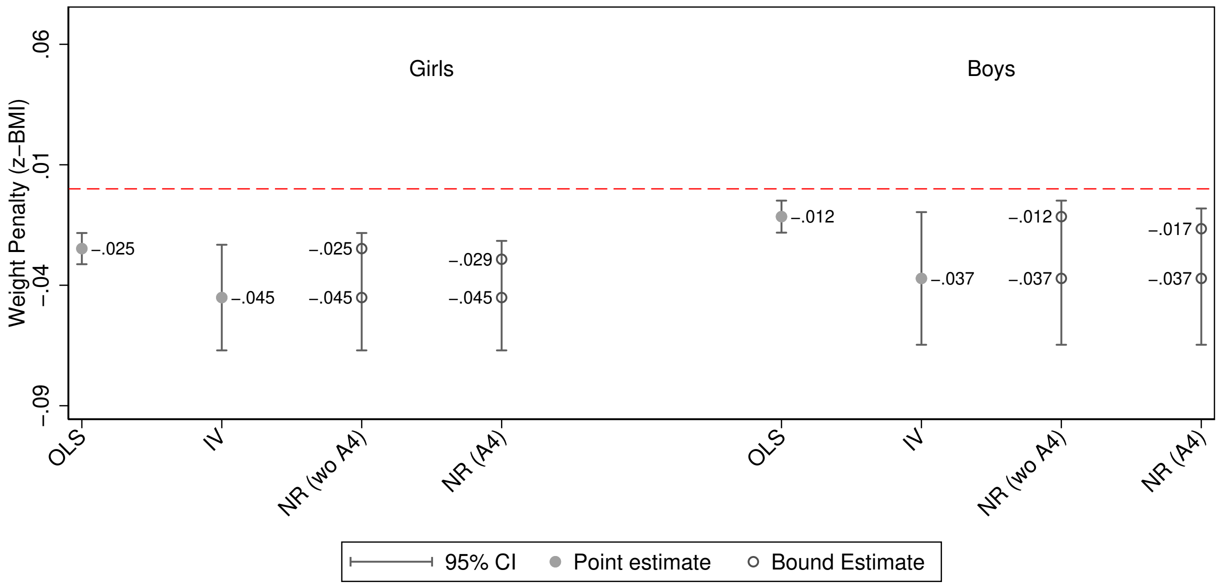
Notes: Each graph shows the conditional predicted values of BMI, z-BMI, weight (controlling for height) and obesity of children for each value of lagged mother's BMI. The predicted values for obesity are obtained using a conditional Probit model. We use quadratic specifications and control for the same controls as in Table 2.

Figure 2: Socioemotional development and obesity based on the relative position on sex-age-weight distribution: IV estimates with 95% CI



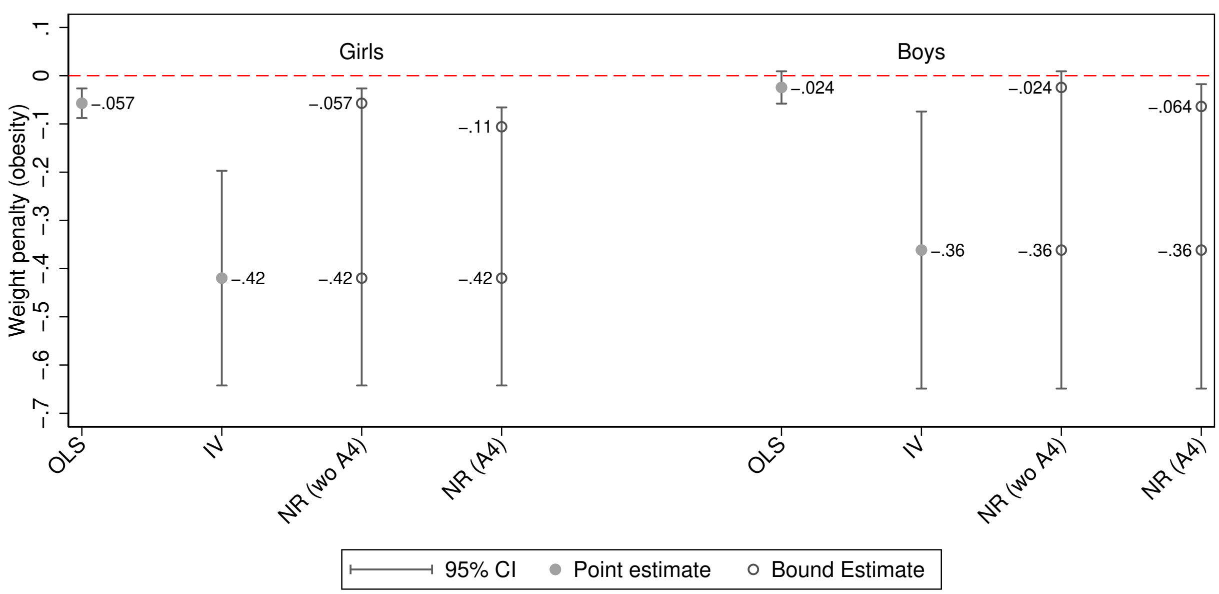
Notes: Each point estimate corresponds to the IV coefficient of being obese on a regression between $-1 \times \ln(\text{CBCL})$ and the same controls use in Table 2. Standard errors were clustered at the child level. A child is considered obese if her BMI is equal to or above the τth percentile of age-gender-BMI distribution. The x-axis shows the estimate for $\tau \in (0.5, 0.95)$

Figure 3: Bound estimates for z-BMI: 95% CI



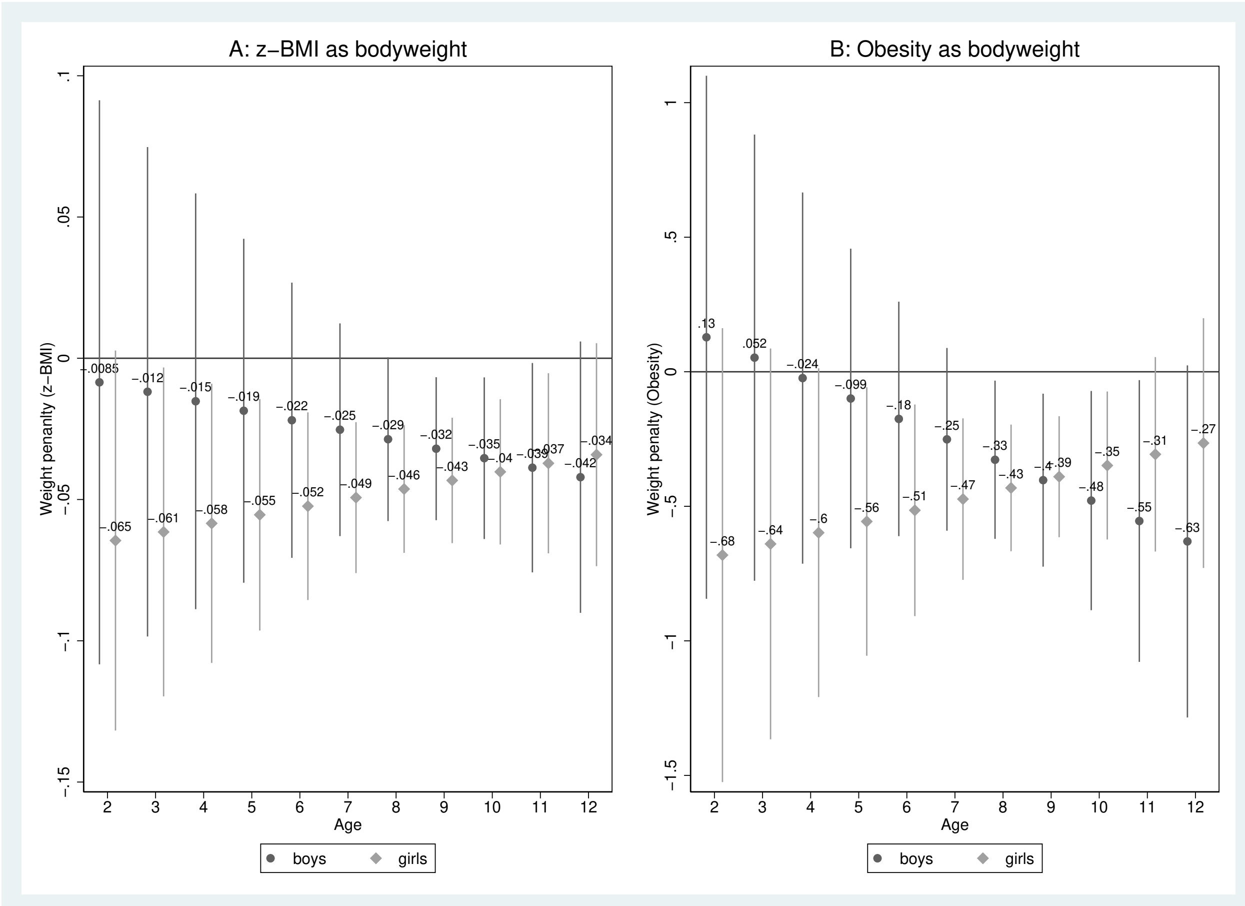
Notes: The dependent variable is $-1 \times \ln(\text{CBCL})$. OLS and IV estimates include all controls as in Table 4. The hollowed circles represent the Nevo and Rosen (2012)'s upper and lower bounds and do not have a corresponding point estimate. Confidence intervals on Nevo and Rosen bound are estimated following the Chernozhukov et al. (2013) implemented in **imperfectiv** command in Stata (Clarke and Matta, 2017).

Figure 4: Bound estimates for obesity: 95% CI



Notes: The dependent variable is $-1 \times \ln(\text{CBCL})$. OLS and IV estimates include all controls as in Table 4. The hollowed circles represent the Nevo and Rosen (2012)'s upper and lower bounds and do not have a corresponding point estimate. Confidence intervals on Nevo and Rosen bound are estimated following the Chernozhukov et al. (2013) implemented in **imperfectiv** command in Stata (Clarke and Matta, 2017).

Figure 5: Weight penalty by gender and age: 95% CI



Notes: The dependent variable is $-1 \times \ln(\text{CBCL})$. OLS and IV estimates include the same controls use in Table 4. The IV estimates use the mother's lagged z-BMI and its interaction with child's age as instruments.

Tables

Table 1: Summary statistics

	Girls			Boys		
	Mean	SD	N	Mean	SD	N
Children covariates:						
CBCL-test score	51.47	10.90	5407	52.29	10.75	5484
Weight	36.07	13.81	5407	35.62	13.12	5484
Height	132.67	17.13	5407	132.54	16.24	5484
Child's BMI	19.70	3.93	5407	19.57	3.86	5484
Child's z-BMI	-0.01	1.01	5407	-0.01	0.98	5484
Obese	0.05	0.22	5407	0.05	0.21	5484
Child's age in months	105.68	30.68	5407	106.07	30.28	5484
Number of older siblings	0.76	0.88	5407	0.75	0.87	5484
Number of younger siblings	0.42	0.62	5407	0.44	0.64	5484
Household size	4.64	1.56	5407	4.58	1.50	5484
Mother's covariates:						
Age (in years)	35.35	7.51	5407	35.38	7.51	5484
Household head	0.36	0.48	5407	0.37	0.48	5484
Married	0.38	0.49	5407	0.39	0.49	5484
Cohabitating	0.29	0.45	5407	0.30	0.46	5484
Separated/divorce	0.07	0.26	5407	0.08	0.27	5484
Single	0.25	0.43	5407	0.23	0.42	5484
Widowed	0.01	0.09	5407	0.01	0.07	5484
Mother's BMI in previous period	27.97	5.38	5407	27.93	5.74	5484
N	10891					

Notes: Sample use in regressions. See Section 2 for an explanation of the variables.

Table 2: Benchmark results for the relationship between socioemotional development and bodyweight

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Unconditional OLS						
z-BMI	-0.028***			-0.013***		
	(0.003)			(0.003)		
Obese		-0.073***			-0.032*	
		(0.016)			(0.017)	
Weight			-0.004***			-0.002***
			(0.000)			(0.000)
Height			0.002***			0.002***
			(0.000)			(0.000)
N	5,038	5,038	5,038	4,991	4,991	4,991
Panel B: OLS + Controls						
z-BMI	-0.028***			-0.013***		
	(0.003)			(0.003)		
Obese		-0.072***			-0.034**	
		(0.016)			(0.017)	
Weight			-0.004***			-0.002***
			(0.000)			(0.000)
Height			0.001**			0.000
			(0.001)			(0.001)
N	5,038	5,038	5,038	4,991	4,991	4,991
Panel C: IV						
z-BMI	-0.067***			-0.064***		
	(0.011)			(0.015)		
Obese		-0.622***			-0.610***	
		(0.122)			(0.165)	
Weight			-0.010***			-0.009***
			(0.002)			(0.002)
Height			0.006***			0.005***
			(0.001)			(0.002)
F first-stage	324.090	67.302	311.190	209.972	46.226	195.340
N	5,038	5,038	5,038	4,991	4,991	4,991

Notes: The dependent variable is $-1 \times \ln(CBCL)$. Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI survey. Panel B and C includes the following controls: child's age in months (linear and squared), number of older siblings, number of younger siblings, region dummies, a dummy for second wave, household size, mother's age, a dummy that takes the value of one if the mother is the head of the household and marital status. Mother's BMI in the previous wave is the instrument for child's bodyweight in Panel C. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Pooled IV-estimates with gender interactions

	(1)	(2)	(3)
z-BMI	-0.067^{***}		
	(0.011)		
z-BMI× boy	0.002		
	(0.019)		
Obese		-0.631^{***}	
		(0.124)	
Obese× boy		0.028	
		(0.205)	
Weight			-0.010^{***}
			(0.001)
Weight× boy			0.001
			(0.002)
N	10,029	10,029	10,029
F-stat	104.845	23.041	149.541

Notes: The dependent variable is $-1 \times \ln(CBCL)$. *Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI survey. All specifications use the same controls as in Table 2. We used the lagged mother's BMI and its interaction with child's gender as instruments.* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Sensitivity analysis to additional controls: IV-estimates

	Girls					Boys				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: z-BMI										
z-BMI	-0.068***	-0.056***	-0.067***	-0.054***	-0.045***	-0.065***	-0.049***	-0.066***	-0.047***	-0.037***
	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)
Actual depression		-0.104***			-0.100***		-0.108***			-0.103***
		(0.007)			(0.007)		(0.007)			(0.007)
Post-partum depression		-0.027***			-0.026***		0.005			0.005
		(0.010)			(0.010)		(0.010)			(0.010)
Smoked during pregnancy			-0.023*		-0.010			-0.032***		-0.022**
			(0.012)		(0.012)			(0.011)		(0.011)
Drunk during pregnancy			-0.034***		-0.030**			-0.011		-0.012
			(0.013)		(0.012)			(0.013)		(0.012)
Used drugs during pregnancy			-0.013		-0.014			-0.028		-0.022
			(0.030)		(0.030)			(0.033)		(0.032)
ln(household income)				0.003	0.002				-0.000	-0.000
				(0.002)	(0.002)				(0.002)	(0.002)
Mother's education				0.007***	0.006***				0.008***	0.006***
				(0.001)	(0.001)				(0.001)	(0.001)
F first-stage	307.927	304.473	306.039	293.607	290.159	202.590	201.076	202.015	198.137	197.350
% Reduction in bodyweight coefficient		18	1	20	33		24	-2	27	42
N	4,701	4,701	4,701	4,701	4,701	4,690	4,690	4,690	4,690	4,690
Panel B: Obesity										
Obesity	-0.622***	-0.510***	-0.622***	-0.507***	-0.420***	-0.613***	-0.462***	-0.620***	-0.465***	-0.362**
	(0.124)	(0.115)	(0.125)	(0.121)	(0.114)	(0.166)	(0.148)	(0.167)	(0.161)	(0.147)
Actual depression		-0.106***			-0.102***		-0.110***			-0.105***
		(0.008)			(0.008)		(0.007)			(0.007)
Post-partum depression		-0.027**			-0.027**		0.004			0.003
		(0.011)			(0.010)		(0.010)			(0.010)
Smoked during pregnancy			-0.012		-0.003			-0.029**		-0.021*
			(0.014)		(0.013)			(0.012)		(0.011)
Drunk during pregnancy			-0.045***		-0.037***			-0.013		-0.014
			(0.014)		(0.013)			(0.014)		(0.013)
Used drugs during pregnancy			0.010		0.002			-0.003		-0.008
			(0.038)		(0.033)			(0.041)		(0.036)
ln(household income)				0.002	0.001				-0.002	-0.002
				(0.002)	(0.002)				(0.002)	(0.002)
Mother's education				0.007***	0.006***				0.007***	0.006***
				(0.001)	(0.001)				(0.001)	(0.001)
F first-stage	64.591	64.570	63.599	62.268	61.791	45.352	45.231	45.481	41.849	42.271
% Reduction in bodyweight coefficient		18	0	18	33		25	-1	24	41
N	4,701	4,701	4,701	4,701	4,701	4,690	4,690	4,690	4,690	4,690

Notes: The dependent variable is $-1 \times \ln(CBCL)$*. Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI. All specifications include the same controls as in Table 2. The lagged mother's BMI is the instrument for child's bodyweight.* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

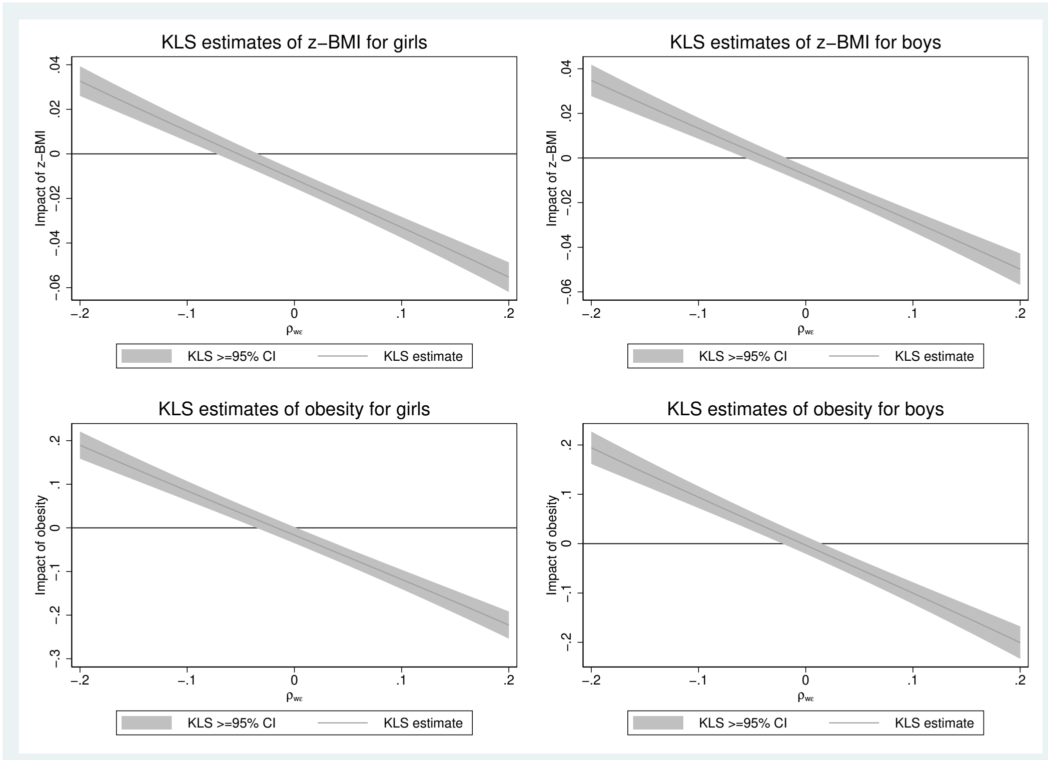
Table 5: Potential mechanisms: IV estimates

	Girls					Boys				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: z-BMI as bodyweight measure										
Weight penalty	-0.032***	-0.031***	-0.030***	-0.031***	-0.028**	-0.034***	-0.029**	-0.033***	-0.032***	-0.027**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Bullying		-0.007***			-0.007***		-0.006***			-0.005***
		(0.001)			(0.001)		(0.001)			(0.001)
Bad health			-0.039***		-0.035***			-0.030***		-0.030***
			(0.009)		(0.009)			(0.009)		(0.009)
BI satisfaction				0.019***	0.009*				0.022***	0.016***
				(0.005)	(0.005)				(0.005)	(0.005)
F first-stage	284.127	283.660	280.492	282.143	279.073	214.571	212.971	211.360	210.468	206.310
% Reduction in bodyweight coefficient		4	6	4	12		16	3	8	23
N	3,730	3,730	3,730	3,730	3,730	3,766	3,766	3,766	3,766	3,766
Panel B: Obesity as bodyweight measure										
Weight penalty	-0.258***	-0.247***	-0.242**	-0.247***	-0.228**	-0.283***	-0.243**	-0.275***	-0.265**	-0.224**
	(0.095)	(0.094)	(0.095)	(0.095)	(0.094)	(0.102)	(0.102)	(0.102)	(0.104)	(0.103)
Bullying		-0.007***			-0.006***		-0.006***			-0.005***
		(0.001)			(0.001)		(0.001)			(0.001)
Bad health			-0.038***		-0.035***			-0.030***		-0.030***
			(0.010)		(0.009)			(0.010)		(0.009)
BI satisfaction				0.019***	0.009*				0.018***	0.013**
				(0.005)	(0.005)				(0.005)	(0.005)
F first-stage	66.199	66.242	65.603	65.646	65.179	51.634	50.259	50.996	49.990	48.539
% Reduction in bodyweight coefficient		4	6	4	11		14	3	7	21
N	3,730	3,730	3,730	3,730	3,730	3,766	3,766	3,766	3,766	3,766

Notes: Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI. All specifications include the same controls as in Table 4. The lagged mother's BMI is the instrument for child's bodyweight. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

A Appendix: Additional figures and tables

Figure A.1: Kinky least squared estimates: 95% CI



Notes: The KLS approach corrects the bias of the OLS estimator analytically assuming the degree of endogeneity: $\rho_{w,\epsilon}$. The asymptotically conservative CIs are obtained as the union of the CIs over the considered grid. The estimates are obtained using **kinkyreg** command in Stata Kripfganz and Kiviet (2021).

Table A.1: Summary statistics: Full sample without missing values

	Girls			Boys		
	Mean	SD	N	Mean	SD	N
Children covariates:						
CBCL-test score	53.02	11.42	14179	53.95	11.44	14345
Weight	31.56	13.55	14946	30.55	13.02	15195
Height	123.92	22.42	14946	134.37	21.82	15195
Child's BMI	18.37	3.27	14946	18.36	3.24	15195
Obese	0.05	0.22	14946	0.05	0.21	15195
Child's age in months	90.55	38.98	14946	91.68	39.26	15195
Number of older siblings	0.79	0.92	14946	0.77	0.89	15195
Number of younger siblings	0.29	0.53	14946	0.30	0.55	15195
Household size	4.71	1.60	14946	4.68	1.59	15195
Mother's covariates:						
Age (in years)	32.74	7.60	14946	32.62	7.64	15195
Household head	0.27	0.45	14946	0.28	0.45	15195
Married	0.37	0.48	14946	0.37	0.48	15195
Cohabitating	0.31	0.46	14946	0.32	0.47	15195
Separated/divorce	0.06	0.23	14946	0.06	0.24	15195
Single	0.26	0.44	14946	0.25	0.43	15195
Widowed	0.01	0.08	14946	0.00	0.06	15195
N	30141					

Table A.2: Benchmark results with full list of controls

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Conditional OLS						
z-BMI	-0.028***			-0.013***		
	(0.003)			(0.003)		
Obese		-0.072***			-0.034**	
		(0.016)			(0.017)	
Weight			-0.004***			-0.002***
			(0.000)			(0.000)
Height			0.001**			0.000
			(0.001)			(0.001)
Child's age (months)	-0.000	-0.000	-0.001	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Child's age squared	0.000	0.000	0.000*	-0.000**	-0.000**	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of older siblings	0.002	0.002	0.002	0.001	0.002	0.000
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of younger siblings	0.000	0.002	-0.000	-0.015***	-0.015**	-0.016***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Household size	-0.008***	-0.008***	-0.008***	-0.001	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Mother is HH	-0.007	-0.007	-0.007	-0.010	-0.010	-0.010
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)
Mother cohabitating	-0.023***	-0.024***	-0.023***	-0.021***	-0.021***	-0.020***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Mother separated/divorce	-0.023*	-0.024*	-0.023*	-0.040***	-0.039***	-0.040***
	(0.014)	(0.014)	(0.014)	(0.013)	(0.013)	(0.013)
Mother single	-0.031***	-0.031***	-0.031***	-0.028***	-0.028***	-0.029***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Mother widowed	0.009	0.010	0.008	-0.024	-0.027	-0.023
	(0.034)	(0.035)	(0.034)	(0.035)	(0.035)	(0.035)
Mother's age (years)	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Year 2017	0.088***	0.085***	0.086***	0.038**	0.037**	0.037**
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
N	5,038	5,038	5,038	4,991	4,991	4,991
Panel B: IV						
z-BMI	-0.067***			-0.064***		
	(0.011)			(0.015)		
Obese		-0.622***			-0.610***	
		(0.122)			(0.165)	
Weight			-0.010***			-0.009***
			(0.002)			(0.002)
Height			0.006***			0.005***
			(0.001)			(0.002)
Child's age (months)	-0.000	-0.000	-0.003***	0.003***	0.002*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Child's age squared	0.000	-0.000	0.000***	-0.000**	-0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of older siblings	0.001	-0.000	0.001	-0.002	0.000	-0.001
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Number of younger siblings	-0.002	-0.002	-0.004	-0.019***	-0.018***	-0.019***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Household size	-0.007***	-0.007**	-0.007***	-0.001	0.000	-0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)

Mother is HH	-0.008	-0.006	-0.007	-0.010	-0.012	-0.010
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
Mother cohabitating	-0.024***	-0.029***	-0.024***	-0.020**	-0.026***	-0.019**
	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)	(0.008)
Mother separated/divorce	-0.022	-0.021	-0.022	-0.043***	-0.038***	-0.043***
	(0.014)	(0.015)	(0.014)	(0.013)	(0.014)	(0.013)
Mother single	-0.032***	-0.034***	-0.032***	-0.033***	-0.041***	-0.033***
	(0.009)	(0.010)	(0.009)	(0.009)	(0.011)	(0.009)
Mother widowed	0.010	0.025	0.009	-0.019	-0.055	-0.016
	(0.033)	(0.039)	(0.032)	(0.035)	(0.036)	(0.036)
Mother's age (years)	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Year 2017	0.097***	0.106***	0.092***	0.052***	0.084***	0.046***
	(0.018)	(0.020)	(0.017)	(0.018)	(0.023)	(0.017)
Region FE	Yes	Yes	Yes	Yes	Yes	Yes
F first-stage	324.090	67.302	311.190	209.972	46.226	195.340
N	5,038	5,038	5,038	4,991	4,991	4,991

Notes: The dependent variable is $-1 \times \ln(CBCL)$*. Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI survey. Mother's BMI in the previous wave is the instrument for child's bodyweight in Panel B. HH stands for household head. The omitted categories for year and mother's civil status are 2012-year and married, respectively. The region FE include 14 dummy variables.* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: First-stage regressions

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
	z-BMI	Obese	Weight	z-BMI	Obese	Weight
Mother's BMI in previous wave	0.055***	0.006***	0.345***	0.043***	0.005***	0.287***
	(0.003)	(0.001)	(0.020)	(0.003)	(0.001)	(0.021)
Child's age (months)	−0.007*	−0.000	−0.395***	−0.005	−0.002**	−0.312***
	(0.004)	(0.001)	(0.021)	(0.003)	(0.001)	(0.021)
Child's age squared	0.000	−0.000	0.002***	0.000	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of older siblings	−0.055***	−0.007*	−0.291**	−0.071***	−0.004	−0.318**
	(0.021)	(0.004)	(0.134)	(0.020)	(0.004)	(0.133)
Number of younger siblings	−0.057**	−0.005	−0.469***	−0.080***	−0.007	−0.523***
	(0.026)	(0.005)	(0.179)	(0.025)	(0.005)	(0.169)
Household size	−0.003	−0.000	0.029	−0.000	0.002	−0.031
	(0.011)	(0.002)	(0.071)	(0.012)	(0.002)	(0.075)
Mother is HH	−0.014	0.001	0.035	0.013	−0.001	0.064
	(0.033)	(0.007)	(0.225)	(0.032)	(0.007)	(0.223)
Mother cohabitating	−0.019	−0.010	−0.101	0.008	−0.010	0.212
	(0.034)	(0.007)	(0.226)	(0.034)	(0.007)	(0.220)
Mother separated/divorce	0.026	0.005	0.167	−0.068	0.001	−0.495
	(0.057)	(0.012)	(0.410)	(0.057)	(0.012)	(0.413)
Mother single	−0.002	−0.004	−0.050	−0.085**	−0.022***	−0.476*
	(0.041)	(0.009)	(0.267)	(0.038)	(0.008)	(0.255)
Mother widowed	0.089	0.033	0.465	0.063	−0.053***	0.877
	(0.141)	(0.037)	(1.022)	(0.151)	(0.009)	(1.135)
Mother's age (years)	−0.004	−0.001	−0.034**	−0.004	−0.000	−0.038**
	(0.002)	(0.000)	(0.016)	(0.002)	(0.000)	(0.016)
Year 2017	0.217***	0.038**	0.998***	0.287***	0.082***	1.338***
	(0.076)	(0.016)	(0.341)	(0.073)	(0.015)	(0.336)
Height			0.745***			0.685***
			(0.018)			(0.017)
Region FE	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
N	5,038	5,038	5,038	4,991	4,991	4,991

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: OLS and IV-point estimates for the weight-penalty (in 2012) on socioemotional development (in 2017)

	Girls				Boys			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
z-BMI_{2012}	-0.010*	-0.056**			-0.020	-0.064***		
	(0.005)	(0.027)			(0.012)	(0.024)		
$Obese_{2012}$			-0.036	-0.851*			-0.059	-1.087
			(0.031)	(0.470)			(0.062)	(0.720)
F first-stage		306.456		3.362		24.538		2.493
N	740	740	740	740	716	716	716	716

Notes: All specifications use the same controls as in Table 2. The dependent variable is $-1 \times \ln(CBCL)$ *in 2017, whereas the instrument in all IV specifications is mothers' BMI in 2010.* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Sensitivity analysis to additional controls: IV-estimates for weight

	Girls					Boys				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Weight	-0.010***	-0.008***	-0.010***	-0.008***	-0.007***	-0.009***	-0.007***	-0.009***	-0.007***	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Height	0.006***	0.004***	0.006***	0.004***	0.003**	0.005***	0.004**	0.005***	0.003**	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Actual depression		-0.103***			-0.099***		-0.108***			-0.103***
		(0.007)			(0.007)		(0.007)			(0.007)
Post-partum depression		-0.028***			-0.027***		0.005			0.005
		(0.010)			(0.010)		(0.010)			(0.010)
Smoked during pregnancy			-0.021*		-0.010			-0.030***		-0.021**
			(0.012)		(0.012)			(0.011)		(0.011)
Drunk during pregnancy			-0.035***		-0.031**			-0.011		-0.012
			(0.013)		(0.012)			(0.013)		(0.012)
Used drugs during pregnancy			-0.021		-0.019			-0.027		-0.021
			(0.030)		(0.030)			(0.033)		(0.031)
ln(household income)				0.002	0.001				-0.000	-0.000
				(0.002)	(0.002)				(0.002)	(0.002)
Mother's education				0.007***	0.006***				0.008***	0.006***
				(0.001)	(0.001)				(0.001)	(0.001)
F first-stage	300.385	294.691	298.291	283.067	278.310	189.046	186.806	188.533	180.617	179.527
% Reduction in bodyweight coefficient		19	1	20	35		25	-2	28	45
N	4,701	4,701	4,701	4,701	4,701	4,690	4,690	4,690	4,690	4,690

Notes: The dependent variable is $-1 \times \ln(CBCL)$. Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI. All specifications include the same controls as in Table 2. The mother's lagged BMI is the instrument for child's bodyweight. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Relationship between children's weight with the main caregiver's weight

	(1) BMI of the child	(2) Weight of the child
BMI of main caregiver	0.0302	0.0262
	(0.0195)	(0.0210)
Child's height		0.3300***
		(0.0339)
N	373	373

Notes: This table shows the OLS estimates of the non-biological mother's weight (BMI of main caregiver) on the bodyweight of an unrelated child (BMI and weight). All specifications use the same controls as in Table 4. Robust standard errors in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Sensitivity analysis for different specification of the instrument

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Contemporaneous mother's BMI as IV						
z-BMI	-0.047***			-0.044***		
	(0.008)			(0.011)		
Obese		-0.442***			-0.378***	
		(0.082)			(0.101)	
Weight			-0.009***			-0.008***
			(0.002)			(0.002)
Height			0.005***			0.004***
			(0.001)			(0.001)
F first-stage	570.252	113.712	523.418	313.558	82.433	295.540
N	11,136	11,136	11,136	11,332	11,332	11,332
Panel B: Contemporaneous mother obesity status as IV						
z-BMI	-0.049***			-0.057***		
	(0.010)			(0.014)		
Obese		-0.460***			-0.466***	
		(0.102)			(0.121)	
Weight			-0.009***			-0.011***
			(0.002)			(0.003)
Height			0.005***			0.006***
			(0.001)			(0.002)
F first-stage	397.358	95.079	388.633	208.859	66.819	203.704
N	11,136	11,136	11,136	11,332	11,332	11,332
Panel C: Contemporaneous mother's BMI (linear and squared) as IVs						
z-BMI	-0.046***			-0.044***		
	(0.008)			(0.010)		
Obese		-0.442***			-0.358***	
		(0.082)			(0.106)	
Weight			-0.009***			-0.008***
			(0.002)			(0.002)
Height			0.005***			0.004***
			(0.001)			(0.001)
F first-stage	311.860	100.500	430.855	193.058	68.585	191.469
N	11,136	11,136	11,136	11,332	11,332	11,332
Panel D: Lagged mother obesity status as IV						
z-BMI	-0.049***			-0.033*		
	(0.014)			(0.018)		
Obese		-0.468***			-0.367*	
		(0.148)			(0.214)	
Weight			-0.007***			-0.005
			(0.002)			(0.003)
Height			0.003*			0.002
			(0.002)			(0.002)
F first-stage	210.772	45.504	186.367	130.474	23.378	124.974
N	4,701	4,701	4,701	4,690	4,690	4,690

*Notes: The dependent variable is $-1 \times \ln(CBCL)$. The sample for the models in panels A, B and C corresponds to the first (2010), second (2012) and third wave (2017) of the ELPI. The sample of the models in panel D is reduced since we used the lagged maternal obesity status as instrument. All specifications include the same controls as in Table 4. The mother is considered as obese if her BMI ≥ 30. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table A.8: Child fixed-effects estimates

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Child FE						
z-BMI	-0.024***			-0.016***		
	(0.004)			(0.004)		
Obese		-0.024			-0.035**	
		(0.016)			(0.017)	
Weight			-0.004***			-0.003***
			(0.001)			(0.001)
Height			-0.001*			0.000
			(0.001)			(0.001)
NT	11,136	11,136	11,136	11,332	11,332	11,332
Panel B: IV Child FE						
z-BMI	-0.144***			-0.010		
	(0.044)			(0.082)		
Obese		-2.717			-8.151	
		(2.102)			(501.092)	
Weight			-0.027***			-0.006
			(0.009)			(0.042)
Height			0.013**			0.002
			(0.006)			(0.027)
F first-stage	44.6974	1.0766	22.8924	14.7154	0.7343	1.7896
NT	11,136	11,136	11,136	11,332	11,332	11,332

Notes: The dependent variable is $-1 \times \ln(CBCL)$. Robust standard errors in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI. All specifications include the same controls as in Table 4. The mother's lagged BMI is the instrument for child's bodyweight. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: Internalization and externalization factors: IV estimates

	Girls			Boys		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Internalizing Factors						
z-BMI	-0.029***			-0.016		
	(0.010)			(0.013)		
Obese		-0.232***			-0.124	
		(0.082)			(0.098)	
Weight			-0.004***			-0.002
			(0.002)			(0.002)
Height			0.002			0.000
			(0.001)			(0.002)
F first-stage	331.849	82.850	292.809	57.756	40.363	55.357
N	5,033	5,033	5,033	5,145	5,145	5,145
Panel B: Externalizing Factors						
z-BMI	-0.035***			-0.030**		
	(0.009)			(0.014)		
Obese		-0.281***			-0.231**	
		(0.079)			(0.104)	
Weight			-0.005***			-0.004**
			(0.001)			(0.002)
Height			0.003**			0.002
			(0.001)			(0.002)
F first-stage	331.849	82.850	292.809	57.756	40.363	55.357
N	5,033	5,033	5,033	5,145	5,145	5,145

Notes: Clustered standard errors at the child level in parenthesis. The sample corresponds to the second (2012) and third wave (2017) of the ELPI. All specifications include the same controls as in Table 4. The mother's lagged BMI is the instrument for *child's bodyweight.* * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B Appendix: School bullying victimization variable

The question used by Social and School Climate Scale test are the following.

"Next, you must read a series of questions about yourself at school. In front of each one of them you must select the answer on the Tablet that represents what you think about what is being asked (Answers: never, rarely, almost always, never)"

- My classmates make fun of me, they give me nicknames.
- I feel alone in my class.
- I have a good time with my classmates.
- My classmates are very aggressive.
- My classmates fight a lot.
- My classmates like to make other suffer.
- I have a hard time in the classroom.
- My classmates like to give nicknames.