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SOCIAL COMPARISONS AND ADOLESCENT BODY MISPERCEPTION: EVIDENCE FROM SCHOOL ENTRY CUTOFFS

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ABSTRACT

We provide novel evidence on the role of social comparisons in shaping adolescent body misperception. Using an instrumental variables approach leveraging variation in relative age generated by school entry cutoff months and data from the Health Behaviour in School-Aged Children study, we show that relatively older students are more likely to misperceive their weight harshly relative to their BMIs compared to their same-age counterparts who are relatively younger within their classrooms. Meanwhile, relatively younger students are more likely to misperceive their weight leniently relative to their BMIs. We then show that relatively older students are less likely to be overweight or obese, consume more low-calorie foods, and report higher levels of physical activity. Overall, our results suggest that relatively older students base their weight-related expectations and behaviors on their younger peers, while relatively younger students compare themselves to their older peers.

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1. Introduction

Over the last two decades, the share of adolescents suffering from anxiety or experiencing a major depressive episode doubled (Goodwin et al. 2020; Daly 2022), Notably, this mental health crisis has occurred alongside a dramatic increase in the amount of time that adolescents spend engaging with social media, leading both policymakers and public health advocates to speculate that social media may be facilitating negative social comparisons. Indeed, in his 2023 State of the Union speech, President Biden called on Congress to hold social media companies accountable for their role in undermining adolescent mental health (White House 2023), and a heterogeneous group of states has proposed legislation aimed at limiting adolescents' access to social media.[1] In particular, researchers hypothesize that social media-driven social comparisons may be adversely affecting adolescents' body image by leading them to perceive themselves as heavier than indicated by their BMIs (Rounsefell et al. 2020; Thai et al. 2023; Jarman et al. 2023), and the US Surgeon General recently called for warning labels on social platforms, in part, because "nearly half of adolescents say social media makes them feel worse about their bodies" (Murthy 2024). Despite these concerns, the targeted nature of social media algorithms and potential self-selection on behalf of users makes it difficult to support strong causal claims.

We provide novel evidence on the relationship between social comparisons and adolescent body misperception by leveraging quasi-random variation in students' relative ages within a classroom generated by school entry cutoff months. Key to our analysis is the idea that students born during the school entry cutoff month are expected to be almost

[1] Arkansas (SB396), Florida (HB3), Georgia (SB351), Louisiana (SB162), New York (S7694A), and Utah (HB 464, SB194) have all passed laws intended to limit and regulate adolescents access to social media. Other states, such as California (SB976), are considering similar legislation.

a year older than students within the same classroom who were born immediately prior to the cutoff. Given that adolescence is a period of significant physical development, this age difference implies that students born during the cutoff month are also expected to weigh more than their peers born immediately prior to the cutoff. If students form their body image by comparing their bodies to the bodies to their classroom peers, relatively older students' perceptions of their own bodies will be based, at least in part, on comparisons to the bodies of their younger, smaller peers.

To measure adolescent body image, we use data from the 2002-2018 waves of the Health Behaviour in School-Aged Children (HBSC) study, a cross-national survey of European students Europe. These surveys include a rich set of questions on students' weight-related behaviors and outcomes, including how the students describe their bodies and their body mass index (BMI). We use the difference between students' self-descriptions and their actual BMI status to identify whether they hold lenient, accurate, or harsh views of their bodies (Jiang et al. 2014; Shin and Nam 2015; Christoph et al. 2018; Smith and Zagorsky 2018; Carpenter and Churchill forthcoming). Importantly, for our purposes, these data also include information on the students' ages (in months) at the time of the survey and classroom-specific identifiers, allowing us to identify students who are relatively older and younger than their classroom peers.

Parents often have some discretion over when their children start school, so relative age within the classroom is not necessarily randomly determined. For example, parents may opt to hold their children back an extra year so that they are more mature when they first begin school (Black et al. 2011; Page et al. 2019; Cook and Kang 2020). To account for the possibility that this manipulation of relative age within the classroom may be correlated with our outcomes of interest, we adopt an instrumental variables identification strategy leveraging differences between the students' birth months and the school entry cutoff months in 33 European countries (Allen and Barnsley 1993; Bedard and Dhuey 2006; Fumarco and Baert 2019).[2] The idea behind this strategy is that while a student's expected relative age generated by the school entry cutoff should reasonably predict her actual relative age, it will be otherwise unrelated to the determinants of her body image.

We document several key findings. First, we show that relatively older students (i.e., those with younger peers) are more likely to describe their bodies as heavier than indicated by their BMIs compared to students of the same age who are relatively younger within their respective classrooms. Likewise, relatively younger students (i.e., those with older peers) are more likely to describe their bodies as lighter than indicated by their BMIs. We then show that this body misperception is driven by relative age influencing (i) how adolescents describe their bodies and (ii) their underlying BMIs. Second, we show that relatively older students are more likely to report that they don't have any reason to diet, while relatively younger students are more likely to report that they should try and gain weight. Third, we show that relatively older students consume more low-calorie food items, while relatively younger students consume more sweets and sugar sweetened beverages. These diet differences imply that students who are one standard deviation older in relative age than their classmates consume 1,381 fewer calories over the course of the year compared to students of the exact same age who are younger within their respective classrooms. Finally, we find that relatively older students report higher levels of physical

[2] Twenty countries have a January cutoff, one country has a March cutoff, one country has an April cutoff, two countries have a July cutoff, seven countries have a September cutoff, and two countries have an October cutoff.

activity than their relatively younger counterparts. Overall, our results suggest that relatively older students base their body image and weight-related behaviors on comparisons to their younger peers, while relatively younger students' behaviors are driven by comparisons with their older peers.

Our paper builds on an economics literature studying how peer comparisons influence health behaviors. These studies have found that unfavorable social comparisons are associated with worse self-reported physical and mental health, increases in risky health behaviors, and increased risk of death (Eibner and Evans 2005; Pham-Kanter 2009; Balsa et al. 2014; Braghieri et al. 2022). Specifically studying weight-based social comparisons, prior work has shown that women with relatively thinner peers are more likely to engage in disordered eating behaviors (Costa-Font and Jofre-Benet 2013; Arduini et al. 2019) and that relatively heavier adolescents experience greater behavioral problems (Huang et al. 2020).

We also add to literature specifically analyzing the effects of relative age on health behaviors. Leveraging variation in relative age generated by school entry cutoff dates, this work has shown that relatively younger adolescent girls (i.e., those with older peers) have elevated rates of substance use and risky sexual activity (Argys and Rees 2008; Black et al. 2011; Johansen 2021). Using the HBSC data to study peer social networks, Fumarco and Baert (2019) showed that relatively younger students were more likely to electronically communicate with their friends than their relatively older peers but had fewer face-to-face relationships. Meanwhile, Fumarco et al. (2020) showed that relatively older students reported greater life satisfaction, had higher self-reported general health, reported fewer psychosomatic complaints, and were less likely to be overweight than their relatively younger counterparts. This latter finding is in line with Anderson et al. (2011) who showed that United States students born immediately following the school entry cutoff date were less likely to be overweight, though the results were imprecisely estimated.

We build on this prior work in several important ways. First, we provide the first evidence that relative age influences how adolescents misperceive their own bodies, highlighting the important role that social comparisons can play in shaping adolescent body image. Second, we provide novel evidence that relatively younger students – who have older, heavier peers – are more likely to report a desire to gain weight, even though they are also more likely to be overweight for their age. This result suggests that social comparisons may play an important role in the rising rate of overweight and obesity, given that individuals are comparing themselves to an increasingly overweight reference group (Chomitz et al. 2003; Maximova et al. 2008; Prina and Royer 2014; Madsen et al. 2021; Churchill 2024). Third, we provide new evidence that relative age is related to changes in nutrient intake and – consistent with a literature studying the effects of relative age on sports participation (Dhuey and Lipscomb 2008; Fumarco and Schultze 2020) – further evidence that relative age leads to different levels of physical activity. Finally, by separately examining responses for adolescent girls and boys, we provide novel evidence on how social comparisons separately influence these groups.

The rest of the paper proceeds as follows: Section 2 discusses the literature on how social comparisons affect economically meaningful outcomes, as well as the literature on the effects of relative age on educational and health outcomes. Section 3 describes the data and outlines our instrumental variables identification strategy. Section 4 presents the results, and Section 5 discusses and concludes.

2. Literature Review

2.1 Literature on Social Comparisons

Our paper contributes to an economics literature exploring the effects of various types of social comparisons on health outcomes. For example, several papers have studied the relationship between relative socioeconomic position – a type of social comparison – and risky health behaviors (Luttmer 2005; Pham-Kanter 2009; Mangyo and Park 2011). Eibner and Evans (2005) showed that individuals with less income than those in their reference group had worse self-reported health, higher body mass index, and increased risk of death. Similarly, Balsa et al. (2014) found that adolescent males in the AddHealth data in a relatively lower socioeconomic position than their peers were more likely to use alcohol, had heavier alcohol use, and were more likely to smoke. In another strand of literature, scholars have begun exploring the effects of social media use on social comparisons and mental health. Using both experimental (Allcott et al. 2020; Mosquera et al. 2020) and quasi-experimental methods (Braghieri et al. 2022), these papers have shown that social media use harms mental health, presumably by fostering unfavorable social comparisons.

We also add to a smaller literature documenting the relationship between relative bodyweight and economically meaningful health outcomes. For example, Costa-Font and Jofre-Benet (2013) showed that women with heavier peers were less likely to be anorexic, while Arduini et al. (2019) found that teen girls with relatively thinner peers were more likely to perceive themselves as heavier than their BMI and to engage in disordered eating behaviors. Using the AddHealth data, Brunello et al. (2020) showed that an increase in peers’ average genetic predisposition to high BMI raised the probability that adolescents underestimated their weight and increased obesity among adolescent girls. There is also evidence that adolescents' relative position in the weight distribution can influence their self-esteem and other non-cognitive outcomes. Leveraging variation in relative body size induced by movements between MSAs, Huang et al. (2020) showed that adolescents who moved to thinner areas – and therefore became relatively heavier – experienced increased behavioral problems.

2.2 Literature on Relative Age

This paper also builds on a large body of evidence studying the effects of relative age on education, labor market, and health outcomes (Allen and Barnsley 1993; Bedard and Dhuey 2006; Evans et al. 2010; Page et al. 2019). One complication in this literature is that students who are relatively older than their peers are also older in the absolute sense. For example, if a 15.5-year-old performs better on an exam than her 15.0-year-old classmate, it is unclear whether this difference was because of a benefit to being a relatively older within the classroom or because the student was simply 0.5 years older at the time of the exam. Using a variety of identification strategies to disentangle these relative and absolute age effects, researchers have generally found large, positive effects of absolute age at the time of the exam and smaller positive effects of starting school younger (Black et al. 2011; Cascio and Schanzenbach 2016; Peña 2017).

Examining the effects of relative age on risky health behaviors, Argys and Rees (2008) used data from the National Longitudinal Survey of Youth – 1997 and state-level variation in kindergarten starting dates to show that relatively younger adolescent girls (i.e., those with older peers) were more likely to use marijuana, drink alcohol, and smoke cigarettes. More recently, Johansen (2021) used Danish register data to show that being young-for-grade increased the probabilities that a girl had an abortion and experienced alcohol poisoning during adolescence.[3] Interestingly, neither paper found a relationship between relative age and adolescent boys' risky health behaviors. Particularly relevant for our context, Anderson et al. (2011) found that students in the Early Childhood Longitudinal Study – Kindergarten Cohort of 1998 who were born immediately following the school entry date were less likely to be classified as overweight, though the results were statistically insignificant.

There is also evidence that relative age can influence social networks and overall life satisfaction. Using Health Behaviour in School-Aged Children data and leveraging variation generated by school entry cutoff dates, Fumarco and Baert (2019) found that, after controlling for absolute age, relatively younger students were more likely to electronically communicate with their friends than their relatively older peers but had fewer face-to-face relationships.[4] Similarly, Fumarco et al. (2020) showed that relatively older students reported greater life satisfaction and health, and in a contemporaneous working paper Fumarco et al. (2024) explore the relationship between relative age and eating behaviors.

3. Data Description and Empirical Approach

3.1 Data: Health Behaviour in School-Aged Children, 2002-2018

We obtain data on adolescent body image from five waves of the Health Behaviour in School-Aged Children (HBSC) study. HBSC is a cross-national study of adolescents across Europe and North America conducted in collaboration with the World Health

[3] In line with these findings, Black et al. (2011) found that girls who started school when they were older were less likely to experience teen pregnancy.

[4] In our results section, we will show that our results are consistent across each survey wave. Because very few adolescents had cell phones and social media in 2002, these patterns suggest that our findings are not attributable to changes in technology utilization.

Organization. Data are collected from school-based surveys using a standard methodology to produce nationally representative estimates of 11-, 13-, and 15-year-old adolescents. While the surveys have been fielded every four years since 1983/84, only the 2001/02, 2005/06, 2009/10, 2013/14, and 2017/18 waves are publicly available.

For our purposes, these data offer a few key advantages. First, they include information on each student's age (in months) at the time of the survey, allowing us to identify students in the classroom who are relatively older or younger. Second, these data include information on students from a wide range of absolute ages, allowing us to separately identify the effects of relative age and absolute age.[5] Finally, the cross-country nature of the data allows us to exploit additional variation in the school entry cutoff month, increasing confidence that the relative age effects we identify are not being driven by unobserved factors correlated with birth month.

We calculate a student's relative age as the difference between age (in months) of the student and the oldest "regular" student within the same class (Fumarco and Baert 2019; Fumarco et al. 2020). To identify regular students, we first find the modal year of birth for students born in the second academic quarter, given that these students are least likely to be in the "wrong" class due to retention or being "redshirted" (i.e., held back a year) by their parents. We then use this birth year and the relevant school entry cutoff month to identify older students (i.e., those that repeated a grade or were redshirted) and younger students (i.e., those that started school early). The remaining students are regular students

[5] This is more difficult if all students are surveyed at the same age because relative age is collinear with absolute age (i.e., the relatively older students in the classroom are also absolutely older than their peers). For example, the Programme for International Student Assessment (PISA) includes information on 15-year-olds' academic performance.

(i.e., that are in the expected class).[6] If all students entered on time and did not repeat a grade, relative age would vary from -12 to 0 with a mean of -6. However, Figure 1 shows that the data are right skewed with an average relative age of -3.8, consistent with prior work showing that parents may strategically choose to delay enrolling their children in school (Allen and Barnsley 1993; Bedard and Dhuey 2006; Evans et al. 2010; Page et al. 2019).[7] We report summary statistics for our explanatory variables of interest and our dependent variables in Table 1.[8]

Our main goal is to understand whether and how social comparisons influence adolescent body image. To do so, we follow the literature and construct a measure of weight perception that compares how adolescents describe their bodies to their BMI status (Jiang et al. 2014; Shin and Nam 2015; Christoph et al. 2018; Smith and Zagorsky 2018; Carpenter and Churchill forthcoming). As part of the survey, students are asked whether they think that their body is (i) “much too thin,” (ii) “a bit too thin,” (iii) “about the right size,” (iv) “a bit too fat,” or (v) “much too fat.” Students are also asked about their height and bodyweight, allowing us to calculate their BMIs (weight in kg/height in squared meters) and use the World Health Organization’s 2007 sex-specific BMI-for-age (in months) thresholds to determine whether an adolescent is classified as (i) severely thin, (ii) thin, (iii) normal weight, (iv) overweight, or (v) obese.[9] We code the self-described body

[6] Because this process requires classroom-specific information, we exclude observations without a classroom identifier. We also follow prior work and exclude classes in the top and bottom 5% of the class size distribution, given concerns that these codes are not identifying unique classrooms. Our remaining classes range from 8 to 32 students, consistent with Fumarco and Baert (2019).
[7] For Figure 1, we bin the endpoints at -12 and 12. However, we use the non-binned values throughout our analyses.
[8] We report additional summary statistics in Appendix Table 1.
[9] The WHO provides sex-specific BMI-for-age (in months) thresholds. Adolescents whose BMI is more than 3 standard deviations below the cutoff are considered “severely thin,” those whose BMI is more than 2

type measure and the BMI status variable to both take on values 1 through 5, and our measure of body image is the difference between these two variables. This measure of weight perception will be positive for students who describe themselves as heavier than indicated by their BMI status, zero for those whose self-descriptions are consistent with their BMI status, and negative for students who describe themselves as lighter than indicated by their BMI status.

We show in Figure 3 that approximately 20 percent of adolescents in the HBSC data describe themselves as lighter than indicated by their BMI status, 60 percent describe themselves in a way that is consistent with their BMI status, and 20 percent describe themselves as heavier than indicated by their BMI status. While this distribution is symmetric for the entire sample, we show in Appendix Figure 1 that this symmetry masks meaningful heterogeneity by sex. Adolescent girls are more likely to have a harsh body image (29 percent vs. 12 percent) and less likely to have a lenient body image (15 percent vs. 28 percent) compared to adolescent boys.

3.2 Empirical Approach: Instrumental Variables

To study the relationship between relative age and body misperception, we could estimate the following naïve ordinary least squares regression:

$$(1) \quad Y_{iact} = \alpha_0 + \alpha_1 \cdot \mathit{RELATIVE\ AGE}_a + \alpha_2 \cdot \mathit{AGE}_a + \alpha_3 \cdot X'_{iact} + \alpha_4 \cdot C_c + \alpha_5 \cdot T_t + \varepsilon_{iact}$$

where the dependent variable, Y, is the outcome of interest for adolescent *i* of age *a* from country *c* and survey year *t*. In this setting, the vector X includes individual-level

standard deviations below the cutoff are considered "thin," those whose BMI is more than 1 standard deviation above the cutoff are considered "overweight," and those whose BMI is more than 2 standard deviations above the cutoff are considered "obese." This definition implies than anyone who is "severely thin" is also "thin" and anyone who is "obese" is also "overweight." When calculating the weight perception variable, we allow these categories to be mutually exclusive.

demographic characteristics that might influence body misperception and various weight-related health behaviors, including indicators for month-of-birth, sex, whether the adolescent's mother and/or father are present in the household (Anderson et al. 2003; Anderson 2012), and socioeconomic status (Cawley 2015).[10] We also include country fixed effects, C, and survey wave fixed effects, T.

The independent variables of interest are (i) *RELATIVE AGE*, which captures the change in the outcome variable associated with being one month older than the typical classroom peer, and (ii) *AGE*, which captures the change in the outcome variable associated with being one additional month older. One potential issue with this approach is that relative age can be manipulated in a way that may be correlated with factors affecting the outcomes of interest. For example, parents may time conception to assure a particular season of birth, parents may choose to delay enrolling their eligible child in school for a year, or the child may repeat a grade due to poor academic performance.

To address the potential endogeneity inherent in relative age, we follow the literature and leverage plausibly exogeneous variation generated by the country-specific school entry cutoff month using an instrumental variables approach (Datar 2006; Black et al. 2011; Peña and Duckworth 2018; Johansen 2021).[11] The idea behind this approach is that students born just after the school entry cutoff month will be nearly a year older than those born just before the cutoff, though they will both be part of the same academic class. For example, Figure 2 shows a clear negative relationship between students' birth months

[10] HBSC guidelines suggest that socioeconomic status be measured by adding the answers to four questions: (i) whether the respondent's family owns zero, one, or more than one car; (ii) whether the respondent sleeps in her own bedroom; (iii) whether the respondent has traveled for holidays in the prior twelve months never, once, or more than once; and (iv) whether the respondent's family owns zero, one, or more than one computer. The resulting sum is then divided into three levels (i.e., low, medium, and high socioeconomic status).
[11] Appendix Table 2 lists the country-specific school entry cutoff dates.

relative to the school entry cutoff and average relative age, with students born in the cutoff month having an average relative age of -1.4 while those born eleven months later had an average relative age of -7.3.

Given evidence that students born in the first and last few months of the academic year are more likely to be non-regular students (Bedard and Dhuey 2006; Sprietsma 2010), we disaggregate the instrument into twelve indicator variables corresponding to the months of the academic year (Angrist and Pishke 2008; Fumarco and Baert 2019).[12] However, throughout the analysis, we also show the robustness of our results to dropping students born around the cutoff month. Because many of the endogeneity concerns related to relative age could also affect the absolute age of the adolescent, we also instrument for absolute age with the average age of students from the same country, who were interviewed in the same survey wave, were in the same classroom, and were born during the same quarter of the academic year (Peña and Duckworth 2018; Fumarco and Baert 2019; Fumarco et al. 2020).

Using these two instruments, we estimate our first stage regression relating the endogeneous variables (i.e., relative age and age) to our two instruments:

$$(2)\quad ENDOGENEOUS_{iact} = \delta_0 + \delta_1 \cdot \textit{BIRTH MONTH RELATIVE TO CUTOFF}_{ic} + \delta_2 \cdot \textit{AVG AGE}_{iact} + \delta_3 \cdot X'_{iact} + \delta_4 \cdot C_c + \delta_5 \cdot T_t + \varepsilon_{iact}$$

where *BIRTH MONTH RELATIVE TO CUTOFF* is a series of twelve indicator variables denoting the position of the student's birth month based on that country's school entry

[12] Because we have significant variation in the school entry cutoff month, the months of the academic year do not overlap with the months of the calendar year.

cutoff month and *AVG AGE* is the average age of the student's comparable peers. We then estimate the second stage equation:

$$Y_{iact} = \beta_0 + \beta_1 \cdot \widehat{RELATIVE\ AGE}_a + \beta_2 \cdot \widehat{AGE}_a + \beta_3 \cdot X'_{iact} + \beta_4 \cdot C_c + \beta_5 \cdot T_t + \varepsilon_{iact} \quad (3)$$

where $\widehat{RELATIVE\ AGE}$ and $\widehat{AGE}$ indicate the predicted values of relative age and absolute age obtained from the first stage equations. Throughout the paper, we report these two-stage least squares (2SLS) estimates and cluster standard errors at the classroom level.[13]

4. Results

4.1 Effects on Body Misperception

We begin in Table 2 by exploring the relationship between relative age and body misperception using the ordinary least squares specification in equation (1). For ease of interpretation, we have scaled the estimates to reflect a one standard deviation increase in relative age (approximately 5.3 months). The dependent variable in column 1 measures the difference between how students describe their bodies and their BMI status. This variable takes on a negative value when a student describes herself as lighter than indicated by her BMI status, zero when her self-description is aligned with her BMI status, and a positive value when her self-description is heavier than indicated by her BMI status. The dependent variables in columns 2-4 discretize this outcome into indicators for whether a student holds a lenient body image, an accurate body image, or a harsh body image.

These results suggest that relatively older students are more likely to describe themselves as heavier than indicated by their BMI status compared to their same-age counterparts who are relatively younger within their respective classrooms (column 1).

[13] Appendix Table 3 shows that our instrumental variables for relative age are generally unrelated to the righthand side demographic characteristics. The one unsurprising exception is that students born further from the school entry cutoff month are consistently younger in absolute age.

Meanwhile, relatively older students are less likely to describe their bodies leniently compared to their BMIs (column 2). Instead, we find that being relatively older within the classroom is associated with an increase in likelihood that students accurately describe their bodies (column 3) and an increase in the likelihood that they describe their bodies as heavier than indicated by their BMIs (column 4). While these associations do not account for the potential endogeneity of relative age, they suggest that relatively older students (i.e., those with younger peers) hold less favorable views of their bodies compared to their same-age counterparts who are relatively younger within their respective classrooms (i.e., those with older peers).

Of course, relative age can be endogenously determined by parents opting to hold their children back a year, and the characteristics associated with this decision may also be correlated with household weight-related attitudes that shape adolescents' body misperception. To account for this possibility, we instrument for relative age with the difference between students' birth months and the relevant school entry cutoff month. Figure 4 shows a stark first stage relationship; students born immediately prior to the school entry cutoff month are on average four months younger than students of the same age who were born immediately following their respective school entry cutoff month. Meanwhile, the reduced form estimates in Figure 5 show a clear relationship between students' birth months relative to the school entry cutoff month and their body misperception. Compared to students of the exact same age who were born during the cutoff month, students born further from the cutoff month describe themselves as lighter than indicated by their BMI status (Panel A). Specifically, the reduced form estimates indicate that students born further from the school entry cutoff month are 1-2 percentage points more likely to hold a lenient body image – a 4.7 to 8.0 percent increase relative to the sample mean (Panel A). While the reduced form results do not reveal a clear relationship with the likelihood that students' self-descriptions are consistent with their BMIs (Panel B), we find that students born further from the school entry cutoff month are nearly 1 percentage point (4.8 percent) less likely to describe their bodies as heavier than indicated by their BMIs (Panel C).

Having shown a strong first-stage relationship between our instrument and the endogenous independent variable, as well as a reduced form relationship between our instrument and students' body misperception, in Table 3 we report results obtained from the two-stage least squares specification shown in equation (3). The estimates are directionally consistent with the ordinary least squares results, though the magnitudes are consistently larger. We find that a one standard deviation increase in relative age leads to a 1.7 percentage point (8 percent) reduction in the likelihood that adolescents have a lenient body image compared to their same-age peers who are relatively younger within their respective classrooms (column 2). Instead, we find that these relatively older students are 0.9 percent points (1.6 percent) more likely to accurately describe their bodies relative to their BMIs (column 3) and 0.8 percentage points (3.8 percent) more likely to describe themselves as heavier than indicated by their BMIs (column 4). Overall, Table 3 indicates that relatively older students (i.e., those with younger peers) are more likely to describe themselves as heavier than their BMIs, while relatively younger students (i.e., those with older peers) are more likely to hold lenient views of their bodies, demonstrating that social comparisons can play an important role in shaping body image.[14] In Appendix Table 5 we

[14] Students born near the school entry cutoff are less likely to be regular students (i.e., they are more likely to have started early, delayed schooling for a year, or repeated a grade), potentially violating our identification

show that the results are robust to limiting our sample to each of the survey waves, indicating that the relationship is not being driven by secular trends occurring throughout our survey period (e.g., rising obesity rates or increased use of social media).

Prior work has found that concerns about body size and weight are more salient for adolescent girls and young women compared to their male counterparts (Costa-Font and Jofre-Benet 2013; Andruini et al. 2019; Carpenter and Churchill forthcoming), suggesting that the relationship between relative age and body misperception may vary by sex. To test this possibility, Figure 6 separately shows the relationship between a one standard deviation increase in relative age and changes in body image for adolescent girls (darker triangles) and adolescent boys (lighter circles). To account for the fact that adolescent girls on average have harsher body images than adolescent boys (see Appendix Figure 1), we report results as a percent change relative to the sample mean. Interestingly, we find that a one standard deviation increase in relative age is associated with similar percent changes in adolescent girls' and adolescent boys' body image. The lack of a clear gendered relationship is consistent with Huang et al. (2020) who found that changes in relative body size generated by moving to relatively thinner or heavier areas were associated with similar behavioral changes for both adolescent girls and boys.[15]

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strategy's monotonicity assumption. While we have tried to minimize this possibility by disaggregating our instrument, in Appendix Table 4 we further address this possibility by dropping students born the month prior to the cutoff or during the cutoff month (column 1); during the two months prior to the cutoff, the cutoff month, and the month following the cutoff (column 2); and during the three months prior to the cutoff, the cutoff month, and the two months following the cutoff (column 3). We continue to find that relatively older students are less likely to have a lenient body image, while relatively younger students are more likely to have a lenient body image.

[15] We also explored heterogeneity by location and age category (i.e., whether the sampled student was intended to be representative of an 11-, 13-, or 15-year-old). Appendix Figures 2 and 3 reveal changes across Europe and for all age groups, though the estimates from Eastern Europe are less precisely estimated and the percent changes are largest for the younger students.

4.2 Components of Body Misperception: Self-Descriptions and Body Mass Index

Our measure of body misperception compares students' self-reported body types to their BMIs (Jiang et al. 2014; Shin and Nam 2015; Christoph et al. 2018; Smith and Zagorsky 2018; Carpenter and Churchill forthcoming). As a result, relative age can influence body misperception by (i) altering how students describe their bodies without affecting their BMIs, (ii) changing students BMIs without affecting how they describe their bodies, or (iii) altering how students describe their bodies and changing their BMIs. In this section, we explore the pathways through which relative age influences body misperception.

The dependent variables in Table 4 are indicators denoting how students describe their bodies.[16] We find that a one standard deviation increase in relative age is associated with a 1.1 percentage point (7.5 percent) decrease in the likelihood that adolescents describe themselves as "much too thin" or "a bit too thin" compared to their same-age counterparts who are relatively younger within their respective classrooms (column 1). Instead, we find that these relatively older students are 1.9 percentage points (3.4 percent) more likely to describe themselves as being "about the right size" (column 2). Perhaps surprisingly, we also find that relatively older students are 0.9 percentage points (3.1 percent) less likely to describe themselves as "a bit too fat" or "much too fat" (column 3).[17]

Why might an increase in relative age lead to reductions in both the likelihood that adolescents describe themselves as too thin and the likelihood that they describe themselves as too fat? One possibility, supported by Table 5, is that the relationship between relative age and how adolescents describe their bodies may depend on the

[16] In addition to these two-stage least squares results, we plot the reduced form results in Appendix Figure 4.
[17] Appendix Table 6 shows that this relationship is robust to dropping observations immediately around the school entry cutoff month.

students' BMIs. We find that underweight and normal weight students who are relatively older are less likely to describe themselves as "much too thin" or "a bit too thin" (column 1) and more likely to describe themselves as being "about the right size" (column 2) compared to their same-age counterparts who are relatively younger within their classrooms (Panels A and B). It is worth emphasizing that BMI-for-age cutoffs vary the month level. As such, relatively older students who are underweight *for their age* might still weigh more than their younger peers that they are comparing themselves against within the same classroom.[18] However, we find suggestive evidence that overweight and obese adolescents who are relatively older are more likely to describe themselves as being "about the right size" (column 2) and less likely to describe themselves as being "a bit too fat" or "much too fat" (column 3) compared their same-age counterparts who are relatively younger within their classrooms (Panel C).[19]

We now test whether relative age is related to changes in BMI. The descriptive statistics in Figure 7 reveal an interesting pattern – students born further from the school entry cutoff month weigh less than those born closer to the cutoff month (Panel A), but they are more likely to be classified as overweight or obese (Panel B). This suggests that while these students born further from the cutoff weigh less in an absolute sense, it is not sufficiently less to keep them within the recommended range of their age-specific BMI recommendation. This possibility is supported by the reduced form evidence in Figure 8

[18] For example, imagine two girls within the same classroom who have a BMI of 15.2. The first girl is 13.75 years old while the second is 13.0 years old. Despite having the same BMI, the relatively older girl is classified as underweight, while the relatively younger girl is classified as normal weight.

[19] Appendix Figure 5 shows similar changes in self-described body types for adolescent girls (darker grey triangles) and boys (lighter grey circles) as a percent of their respective means. Consistent with our prior body image results, we find similar results, regardless of European region (Appendix Figure 6) or age group (Appendix Figure 7).

showing that students born further from the school entry cutoff month have higher BMIs than students of the exact same age (in months) who were born closer to the school entry cutoff month.

We report estimates of the relationship between relative age and BMI using the two-stage least squares specification in Table 6. The dependent variable in column 1 is the student's BMI. Meanwhile, the dependent variables in columns 2-5 are indicators denoting whether the student is classified as "thin," "normal weight," "overweight," or "obese" using the 2007 World Health Organization's BMI-for-age (in months) thresholds for girls and boys. We find that a one standard deviation increase in relative age is associated with a 0.14-unit (0.7 percent) reduction in BMI (column 1).[20] While seemingly modest, the difference between the recommended BMI value and a BMI classifying that adolescent as overweight is 2.8 units for the students in our data. Indeed, relatively older students are more likely to be classified as "thin" (column 2) and "normal weight" (column 3) than their same-age counterparts who are relatively younger within their classrooms. Instead, we find that a one standard deviation increase in relative age is associated with a 1.2 percentage point (6.6 percent) reduction in the likelihood that adolescents are classified as overweight (column 4) and a 0.5 percentage point (12.5 percent) reduction in the likelihood that adolescents as classified as obese.[21] These latter results are consistent with Anderson et al. (2011) who found suggestive evidence that students born immediately following the school entry cutoff date were less likely to be classified as overweight.

[20] Appendix Table 7 shows that this result is robust to dropping students born near the school entry cutoff. Appendix Figure 8 shows similar BMI changes in BMI for all European regions (Panel A) and for 11-, 13-, and 15-year-old adolescents (Panel B).

[21] Appendix Table 8 reports results separately for adolescent girls (Panel A) and adolescent boys (Panel B). We find that relatively older girls are more likely to be classified as thin, while relatively older boys are more likely to be classified as normal weight.

Relative age may influence BMI by leading relatively older (younger) students to adopt the weight-related behaviors of their relatively younger (older) peers. If this is the case, then changes in BMI should be driven by changes in bodyweight and not in height. Consistent with this hypothesis, Figure 9 shows that a one standard deviation increase in relative age is associated with a statistically significant 0.9 percent reduction in bodyweight. In contrast, the relationship between relative age and height is incredibly small, precisely estimated, and statistically insignificant.[22] Taken together, the results in this section show that relative age influences both how adolescents describe their bodies and their BMIs.

4.3 Effects on Weight Management Behaviors

In the prior sections, we showed that students who are relatively older within their classrooms have harsher body image than their same-age counterparts who are relatively younger within their respective classrooms, though relatively older students are also less likely to be classified as overweight or obese. Given these changes in body misperception and weight outcomes, in this section we explore the relationship between relative age and a variety of weight-related health behaviors, including dieting, consumption of healthy foods, and physical activity.

Table 7 tests whether relative age influences adolescents' dieting behaviors. While we do not find any evidence that relative age is associated with a change in whether adolescents report being on a diet (column 1), we do detect a shift in the views of adolescents who report not being on a diet. Students who are one standard deviation older in relative terms than their classroom peers are 1.3 percentage points (2.6 percent) more

[22] We also report these results in Appendix Table 9.

likely to say that they are not on a diet and have no reason to be on one (column 2) and 0.8 percentage points (4 percent) less likely to say that they are not dieting because they need to gain weight (column 3). These results imply that relatively younger students are less likely to report that there is no reason for them to be on a diet and more likely to report a belief that they should gain weight. Finally, we do not find any evidence that relative age is related to changes in the likelihood that adolescents report that while they are not on a diet they should lose weight (column 4). [23,24]

Next, we test the relationship between relative age and caloric intake. The dependent variables in Table 8 are the number of times per week the student reports consuming fruits, vegetables, sweets, and soda. We find that students who are one standard deviation older in relative age report eating fruit 0.09 more times per week – a 1.7 percent increase relative to the sample mean (column 1). These relatively older students also report eating vegetables 0.06 times more per week (column 2). In addition to finding that relatively older students eat more low-calorie items, we also find evidence that they consume fewer calorie-dense foods. We find that students who are one standard deviation older in relative age report eating sweets 0.05 fewer times per week (column 3) and report drinking soda 0.8 fewer times per week (column 4).[25]

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[23] In contrast to our results, a contemporaneous working paper finds evidence that relatively younger students are more likely to report being on a diet (Fumarco et al. 2024). These authors define being on a diet as “a dummy variable which equals one if the student is on a diet or is doing something else,” suggesting that they have aggregated individuals who are on a diet, are not on one but want to lose weight, and are not on one and want to lose weight (i.e., it is the complement to not “No, my weight is fine”).

[24] We do not detect meaningful differences across European regions (Appendix Figure 9), age group (Appendix Figure 10), or sex (Appendix Table 10).

[25] In Appendix Table 11 we show that the reduction in the number of times eating sweets is driven by adolescent girls, while the increase in fruit and vegetable consumption is driven by adolescent boys. Appendix Figure 11 shows similar changes in dietary intake across European regions. Appendix Figure 12 presents mixed evidence for the relationship between relative age and dietary intake for each age group. We find similar changes in fruit consumption (Panel A). However, while we find that relatively older 11-year-

Overall, Table 8 indicates that relatively older students are more likely than their same-age, relatively younger counterparts to consume nutritious, low-calorie items and less likely to consume calorie-dense items. It is worth noting that the measure used in this table (i.e., the number of times eating a category of food) is an imperfect proxy of caloric intake, given that students might consume multiple servings of the items in a single sitting. However, if we are willing to assume that students consume one serving each time they eat the item, we can use the estimates from Table 8 to estimate calorie differences throughout the year. Assuming that dessert has 300 calories per serving and soda has 150 calories per serving, our estimates imply that students who are one standard deviation older in relative age will consume 26.6 fewer calories per week – a 1,381 calorie reduction over the course of the year.[26] There are 7,700 calories in a kilogram, so our estimates imply a 0.18 kilogram reduction in bodyweight attributable to these relatively older students' reduced consumption of sweets and sodas. We previously estimated that a one standard deviation increase in relative age results in a 0.44 kilogram reduction in bodyweight (see Figure 9 and Appendix Table 8), suggesting that changes in dieting behaviors attributable to relative age cannot fully explain the estimated reduction in bodyweight.

Of course, in addition to monitoring and altering their caloric intake, students can influence their bodyweight by changing their caloric expenditure. Consistent with prior evidence studying the relationship between relative age and sports participation (Dhuey and Lipscomb 2008; Fumarco and Schultze 2020), Table 9 indicates that relatively older students are more likely to be physically active. Students who are one standard deviation

olds were less likely to consume sweets and sodas, this relationship appears to flip as students age (Panels C and D).

[26] $(0.051 \times 300) + (0.075 \times 150) = 26.55$.

older in relative age report being physically active on 0.12 more days – a 3.0 percent increase relative to the sample mean (column 1). Likewise, we find these relatively older students report 4.5 percent more instances of exercising outside of school (column 2) and report spending 3.9 percent more hours exercising outside of school (column 3).[27]

5. Discussion and Conclusion

There is a growing concern that social comparisons are adversely affecting adolescent mental health. To study this possibility, we adopt an instrumental variables approach leveraging variation in relative age within the classroom generated by school entry cutoff months and data drawn from the 2002-2018 waves of the Health Behaviour in School-Aged Children (HBSC) study. The idea behind this strategy is that students born immediately following the school entry cutoff will be relatively older within their classroom (i.e., they will have relatively younger and presumably smaller peers) compared to an identically aged student born immediately prior to the cutoff.

We show that relatively older students are more likely to describe themselves as heavier than indicated by their BMIs, while relatively younger students are more likely to describe themselves as lighter than indicated by their BMIs. This change in body misperception is driven by changes in both how relatively older students describe their bodies and in their underlying BMIs. Interestingly, we find that relatively younger students (i.e., those with older peers) are both (i) more likely to describe themselves as being too thin and (ii) more likely to be classified as overweight or obese based on their age-specific

[27] Appendix Table 12 shows that relatively older girls and boys are both more likely to participate in physical activity, though the results are larger for adolescent boys. Appendix Figure 13 shows similar changes across European regions. Appendix Figure 14 suggests that the increase in the number of days active for more than 60 minutes was larger for 13- and 15-year-olds than 11-year-olds (Panel A), though there were similar changes in the number of times all age groups reported exercising outside of school (Panel B).

BMI thresholds. We then show that these relatively younger students are more likely to report a belief that they should gain weight, eat more calorie-dense food, and report lower levels of physical activity. Conversely, we show that relatively older students are more likely to report that they have no reason to try and change their weight, eat lower calorie food items, and report higher levels of physical activity. Overall, our results suggest that relatively older students base their weight-related expectations and behaviors on the behaviors and body types of their younger peers, while relatively younger students are comparing themselves to their older peers.

This study is subject to some limitations. For one, as is common in this literature, our data on weight-related behaviors and outcomes are self-reported. While self-reported data are perhaps most appropriate when examining changes in body image, they provide us with relatively coarse measures of physical activity and calorie intake. While there is no reason to believe that the propensity to under or overreport these measures should be correlated with relative age – particularly when we are exploiting school entry cutoff months throughout the year in a variety of countries – identifying ways to more accurately capture changes in physical activity and calorie intake remains an important area for future research. Also, because our sample is comprised entirely of adolescents, we can only speculate as to whether these social comparisons similarly influence weight-related behaviors among adults. Despite these limitations, this study provides the most comprehensive evidence on the role of peer social comparisons in driving weight-related health behaviors and outcomes.

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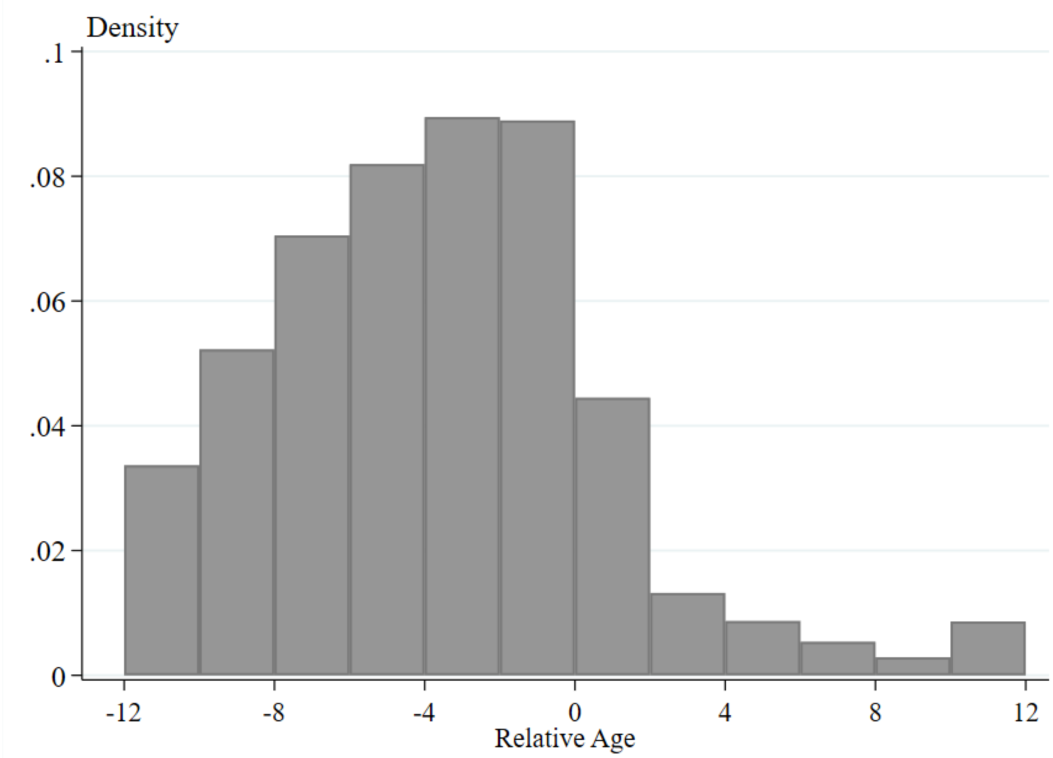
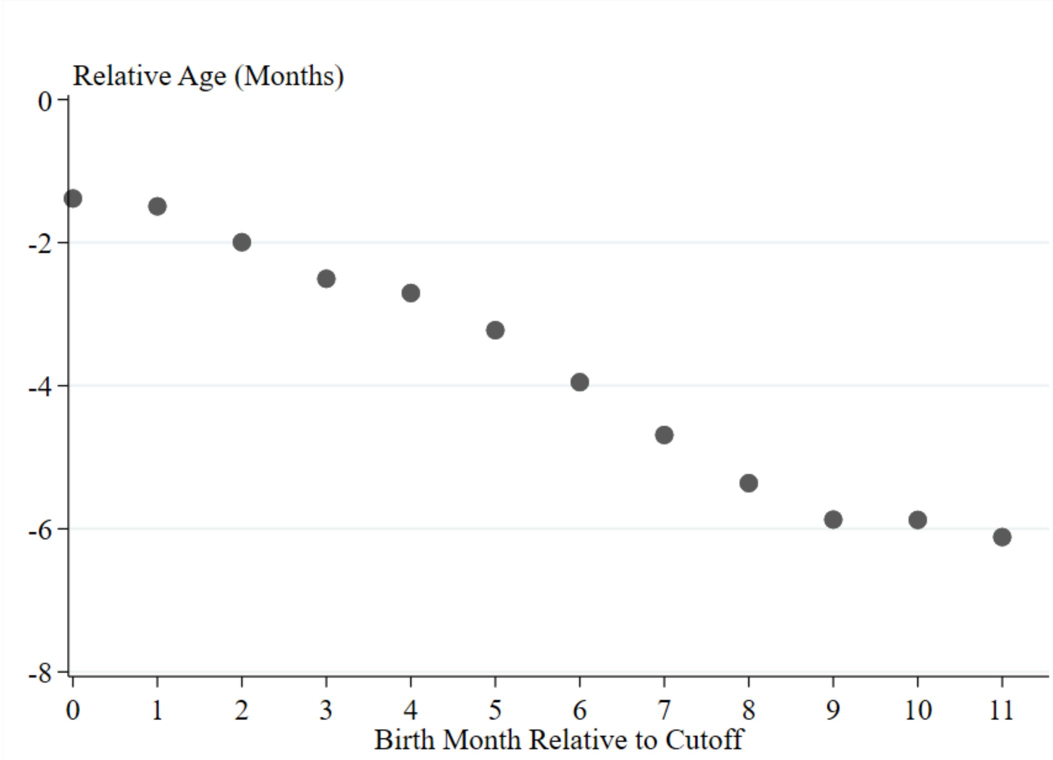
Figure 1: Distribution of Relative Age



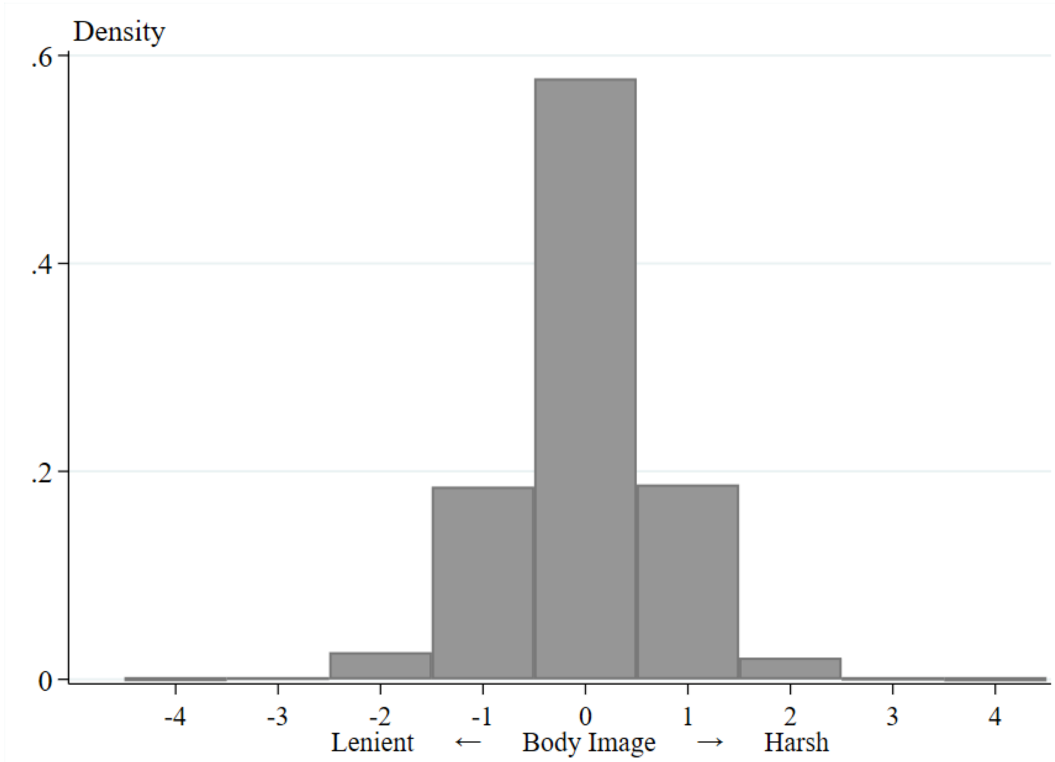
Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figure plots the average relative age (in months) for students based on their birth month relative to the school entry cutoff. The endpoints are binned at -12 and 12 for the sake of the graph, though we use the non-binned values in all analyses. The summary statistics utilize the sample weights.

Figure 2: Adolescents Born Further from the School Entry Cutoff Are Relatively Younger



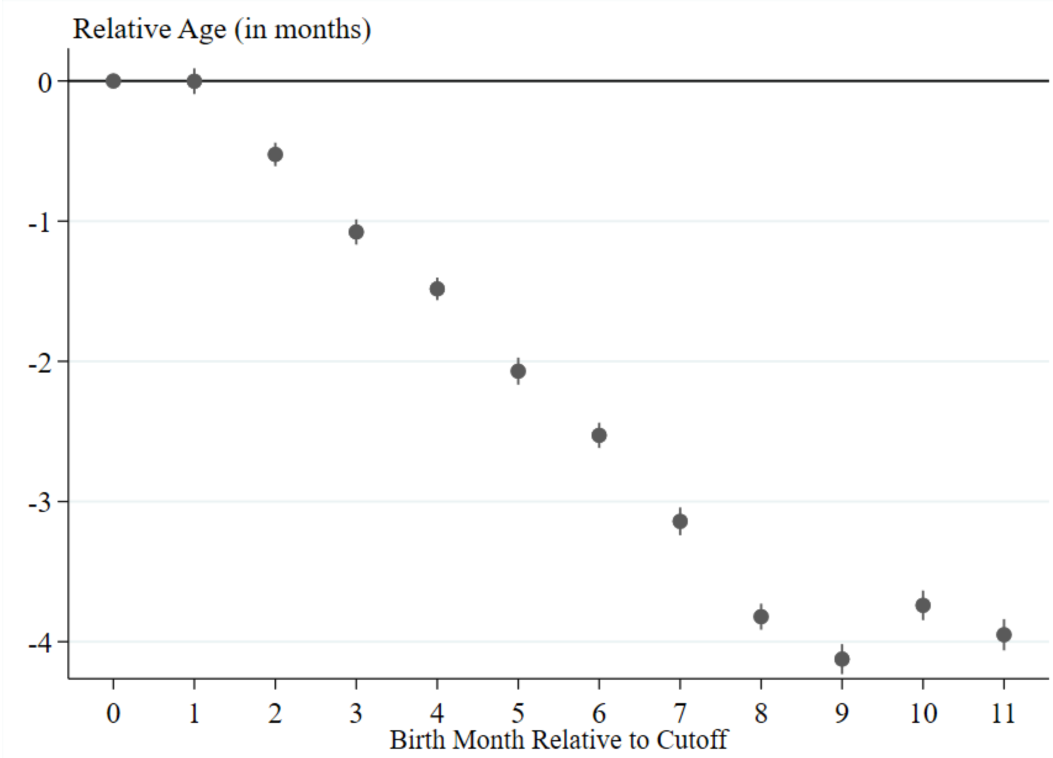
Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figure plots the average relative age (in months) for students based on their birth month relative to the school entry cutoff. The summary statistics utilize the sample weights.

Figure 3: Distribution of Body Misperception



Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the distribution of body image perception. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese."

Figure 4: First-Stage Relationship Between Birth Month Relative to the School Entry Cutoff Month and Relative Age



Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The dependent variable is the student's relative age. The estimates are obtained from the first-stage regression shown in equation (2). The independent variables of interest are indicators for birth month relative to the school entry cutoff month. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.
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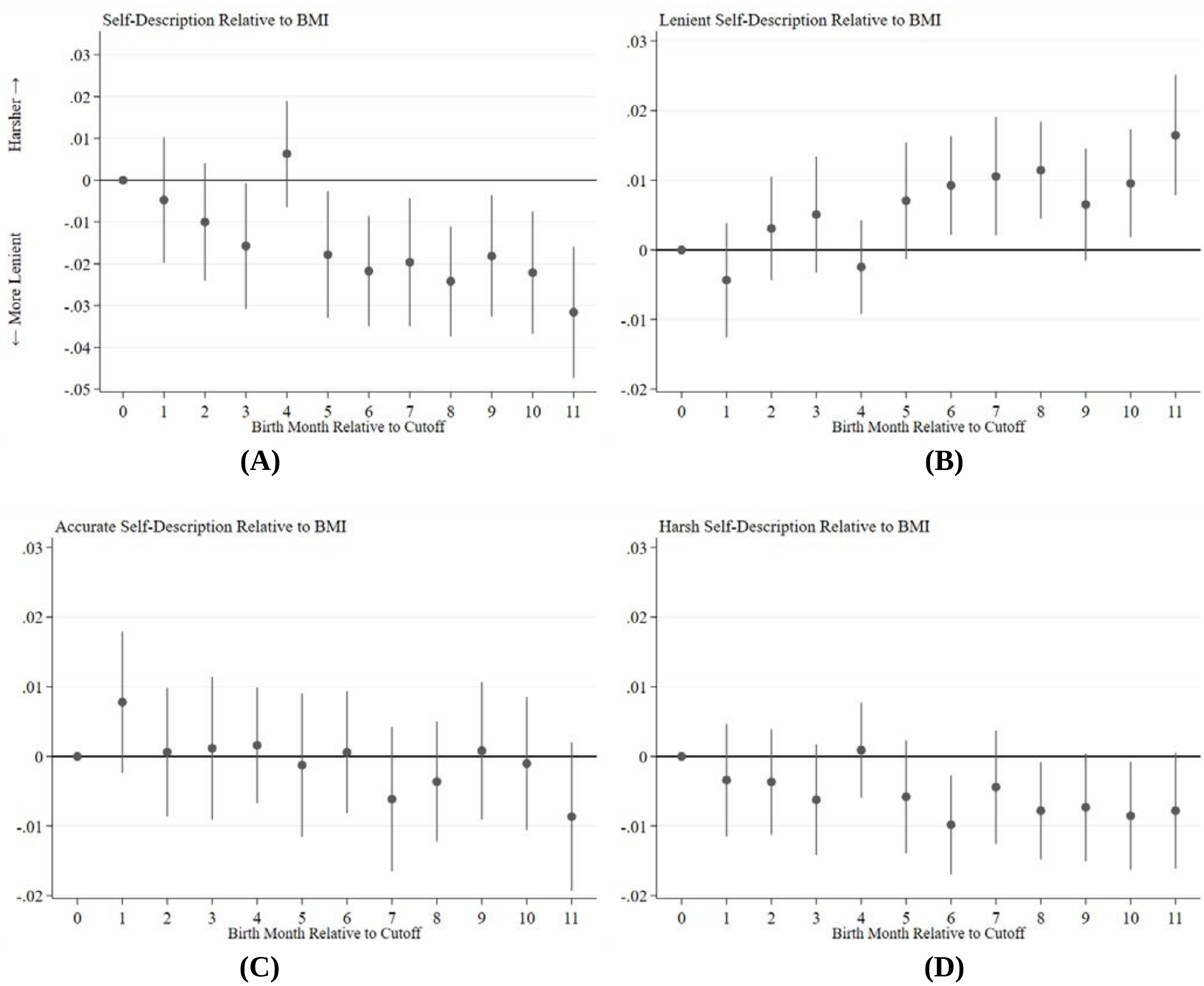
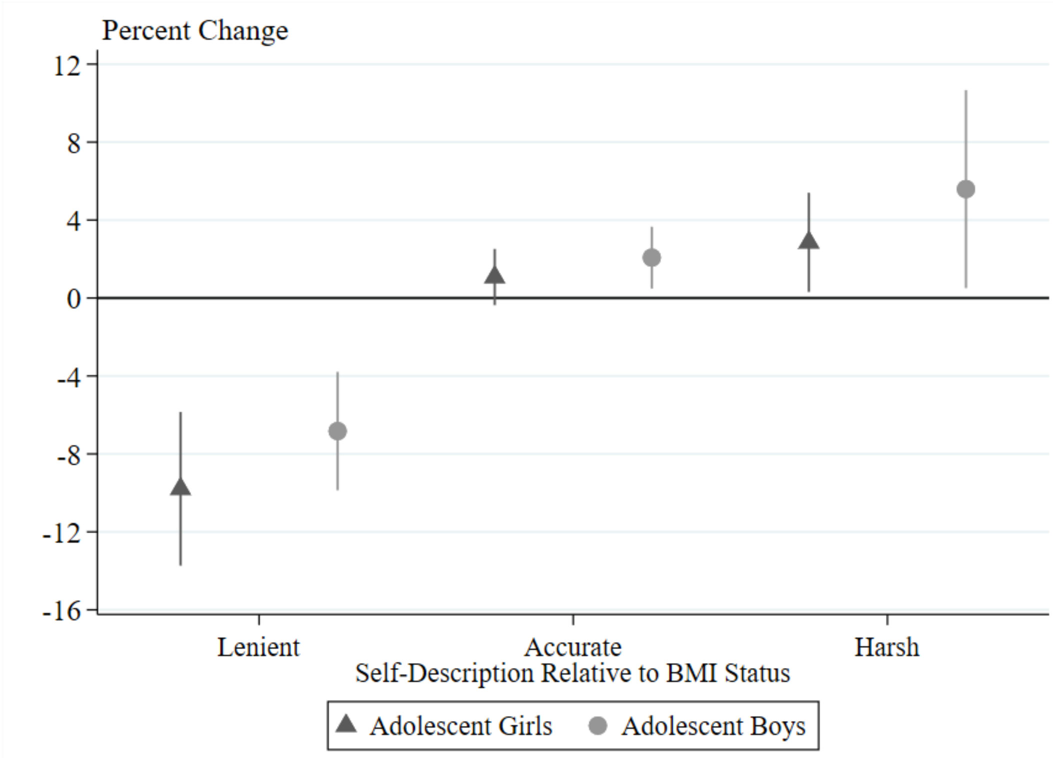
Figure 5: Reduced Form Relationship Between Birth Month Relative to the School Entry Cutoff Month and Body Image



Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The dependent variable in Panel A is the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." Positive values indicate a "harsh" view relative to BMI, and negative values indicate a "lenient" view relative to BMI. The dependent variable in Panel B is an indicator for whether the student had a lenient view, the dependent variable in Panel C is an indicator for whether the student had an accurate view, and the dependent variable in Panel D is an indicator for whether the student had a harsh view. The estimates are obtained from the reduced form regression where the independent variables of interest are indicators for birth month relative to the school entry cutoff month. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The regression includes the full set of controls from equation (2). The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

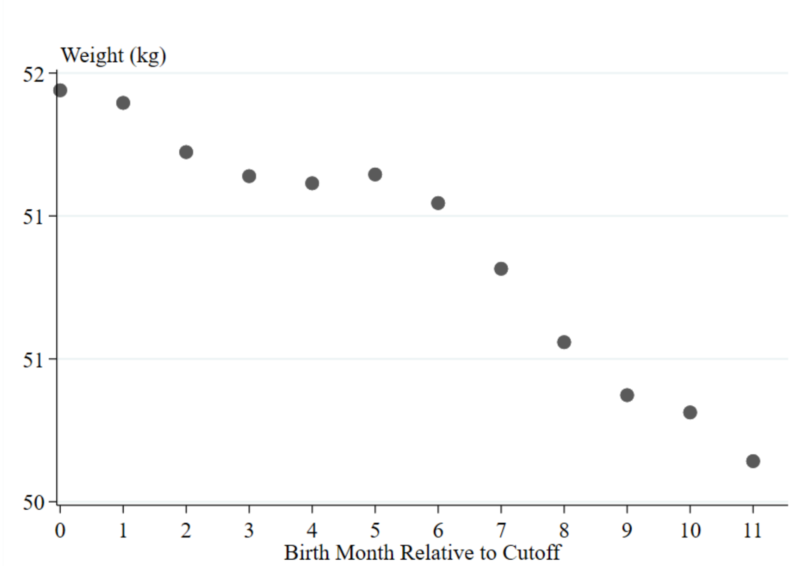
Figure 6: Two-Stage Least Squares Relationship Between Relative Age and Body Image, by Sex



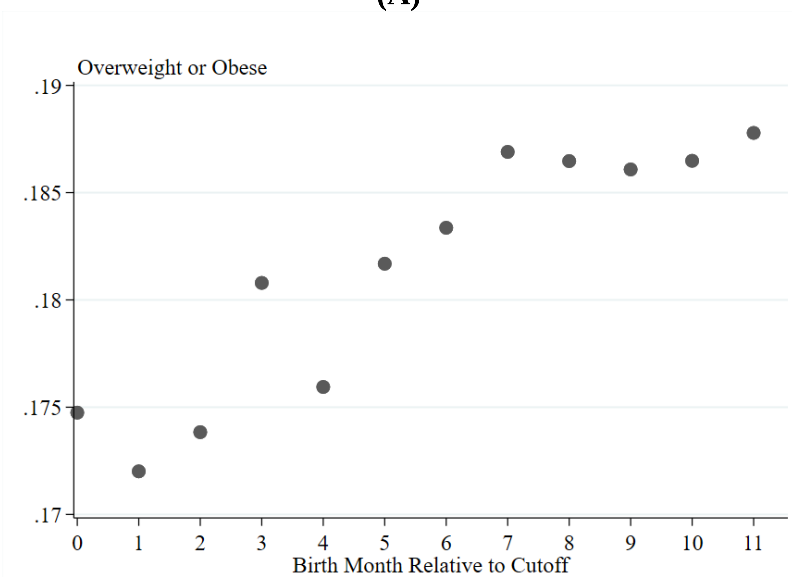
Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variables are listed on the horizontal axis and are indicators for whether the teen's self-described body type was thinner (i.e., lenient), accurate, or heavier (i.e., harsh) compared to his or her BMI status. The dark triangles plot the estimates for adolescent girls, while the lighter grey circles plot the estimates for adolescent boys. The vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. All estimates use the full set of controls from equation (3). The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Figure 7: Descriptive Trends Showing That Adolescents Born Further from the School Entry Cutoff Month Weigh Less but Are More Likely to Be Overweight or Obese for Their Age Than Those Born Closer to the Cutoff Month



(A)

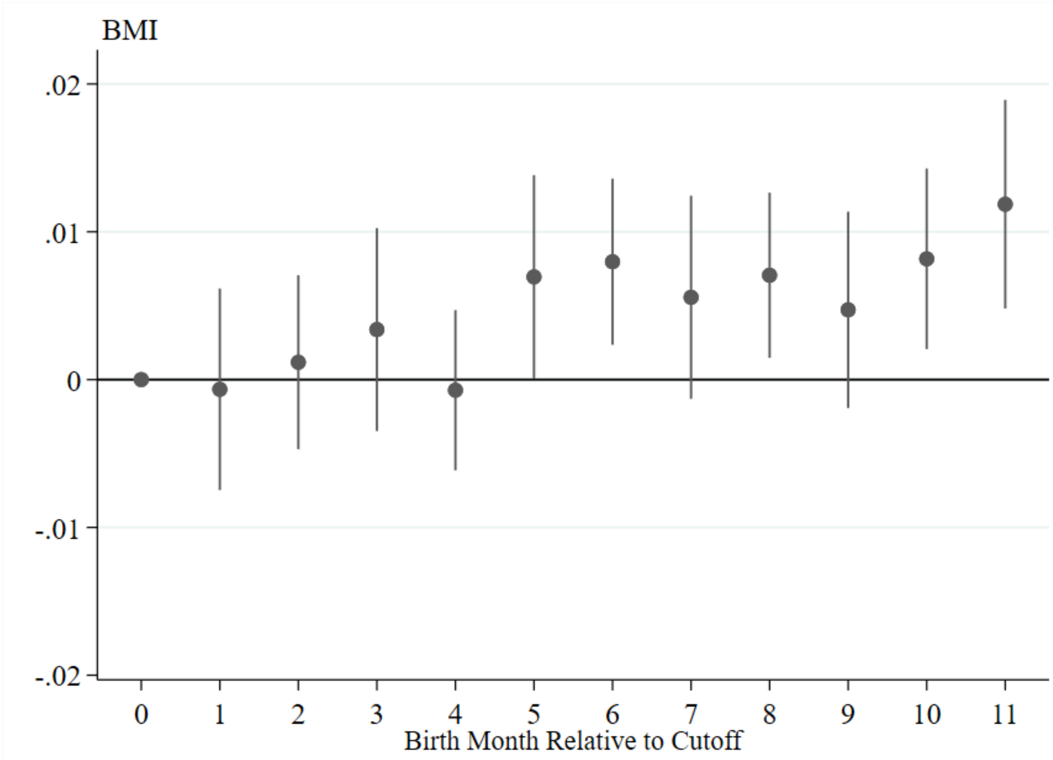


(B)

Source: Health Behaviour in School-Aged Children, 2002-2018

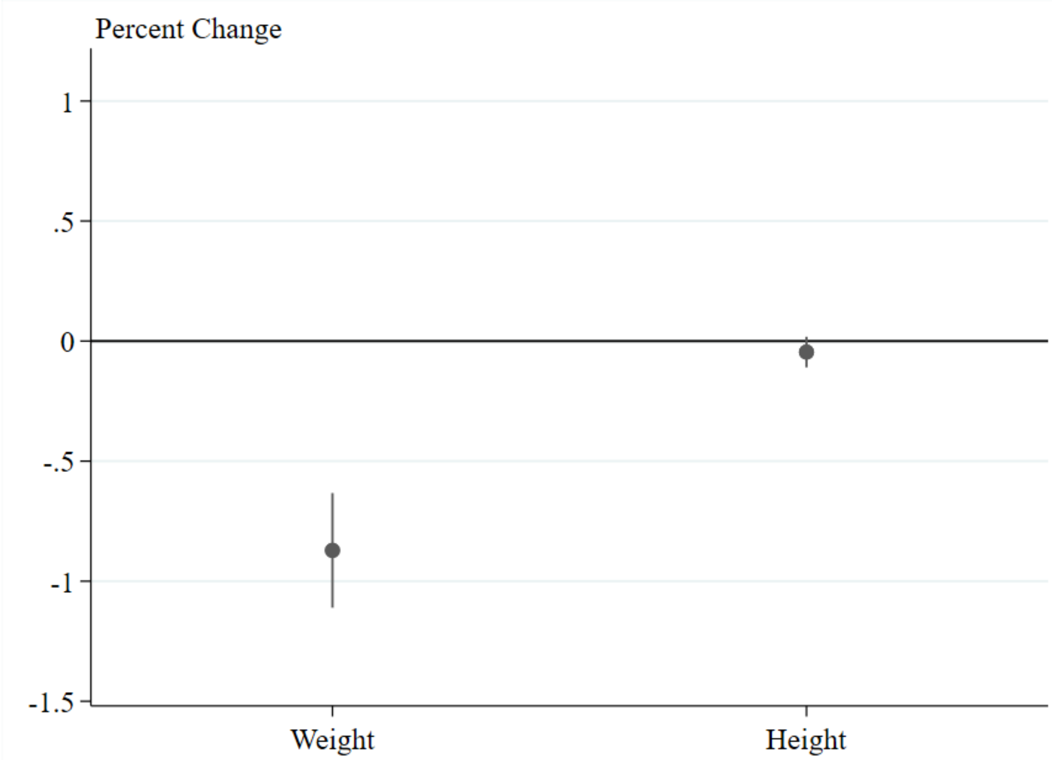
Notes: Panel A plots the average weight (in kilograms) of students based on their birth month relative to the school entry cutoff. Panel B plots the share of students categorized as overweight or obese using their sex-specific BMI-for-age thresholds. The summary statistics utilize the sample weights.

Figure 8: Reduced Form Relationship Between Birth Month Relative to the School Entry Cutoff Month and BMI



Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The dependent variable is the adolescent's body mass index. The estimates are obtained from the reduced form regression in equation (2). The independent variables of interest are indicators for birth month relative to the school entry cutoff month. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Figure 9: Relatively Older Students Weigh Less Than Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms



Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable is listed on the horizontal axis, including the student's weight (in kilograms) and the student's height (in centimeters). The grey circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The corresponding estimates are reported in Appendix Table 13. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Table 1: Summary Statistics

	Mean	Std. Dev.	Minimum	Maximum	Observations
Age Variables					
Relative Age	-3.812	5.328	-65	60	572,889
Absolute Age	13.549	1.644	9.833	17	572,889
Expected Relative Age	5.505	3.354	0	11	572,889
Average Classmate Age	13.550	1.625	9.063	17	572,889
Body Image					
Perception	-0.011	0.769	-4	4	462,675
Lenient	0.213	0.410	0	1	462,675
Accurate	0.578	0.494	0	1	462,675
Harsh	0.209	0.407	0	1	462,675
Self-Description					
Too Thin	0.147	0.354	0	1	554,546
Right Size	0.558	0.497	0	1	554,546
Too Fat	0.294	0.456	0	1	554,546
Weight Outcomes					
BMI	19.389	3.407	5.951	79.861	476,401
Thin	0.047	0.211	0	1	476,401
Normal Weight	0.772	0.419	0	1	476,401
Overweight	0.181	0.385	0	1	476,401
Obese	0.040	0.196	0	1	476,401
Dieting Behaviors					
On a Diet	0.145	0.352	0	1	454,163
No Reason to Diet	0.561	0.496	0	1	454,163
Should Diet to Gain Weight	0.202	0.402	0	1	454,163
Should Diet to Lose Weight	0.091	0.288	0	1	454,163
Number of Times Eating					
Fruits	4.940	3.190	0	10	569,785
Vegetables	4.757	3.080	0	10	568,713
Sweets	3.940	3.086	0	10	568,815
Soda	3.238	3.238	0	10	569,084
Physical Activity					
No. Days Active for 60 Min	4.088	2.045	0	7	560,575
No. Times Exercising	3.321	2.330	0	7	465,717
No. Hours Exercising	2.520	2.223	0	7	358,910

Source: Health Behaviour in School-Aged Children, 2002-2018
Note: The summary statistics utilize the sample weights.

Table 2: Ordinary Least Squares Relationship Between Relative Age and Body Image

	(1)	(2)	(3)	(4)
Outcome →	Self-Description Relative to BMI	Lenient Body Image	Accurate Body Image	Harsh Body Image
1 SD ↑ Relative Age	0.007***	-0.004***	0.002**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Mean	-0.011	0.213	0.578	0.209
Observations	462,765	462,765	462,765	462,765

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." Positive values indicate a "harsh" view relative to BMI, and negative values indicate a "lenient" view relative to BMI. The dependent variable in column 2 is an indicator for whether the student had a lenient view, the dependent variable in column 3 is an indicator for whether the student had an accurate view, and the dependent variable in column 4 is an indicator for whether the student had a harsh view. The estimates are obtained from the ordinary least squares specification in equation (1). The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 3: Two-State Least Squares Results Showing That Relatively Older Students Are More Likely to Describe Themselves as Heavier Than Their BMIs Compared to Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

	(1)	(2)	(3)	(4)
Outcome →	Self-Description Relative to BMI	Lenient Body Image	Accurate Body Image	Harsh Body Image
1 SD ↑ Relative Age	0.028***	-0.017***	0.009***	0.008***
	(0.005)	(0.003)	(0.003)	(0.003)
F-Statistic	918.121	918.121	918.121	918.121
Mean	-0.011	0.213	0.578	0.209
Observations	462,765	462,765	462,765	462,765

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." Positive values indicate a "harsh" view relative to BMI, and negative values indicate a "lenient" view relative to BMI. The dependent variable in column 2 is an indicator for whether the student had a lenient view, the dependent variable in column 3 is an indicator for whether the student had an accurate view, and the dependent variable in column 4 is an indicator for whether the student had a harsh view. The estimates are obtained from the two-stage least squares specification shown in equation (3). The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 4: Relatively Older Students Are More Likely to Describe Themselves as "About the Right Size" Compared to Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

	(1)	(2)	(3)
Self-Description →	Too Thin	About the Right Size	Too Fat
1 SD ↑ Relative Age	-0.011***	0.019***	-0.009***
	(0.002)	(0.003)	(0.003)
F-Statistic	1,074.915	1,074.915	1,074.915
Mean	0.147	0.558	0.294
Observations	554,546	554,546	554,546

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is an indicator for whether the student described his/her body as "much too thin" or "a bit too thin." The dependent variable in column 2 is an indicator for whether the student described his/her body as being "about the right size." The dependent variable in column 3 is an indicator for whether the student described his/her body as being "a bit too fat" or "much too fat." The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10

Table 5: Two-Stage Least Squares Relationship Between Relative Age and Self-Described Body Type, by BMI Status

	(1)	(2)	(3)
Self-Description →	Too Thin	About the Right Size	Too Fat
Panel A: Underweight Adolescents			
1 SD ↑ Relative Age	-0.066***	0.062***	0.001
	(0.017)	(0.017)	(0.002)
F-Statistic	75.514	75.514	75.514
Mean	0.480	0.457	0.063
Observations	21,645	21,645	21,645
Panel B: Normal Weight Adolescents			
1 SD ↑ Relative Age	-0.015***	0.014***	0.001
	(0.003)	(0.003)	(0.003)
F-Statistic	798.501	798.501	798.501
Mean	0.160	0.622	0.219
Observations	357,797	357,797	357,797
Panel C: Overweight and Obese Adolescents			
1 SD ↑ Relative Age	0.002	0.010	-0.012*
	(0.002)	(0.007)	(0.007)
F-Statistic	349.094	349.094	349.094
Mean	0.024	0.329	0.647
Observations	83,323	83,323	83,323

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is an indicator for whether the student described his/her body as “much too thin” or “a bit too thin.” The dependent variable in column 2 is an indicator for whether the student described his/her body as being “about the right size.” The dependent variable in column 3 is an indicator for whether the student described his/her body as being “a bit too fat” or “much too fat.” The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. Panel A examines underweight adolescents, Panel B examines normal weight adolescents, and Panel C examines overweight and obese adolescents. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 6: Relatively Older Students Are Less Likely to Be Overweight or Obese Than Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

	(1)	(2)	(3)	(4)	(5)
		WHO BMI Category			
Outcome →	BMI	Thin	Normal Weight	Overweight	Obese
1 SD ↑ Relative Age	-0.135***	0.004**	0.008***	-0.012***	-0.005***
	(0.020)	(0.001)	(0.003)	(0.002)	(0.001)
F-Statistic	937.662	937.662	937.662	937.662	937.662
Mean	19.389	0.047	0.772	0.181	0.040
Observations	476,401	476,401	476,401	476,401	476,401

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the adolescent's body mass index. The dependent variable in column 2 is an indicator for whether the adolescent is classified as "thin," in column 3 for whether the adolescent is classified as "normal weight," in column 4 for whether the adolescent is classified as "overweight," and in column 5 for whether the adolescent is classified as "obese." The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 7: Relatively Older Students Are Less Likely to Want to Gain Weight Than Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

	(1)	(2)	(3)	(4)
		Not on a Diet…		
Outcome →	Currently on a Diet	My Weight is Fine	Because I Need to Put on Weight	But I Should Lose Weight
1 SD ↑ Relative Age	-0.002	0.013***	-0.008***	-0.003
	(0.002)	(0.003)	(0.002)	(0.002)
F-Statistic	850.319	850.319	850.319	850.319
Mean	0.145	0.561	0.202	0.091
Observations	454,163	454,163	454,163	454,163

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is an indicator for whether the student reported currently being on a diet, in column 2 for whether the student reported not having any reason to diet, in column 3 for whether the student reported that while s/he isn't on a diet s/he should diet to gain weight, and in column 4 for whether the student reported that while s/he isn't on a diet s/he should diet to lose weight. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 8: Relatively Older Students Consume More Low-Calorie Items and Fewer Calorie-Dense Items Than Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

	(1)	(2)	(3)	(4)
Times Per Week Eating →	Fruits	Vegetables	Sweets	Soda
1 SD ↑ Relative Age	0.085***	0.056**	-0.051**	-0.075***
	(0.018)	(0.017)	(0.017)	(0.019)
F-Statistic	1,098.825	1,096.539	1,097.638	1,098.025
Mean	4.940	4.757	3.940	3.238
Observations	569,785	568,713	568,815	569,084

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the number of times per week the student reports eating fruits, in column 2 the number of times per week the student reports eating vegetables, in column 3 the number of times per week the student reports eating sweets, and in column 4 the number of times per week the student reports drinking sodas. The estimates are obtained using a two-stage least squares strategy from equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.01

Table 9: Relatively Older Students Are More Physically Active Than Their Same-Age Counterparts Who Are Relatively Younger Within Their Classrooms

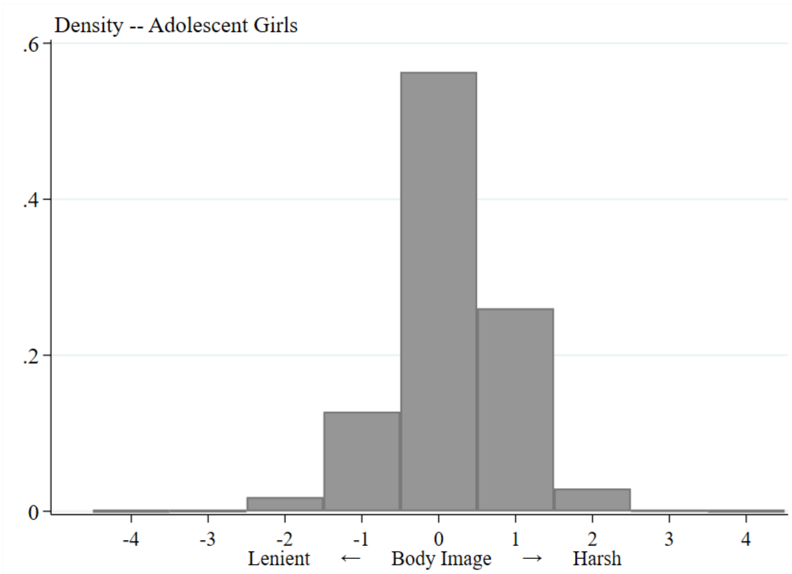
	(1)	(2)	(3)
Outcome →	Number of Days Last Week Physically Active for ≥ 60 Minutes	Number of Times Exercising Outside of School	Number of Hours Exercising Outside of School
1 SD ↑ Relative Age	0.121***	0.150***	0.098***
	(0.011)	(0.014)	(0.014)
F-Statistic	3,286.805	2,924.342	2,423.808
Mean	4.088	3.321	2.520
Observations	560,575	465,717	358,910

Source: Health Behaviour in School-Aged Children, 2002-2018

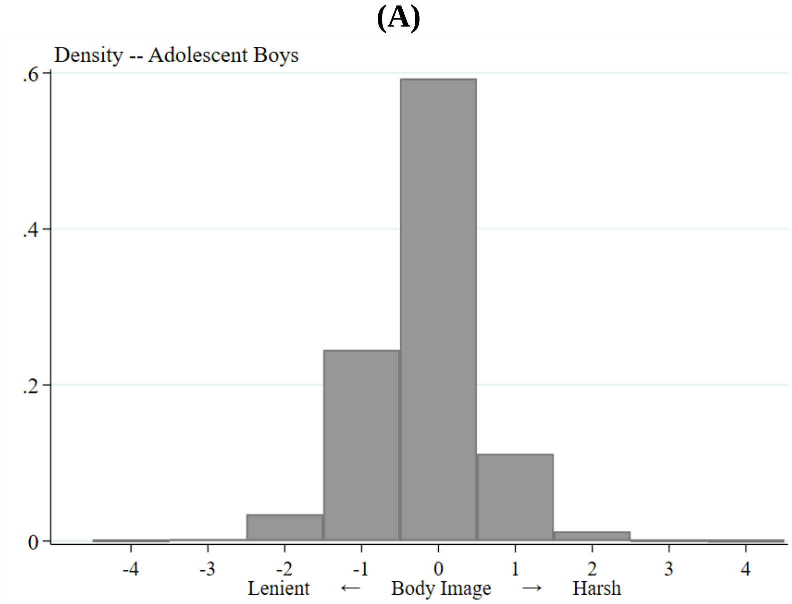
Note: The dependent variable in column 1 is the number of days the student reports being physically active for at least 60 minutes. The dependent variable in column 2 is the number of times the student reports exercising outside of school where s/he gets out of breath or sweats. The dependent variable in column 3 is the number of hours a week that the student reports exercising where s/he gets out of breath or sweats. The estimates are obtained using a two-stage least squares strategy from equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Figure 1: Distribution of Body Image Based on How Adolescents Described Their Bodies in Comparison to Their BMIs, by Sex



(A)

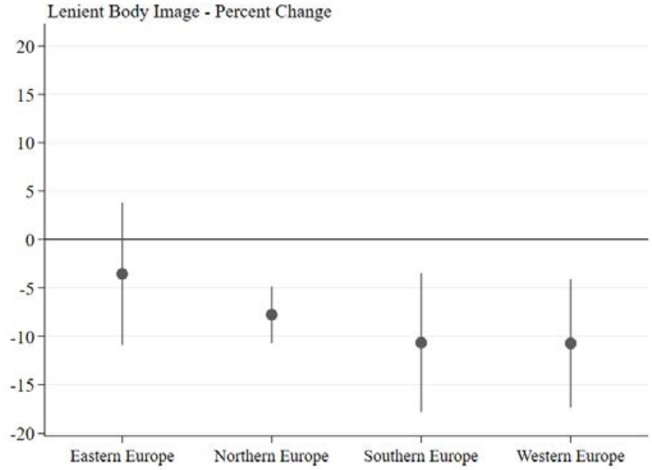


(B)

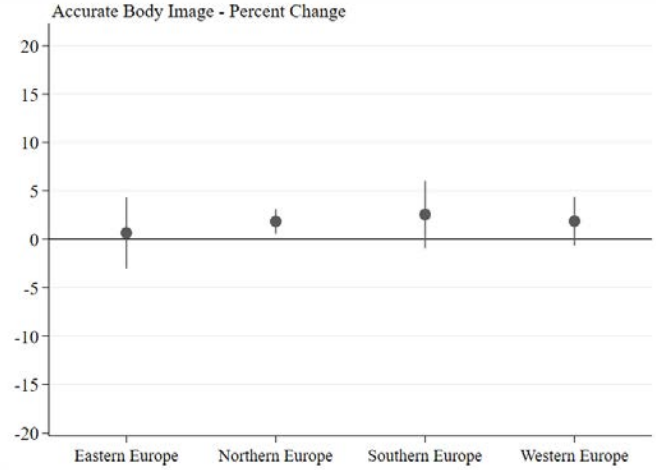
Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the distribution of body image perception for adolescent girls (Panel A) and adolescent boys (Panel B). This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese."

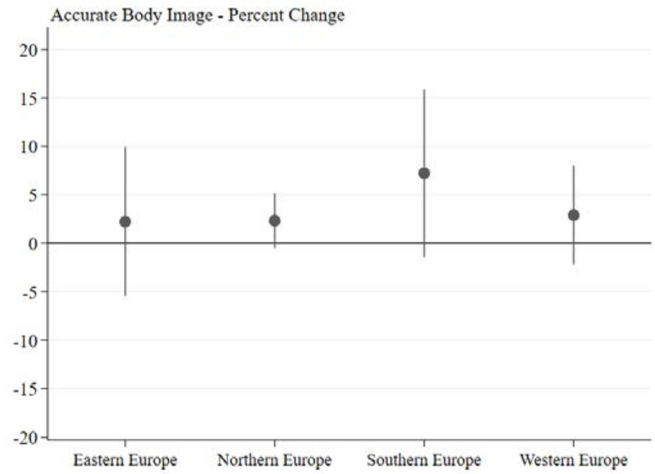
Appendix Figure 2: Relationship Between Relative Age and Body Image, by Region of Europe



(A)



(B)

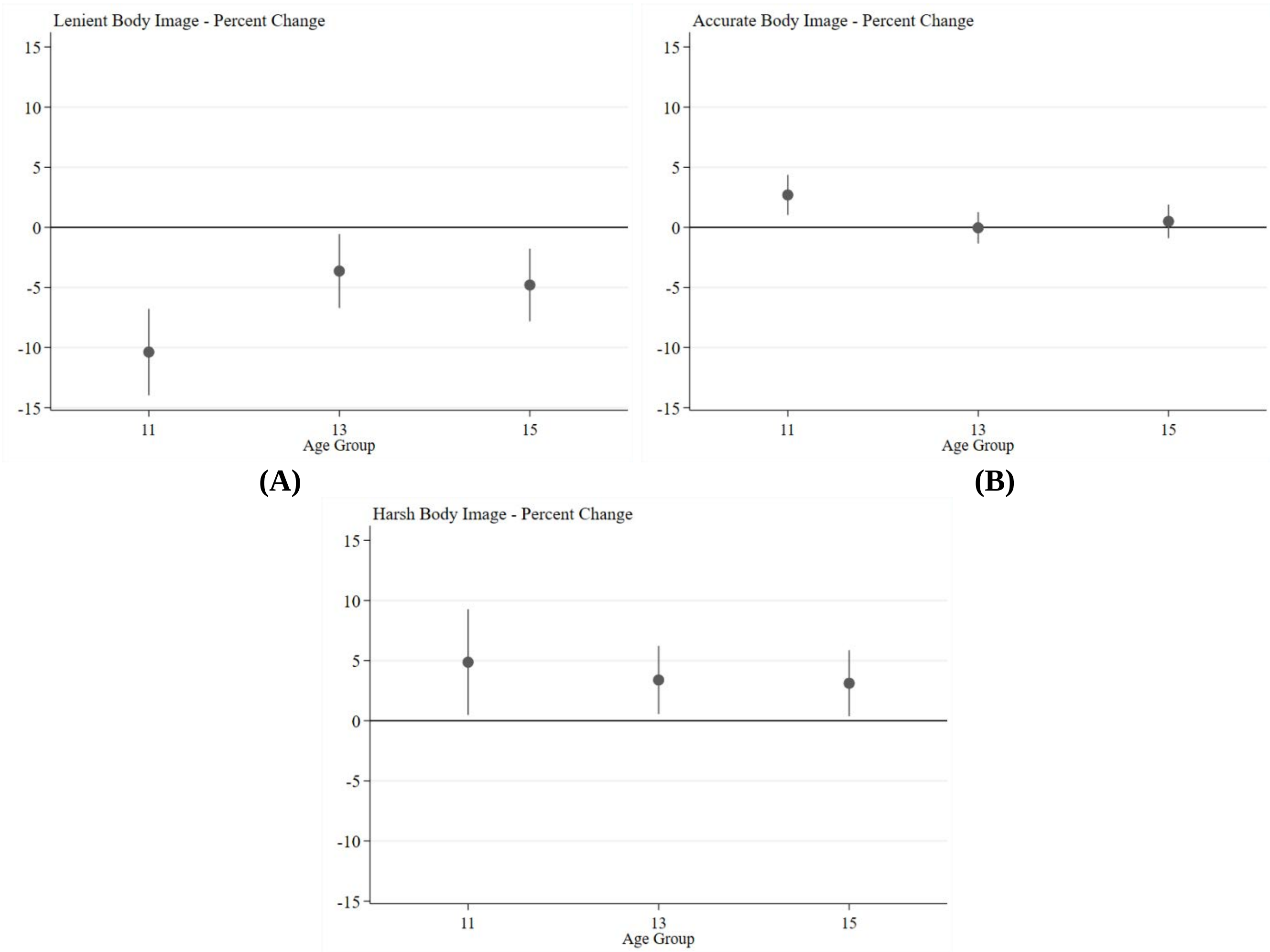


(C)

Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable is based on the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." The dependent variable in Panel A is an indicator for whether the student had a lenient view, the dependent variable in Panel B is an indicator for whether the student had an accurate view, and the dependent variable in Panel C is an indicator for whether the student had a harsh view. Observations are limited to the region of Europe indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Appendix Figure 3: Relationship Between Relative Age and Body Image, by Age Group

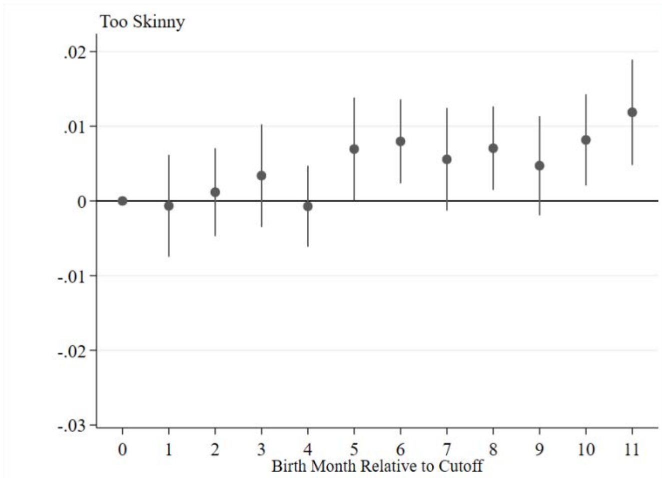


(C)

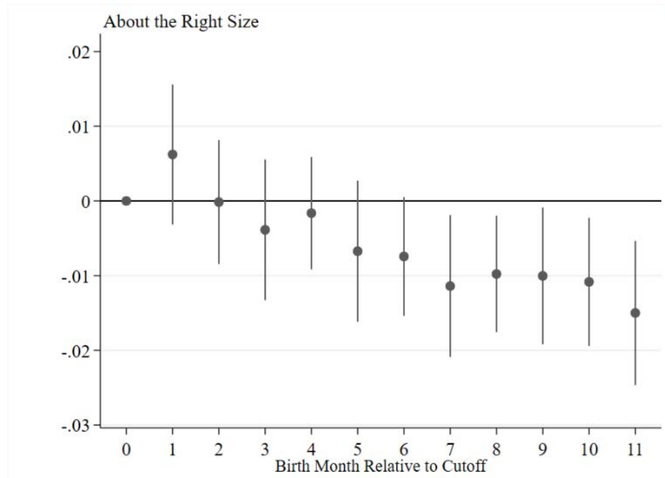
Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable is based on the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." The dependent variable in Panel A is an indicator for whether the student had a lenient view, the dependent variable in Panel B is an indicator for whether the student had an accurate view, and the dependent variable in Panel C is an indicator for whether the student had a harsh view. Observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

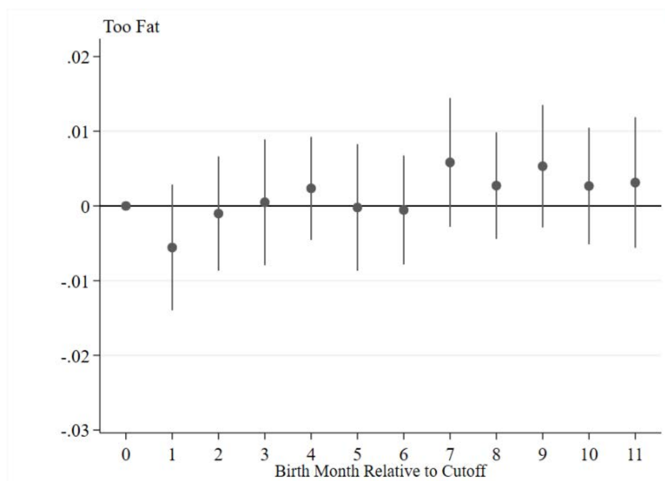
Appendix Figure 4: Reduced Form Relationship Between Birth Month Relative to the School Entry Cutoff Month and Self-Described Body Type



(A)



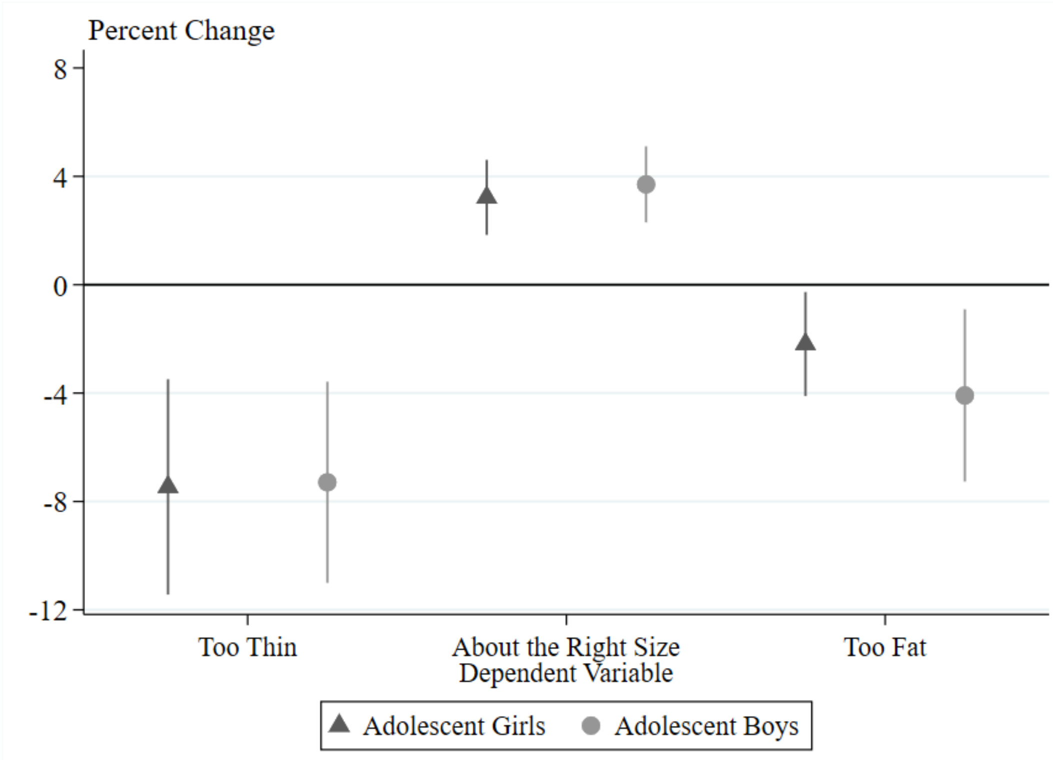
(B)



(C)

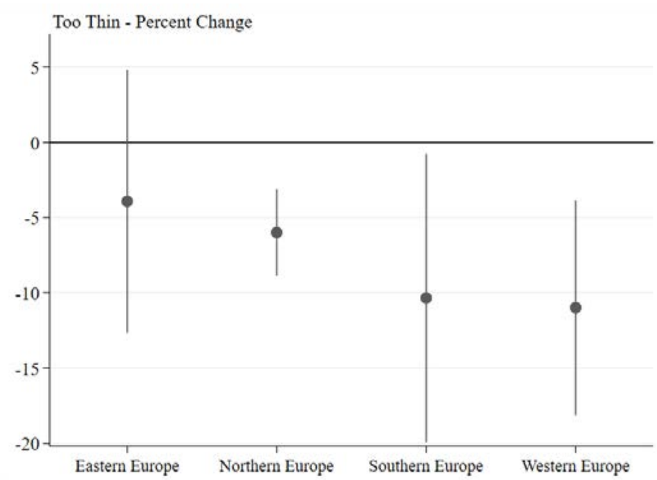
Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The dependent variable in Panel A is an indicator for whether the adolescent described his or herself as “much too thin” or “a bit too thin.” The dependent variable in Panel B is an indicator for whether the adolescent described his or herself as “about the right size.” The dependent variable in Panel C is an indicator for whether the adolescent described his or herself as “a bit too fat” or “much too fat.” The estimates are obtained from the reduced form regression shown in equation (2) where the independent variables of interest are indicators for birth month relative to the school entry cutoff month. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Appendix Figure 5: Two-Stage Least Squares Relationship Between Relative Age and Self-Described Body Type, by Sex

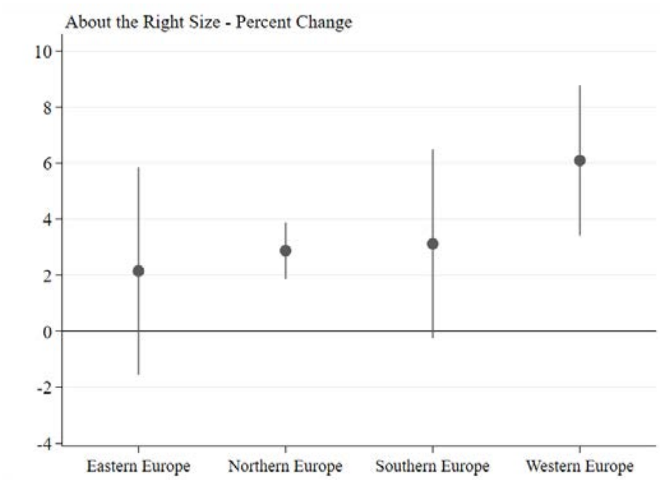


Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variables are listed on the horizontal axis and are indicators for whether the teen described his/her body as "too thin," "about the right size," or "too fat." The dark triangles plot the estimates for adolescent girls, while the lighter grey circles plot the estimates for adolescent boys. The vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

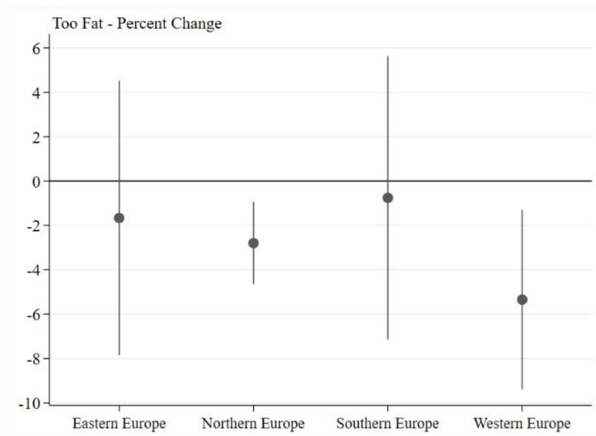
Appendix Figure 6: Relationship Between Relative Age and Self-Described Body Type, by Region of Europe



(A)



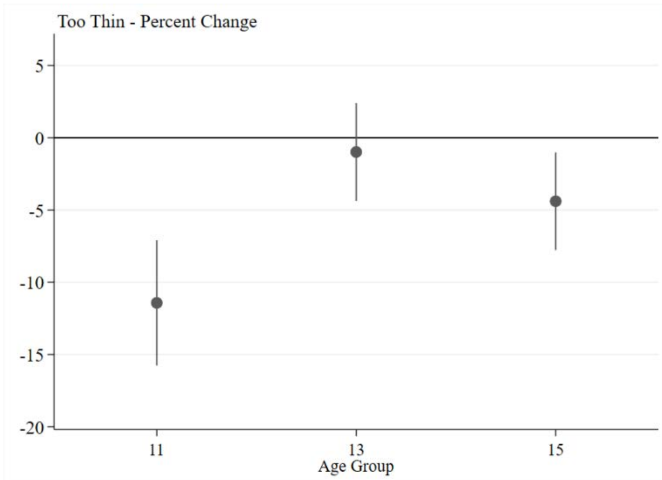
(B)



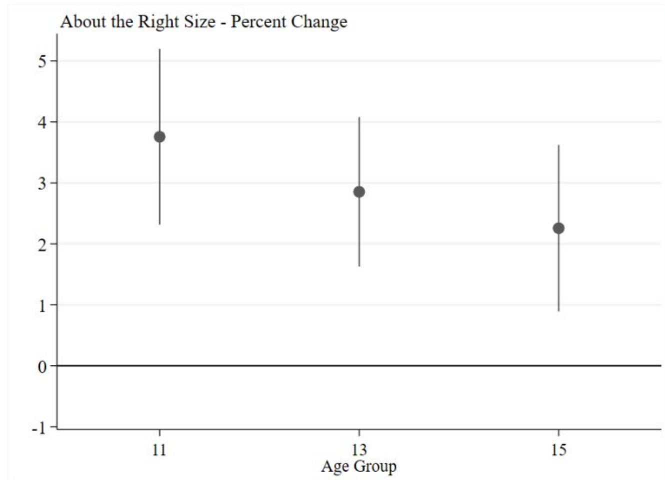
(C)

Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is an indicator for whether the adolescent described his or herself as "too skinny." The dependent variable in Panel B is an indicator for whether the adolescent described his or herself as "about the right size." The dependent variable in Panel C is an indicator for whether the adolescent described his or herself as "too fat." Observations are limited to the region of Europe indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

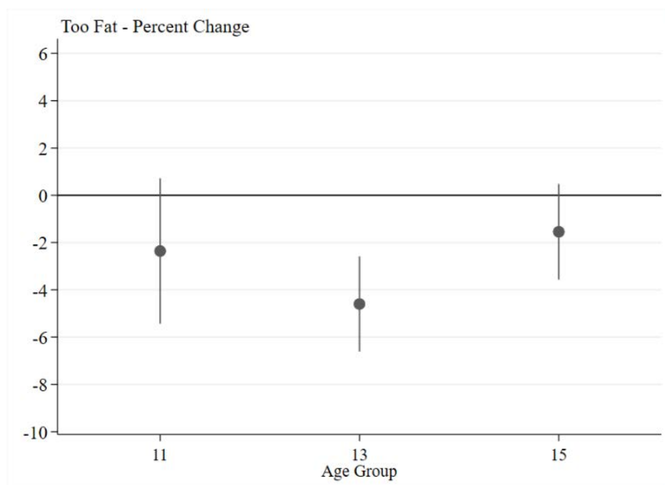
Appendix Figure 7: Relationship Between Relative Age and Self-Described Body Type, by Age Group



(A)



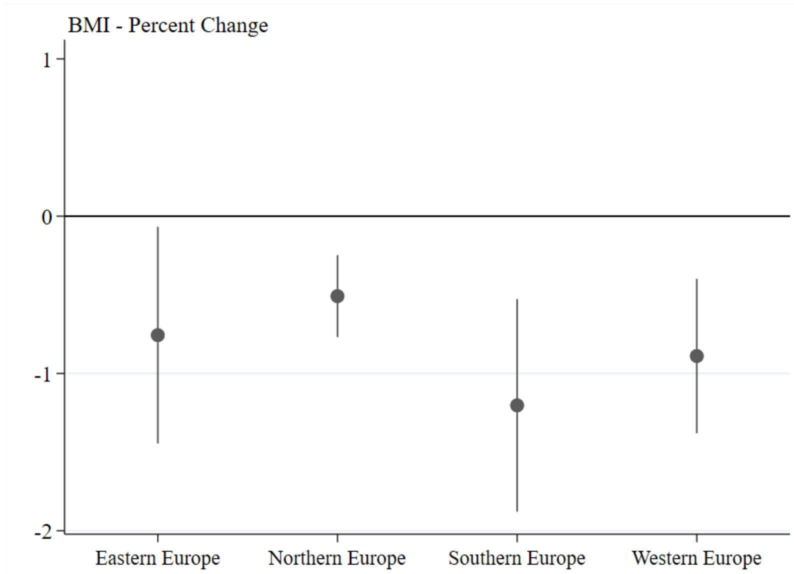
(B)



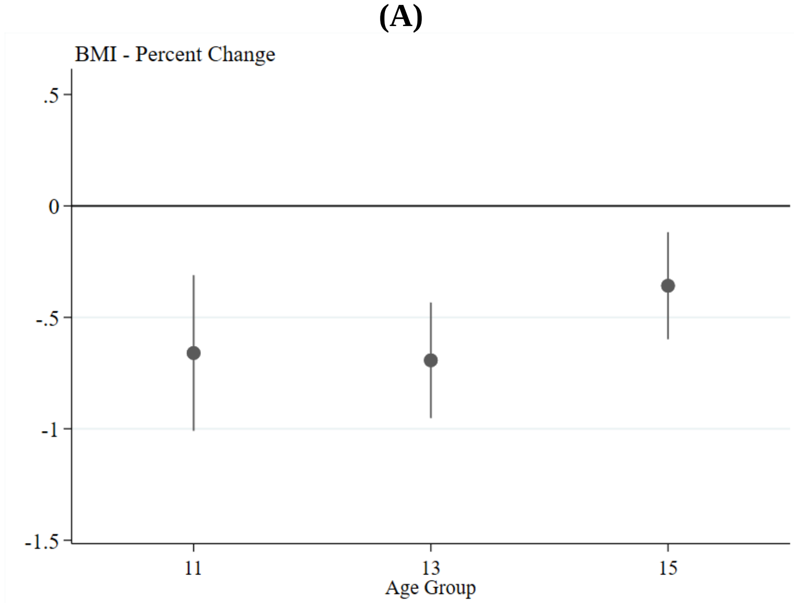
(C)

Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is an indicator for whether the adolescent described his or herself as “too skinny.” The dependent variable in Panel B is an indicator for whether the adolescent described his or herself as “about the right size.” The dependent variable in Panel C is an indicator for whether the adolescent described his or herself as “too fat.” Observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Appendix Figure 8: Relationship Between Relative Age and BMI, by Region of Europe and Age



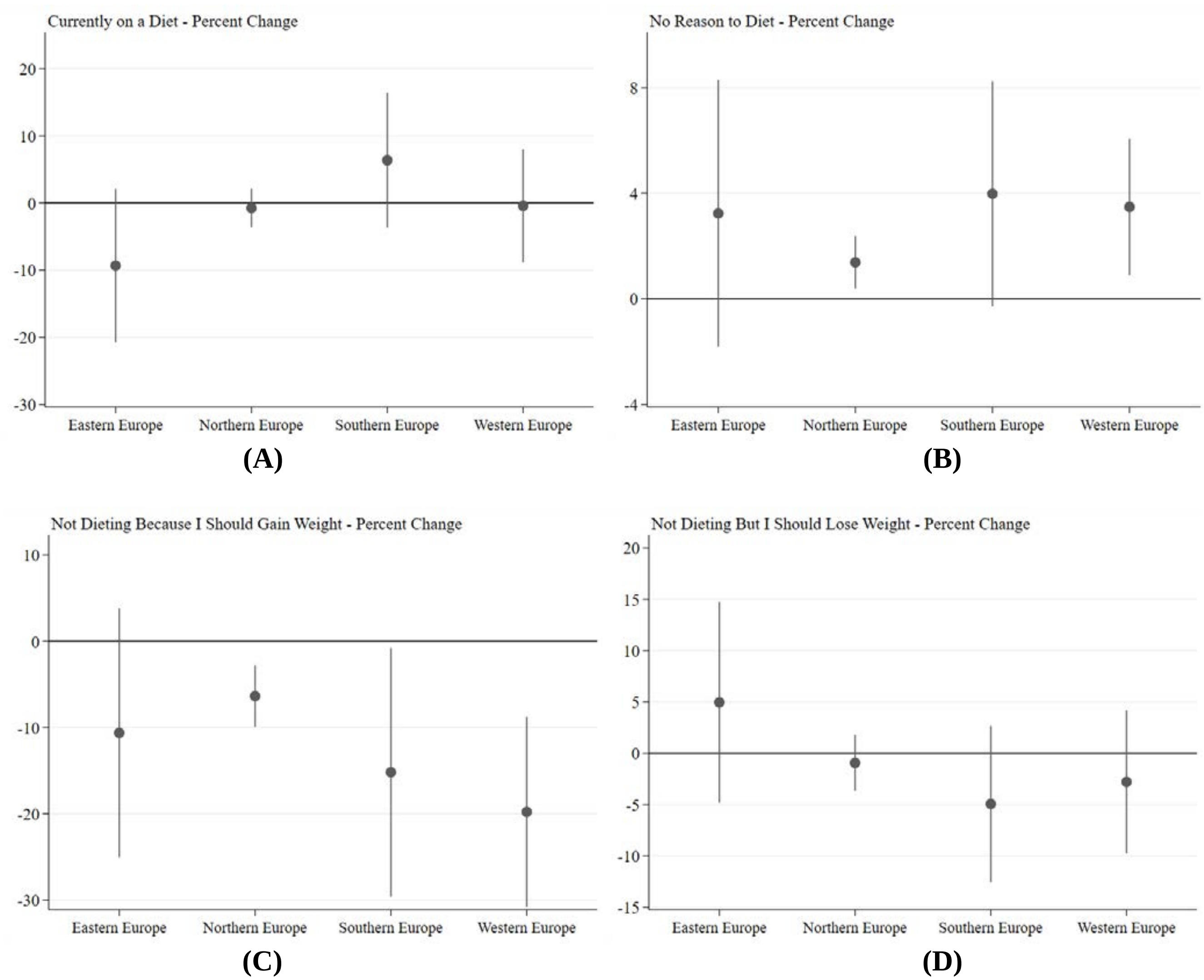
(A)



(B)

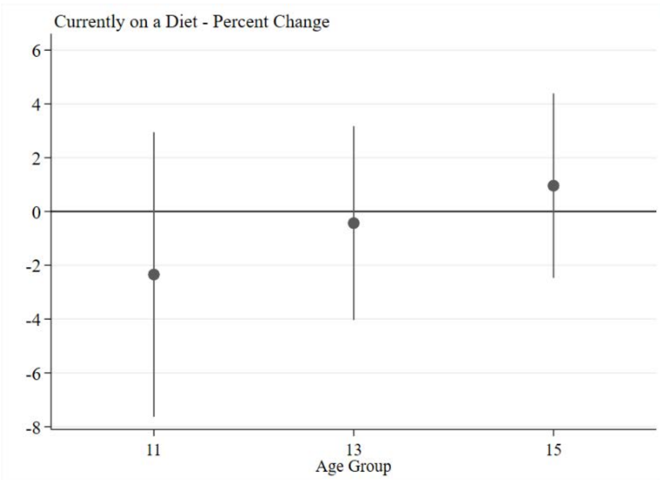
Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable is the adolescent's body mass index. In Panel A, observations are limited to the region of Europe indicated on the horizontal axis. In Panel B, observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Appendix Figure 9: Relationship Between Relative Age and Dieting Behaviors, by Region of Europe

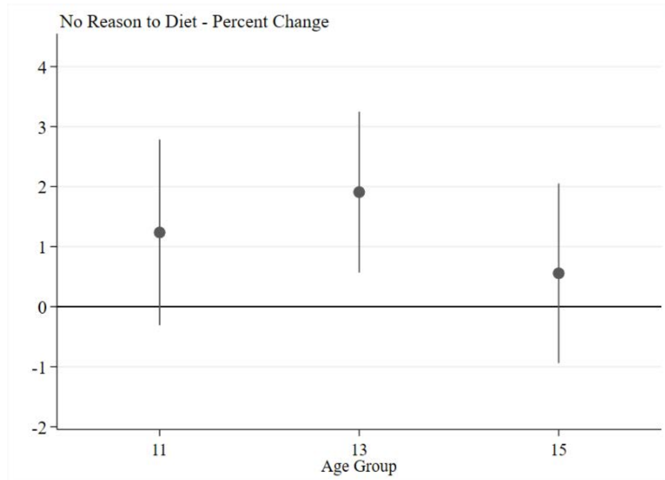


Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is an indicator for whether the adolescent reported being on a diet. The dependent variable in Panel B is an indicator for whether the adolescent reported having no reason to diet. The dependent variable in Panel C is an indicator for whether the adolescent reported not being on a diet but feeling that s/he should gain weight. The dependent variable in Panel D is an indicator for whether the adolescent reported not being on a diet but feeling that s/he should lose weight. Observations are limited to the region of Europe indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

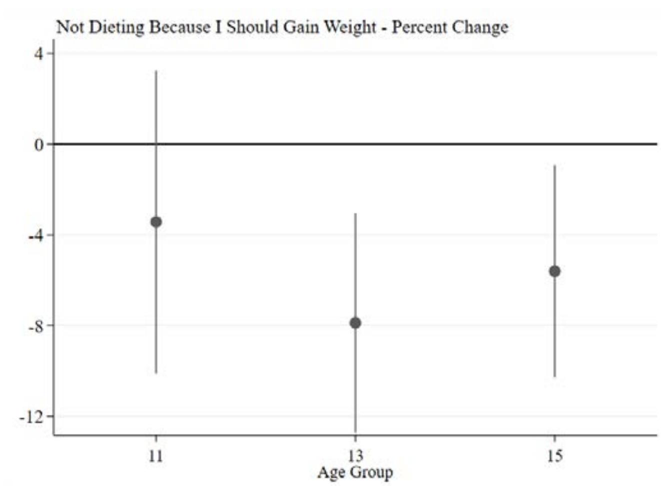
Appendix Figure 10: Relationship Between Relative Age and Dieting Behaviors, by Age Group



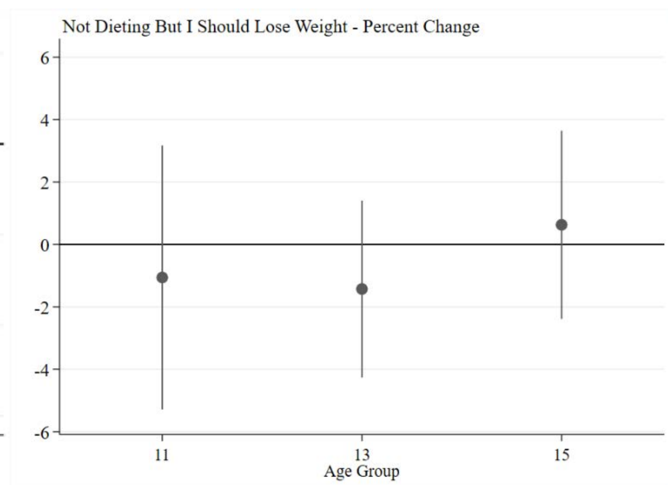
(A)



(B)



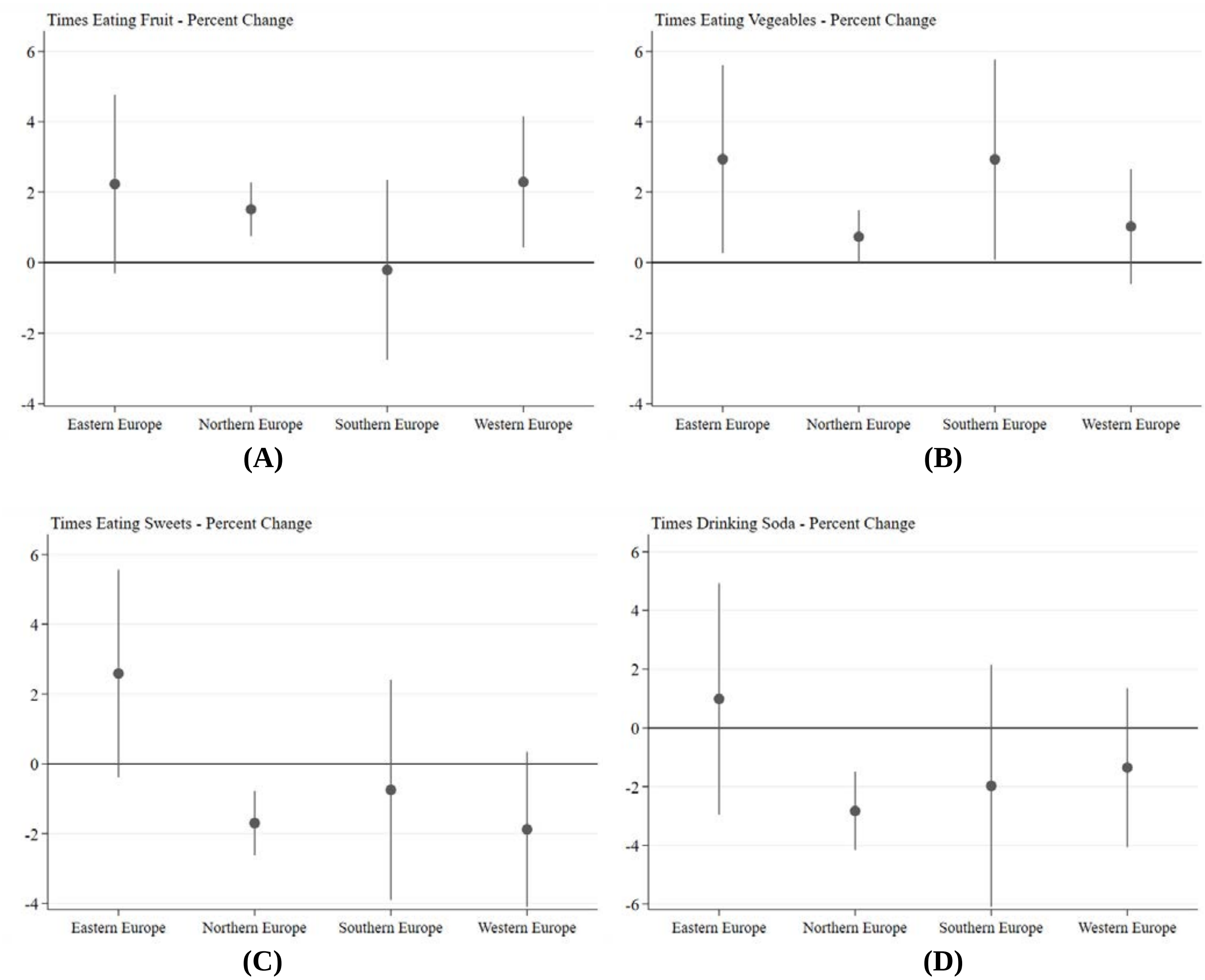
(C)



(D)

Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is an indicator for whether the adolescent reported being on a diet. The dependent variable in Panel B is an indicator for whether the adolescent reported having no reason to diet. The dependent variable in Panel C is an indicator for whether the adolescent reported not being on a diet but feeling that s/he should gain weight. The dependent variable in Panel D is an indicator for whether the adolescent reported not being on a diet but feeling that s/he should lose weight. Observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

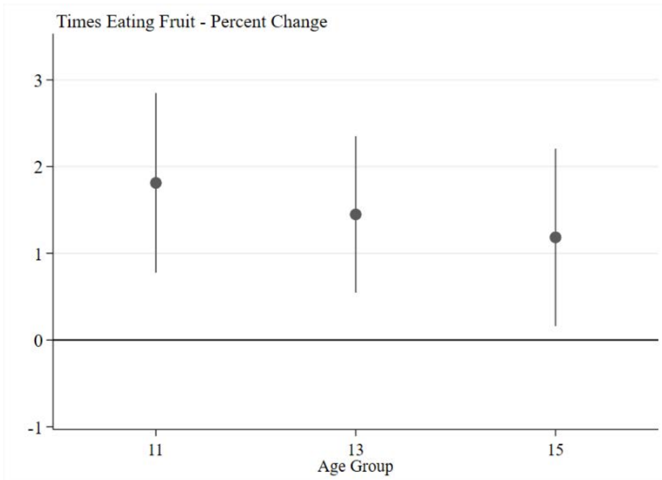
Appendix Figure 11: Relationship Between Relative Age and Nutritional Intake, by Region of Europe



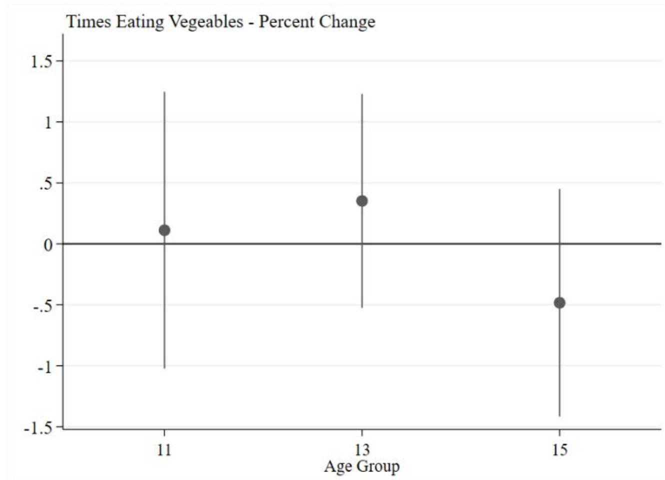
Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is the number of times the adolescent reported consuming fruit each week. The dependent variable in Panel B is the number of times the adolescent reported consuming vegetables each week. The dependent variable in Panel C is the number of times the adolescent reported consuming sweets each week. The dependent variable in Panel D is the number of times the adolescent reported consuming soda each week. Observations are limited to the region of Europe indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

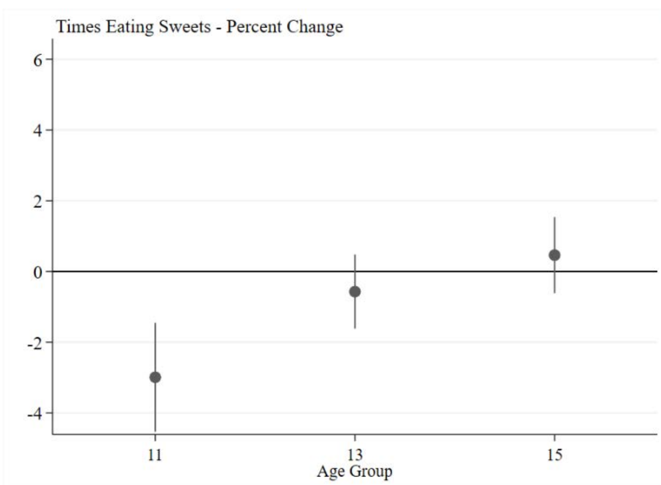
Appendix Figure 12: Relationship Between Relative Age and Nutritional Intake, by Age Group



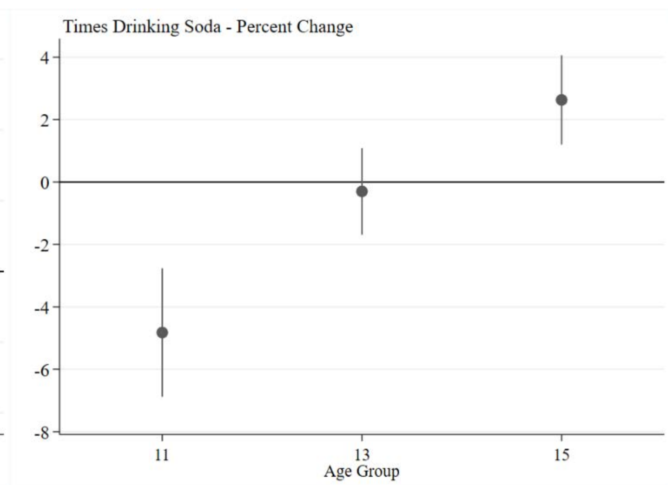
(A)



(B)



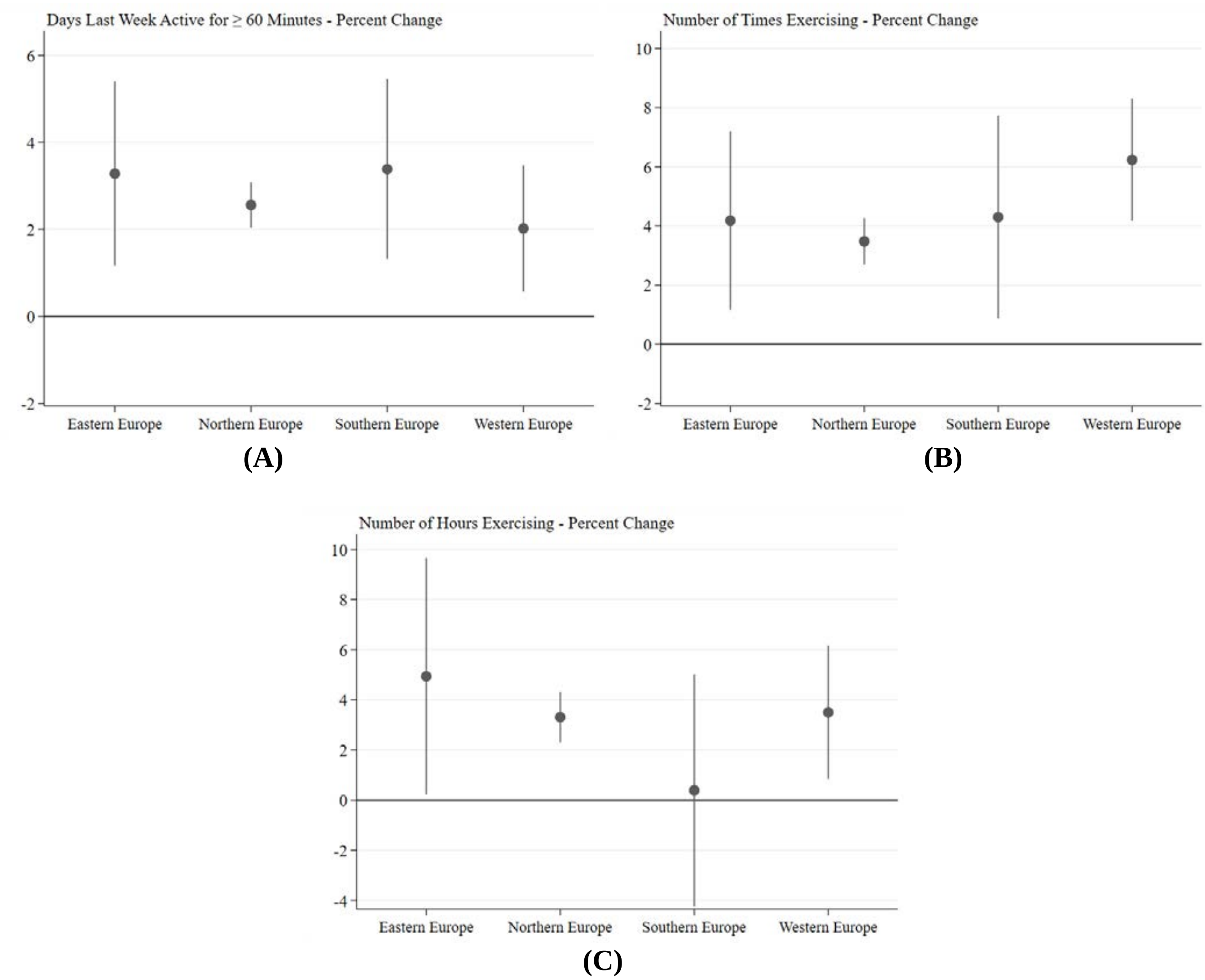
(C)



(D)

Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is the number of times the adolescent reported consuming fruit each week. The dependent variable in Panel B is the number of times the adolescent reported consuming vegetables each week. The dependent variable in Panel C is the number of times the adolescent reported consuming sweets each week. The dependent variable in Panel D is the number of times the adolescent reported consuming soda each week. Observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

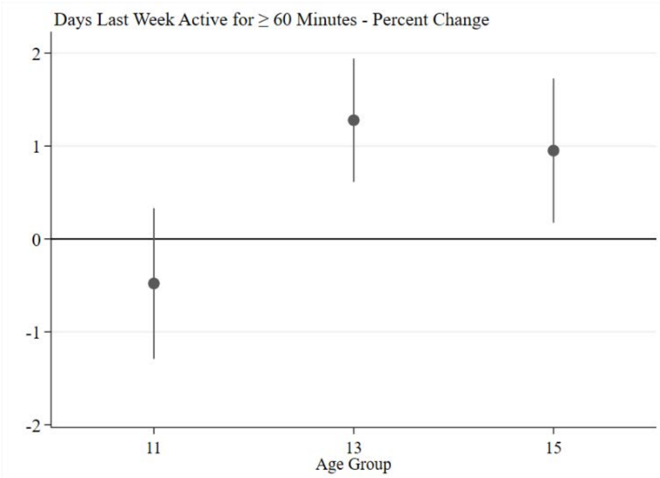
Appendix Figure 13: Relationship Between Relative Age and Physical Activity, by Region of Europe



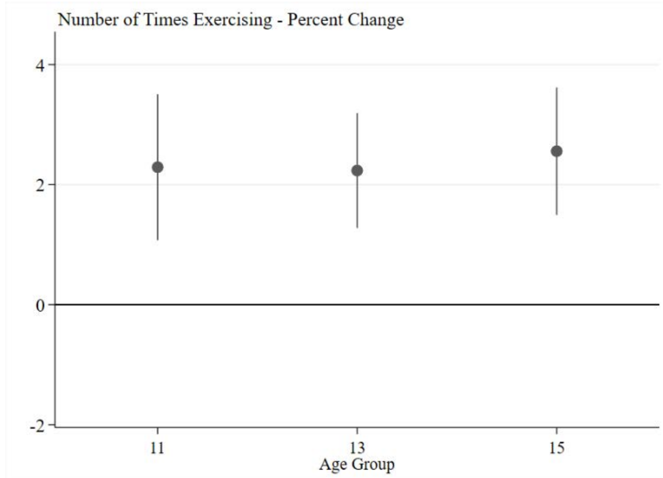
Source: Health Behaviour in School-Aged Children, 2002-2018

Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is the number of days that the adolescent reported being active for at least 60 minutes during the past week. The dependent variable in Panel B is the number of times the adolescent reported exercising outside of school during the past week. The dependent variable in Panel C is the number of hours the adolescent reported exercising outside of school during the past week. Observations are limited to the region of Europe indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

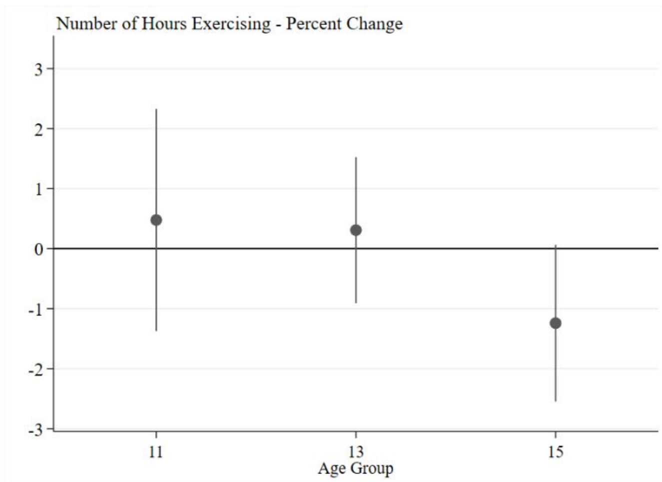
Appendix Figure 14: Relationship Between Relative Age and Physical Activity, by Age Group



(A)



(B)



(C)

Source: Health Behaviour in School-Aged Children, 2002-2018
Notes: The figures plot the percent change relative to the sample mean associated with a one standard deviation increase in relative age. The dependent variable in Panel A is the number of days that the adolescent reported being active for at least 60 minutes during the past week. The dependent variable in Panel B is the number of times the adolescent reported exercising outside of school during the past week. The dependent variable in Panel C is the number of hours the adolescent reported exercising outside of school during the past week. Observations are limited to the age category indicated on the horizontal axis. The circles plot the estimates, and the vertical lines denote the corresponding 95 percent confidence intervals. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors are clustered at the classroom level.

Appendix Table 1: Additional Summary Statistics

	(1)	(2)	(3)	(4)	(5)
	Mean	Std. Dev.	Minimum	Maximum	Observations
Weight	50.975	13.093	19	150	505,980
Height	161.614	11.828	120	256	503,290
Girl	0.511	0.500	0	1	572,889
Mom at Home	0.946	0.225	0	1	572,889
Dad at Home	0.790	0.407	0	1	572,889
Low Socioeconomic Status	0.272	0.445	0	1	572,889
Middle Socioeconomic Status	0.364	0.481	0	1	572,889
High Socioeconomic Status	0.364	0.481	0	1	572,889

Source: Health Behaviour in School-Aged Children, 2002-2018
Note: The summary statistics utilize the sample weights.

Appendix Table 2: School Entry Cutoff Dates

Country	Cutoff
Austria	September 1st
Belgium, Flanders	January 1st
Belgium, Wallonia	January 1st
Bulgaria	January 1st
Croatia	April 1st
Czech Republic	September 1st
Denmark	January 1st
England	September 1st
Estonia	October 1st
Finland	January 1st
France	January 1st
Greece	January 1st
Greenland	January 1st
Hungary	July 1st
Iceland	January 1st
Ireland	January 1st
Italy	January 1st
Latvia	January 1st
Lithuania	January 1st
Luxembourg	September 1st
Macedonia	January 1st
Malta	January 1st
Netherlands	October 1st
Norway	January 1st
Poland	September 1st
Scotland	March 1st
Slovakia	September 1st
Slovenia	January 1st
Spain	January 1st
Sweden	January 1st
Switzerland	July 1st
Ukraine	January 1st
Wales	September 1st

Source: Fumarco and Baert (2019)

Appendix Table 3: Relationship Between the Instrumental Variables and the Righthand Side Demographic Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome →	Age	Girl	Mom at Home	Dad at Home	Low SES	Middle SES	High SES
Birth Month Relative to the School Entry Cutoff							
0	-	-	-	-	-	-	-
1	0.006	-0.001	-0.001	-0.007*	-0.003	0.006	-0.003
	(0.016)	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.004)
2	-0.057***	0.002	-0.001	0.002	-0.002	0.005	-0.004
	(0.014)	(0.004)	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)
3	-0.103***	-0.001	-0.002	-0.003	-0.004	0.002	0.002
	(0.017)	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.004)
4	-0.086***	0.002	-0.004**	-0.002	-0.002	0.001	0.002
	(0.014)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
5	-0.136***	0.000	-0.002	-0.002	0.003	0.007	-0.010**
	(0.017)	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.004)
6	-0.150***	0.003	-0.002	0.001	0.005	-0.002	-0.003
	(0.014)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
7	-0.206***	0.011**	-0.001	0.002	-0.002	0.005	-0.003
	(0.017)	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.004)
8	-0.250***	0.007*	-0.002	0.002	-0.001	0.004	-0.003
	(0.014)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
9	-0.304***	0.003	-0.000	-0.001	-0.003	0.009*	-0.006
	(0.017)	(0.005)	(0.002)	(0.003)	(0.004)	(0.005)	(0.004)
10	-0.260***	0.003	-0.002	-0.003	0.006	0.006	-0.011***
	(0.015)	(0.004)	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
11	-0.298***	0.002	-0.003	-0.007*	0.003	0.001	-0.004
	(0.017)	(0.005)	(0.002)	(0.004)	(0.004)	(0.005)	(0.004)
Country FE?	Y	Y	Y	Y	Y	Y	Y
Survey Wave FE?	Y	Y	Y	Y	Y	Y	Y
Birth Month FE?	Y	Y	Y	Y	Y	Y	Y
Observations	572,889	572,889	572,889	572,889	572,889	572,889	572,889

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the student's age, in column 2 an indicator for whether the student is a girl, in column 3 for whether the student's mother is at home, in column 4 for whether the student's father is at home, in column 5 for whether the student is classified as low socioeconomic status, in column 6 for whether the student is classified as middle socioeconomic status, and in column 7 for whether the student is classified as high socioeconomic status. The estimates report reduced form results where the independent variables of interest indicate the student's birth month relative to the school entry cutoff month. The regressions include country fixed effects, survey wave fixed effects, and month-of-birth fixed effects. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10

Appendix Table 4: The Relationship Between Relative Age and Body Image is Robust to Dropping Students Born Around the School Entry Cutoff Month

	(1)	(2)	(3)
Months Excluded Around the Cutoff →	+/- 1 Month	+/- 2 Months	+/- 3 Months
Panel A: Self-Description Relative to BMI Status			
1 SD ↑ Relative Age	0.021***	0.017**	0.024**
	(0.005)	(0.007)	(0.010)
Mean	-0.010	-0.011	-0.011
Panel B: Lenient Body Image			
1 SD ↑ Relative Age	-0.014***	-0.011***	-0.015***
	(0.003)	(0.004)	(0.006)
Mean	0.213	0.213	0.213
Panel C: Accurate Body Image			
1 SD ↑ Relative Age	-0.008**	0.006	0.009
	(0.004)	(0.005)	(0.007)
Mean	0.578	0.578	0.578
Panel D: Accurate Body Image			
1 SD ↑ Relative Age	0.006**	0.005	0.007
	(0.003)	(0.004)	(0.005)
Mean	0.209	0.209	0.209
F-Statistic	977.923	1,178.145	1,033.546
Observations	391,503	321,869	246,044

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in Panel A is the student's self-perception relative to his or her BMI. This value is constructed by taking the difference between a variable denoting how the student described his or her body and a variable denoting the student's BMI status. The former variable takes on the value of 1 if the student describes his or her body as "much too thin," 2 if the student describes his or her body as "a bit too thin," 3 if the student describes his or her body as "about the right size," 4 if the student describes his or her body as "a bit too fat," and 5 if the student describes his or her body as "much too fat." The latter variable takes on the value of 1 if the student is classified as "severely thin," 2 for those classified as "thin," 3 for those classified as "normal weight," 4 for those classified as "overweight," and 5 for those classified as "obese." Positive values indicate a "harsh" view relative to BMI, and negative values indicate a "lenient" view relative to BMI. The dependent variable in Panel B is an indicator for whether the student had a lenient view, the dependent variable in Panel C is an indicator for whether the student had an accurate view, and the dependent variable in Panel D is an indicator for whether the student had a harsh view. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. Column 1 drops students born the month prior to the school entry cutoff and the month of the school entry cutoff. Column 2 drops students born two months prior to the cutoff month, the cutoff month, or the month following the cutoff. Column 3 drops students born three months prior to the cutoff month, during the cutoff month, or the two months following the cutoff months. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 5: The Relationship Between Relative Age and Body Misperception Exists Throughout Our Survey Window

	(1)	(2)	(3)	(4)
Outcome →	Self-Description Relative to BMI	Lenient Body Image	Accurate Body Image	Harsh Body Image
Panel A: Survey Wave = 2002				
1 SD ↑ Relative Age	0.036***	-0.016**	-0.001	0.017***
	(0.012)	(0.006)	(0.008)	(0.007)
F-Statistic	837.191	837.191	837.191	837.191
Mean	0.025	0.197	0.581	0.222
Observations	84,111	84,111	84,111	84,111
Panel B: Survey Wave = 2006				
1 SD ↑ Relative Age	0.031***	-0.018***	0.010	0.008
	(0.010)	(0.005)	(0.006)	(0.005)
F-Statistic	206.810	206.810	206.810	206.810
Mean	0.015	0.202	0.578	0.220
Observations	101,492	101,492	101,492	101,492
Panel C: Survey Wave = 2010				
1 SD ↑ Relative Age	0.027***	-0.024***	0.022***	0.002
	(0.010)	(0.006)	(0.007)	(0.005)
F-Statistic	243.987	243.987	243.987	243.987
Mean	-0.018	0.210	0.588	0.202
Observations	105,043	105,043	105,043	105,043
Panel D: Survey Wave = 2014				
1 SD ↑ Relative Age	0.027***	-0.011**	0.000	0.011**
	(0.010)	(0.005)	(0.006)	(0.005)
F-Statistic	270.581	270.581	270.581	270.581
Mean	-0.017	0.220	0.571	0.209
Observations	87,673	87,673	87,673	87,673
Panel E: Survey Wave = 2018				
1 SD ↑ Relative Age	0.014	-0.013**	0.010	0.003
	(0.012)	(0.007)	(0.008)	(0.006)
F-Statistic	175.642	175.642	175.642	175.642
Mean	-0.062	0.241	0.568	0.192
Observations	84,446	84,446	84,446	84,446

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the student's self-perception relative to his or her BMI. The dependent variable in column 2 is an indicator for whether the student had a lenient view, the dependent variable in column 3 is an indicator for whether the student had an accurate view, and the dependent variable in column 4 is an indicator for whether the student had a harsh view. The estimates are obtained from the two-stage least squares specification shown in equation (3). Each panel limits the sample to a single survey wave. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 6: The Relationship Between Relative Age and Self-Described Body Type Robust to Dropping Students Born Around the School Entry Cutoff Month

	(1)	(2)	(3)
Months Excluded Around the Cutoff →	+/- 1 Month	+/- 2 Months	+/- 3 Months
Panel A: Too Thin			
1 SD ↑ Relative Age	-0.008***	-0.004	-0.007
	(0.002)	(0.003)	(0.004)
Mean	0.147	0.559	0.294
Panel B: About the Right Size			
1 SD ↑ Relative Age	0.018***	0.012***	0.014**
	(0.003)	(0.004)	(0.006)
Mean	0.147	0.559	0.294
Panel C: Too Fat			
1 SD ↑ Relative Age	-0.010**	-0.008**	-0.007
	(0.003)	(0.004)	(0.006)
Mean	0.147	0.559	0.294
F-Statistic	1,154.384	1,347.288	1,190.749
Observations	468,838	384,865	294,099

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in Panel A is an indicator for whether the student described his or herself as "much too thin" or "a bit too thin." The dependent variable in Panel B is an indicator for whether the student described his or herself as "about the right size." The dependent variable in Panel C is an indicator for whether the student described his or herself as "a bit too fat" or "much too fat." The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. Column 1 drops students born the month prior to the school entry cutoff and the month of the school entry cutoff. Column 2 drops students born two months prior to the cutoff month, the cutoff month, or the month following the cutoff. Column 3 drops students born three months prior to the cutoff month, during the cutoff month, or the two months following the cutoff months. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10

Appendix Table 7: The Relationship Between Relative Age and BMI is Robust to Dropping Students Born Around the School Entry Cutoff Month

	(1)	(2)	(3)
Months Excluded Around the Cutoff →	+/- 1 Month	+/- 2 Months	+/- 3 Months
1 SD ↑ Relative Age	-0.126***	-0.120***	-0.144***
	(0.023)	(0.029)	(0.044)
F-Statistic	995.775	1,195.291	1,038.124
Mean	19.395	19.399	19.408
Observations	403,080	331,469	253,443

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable is the adolescent's BMI. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. Column 1 drops students born the month prior to the school entry cutoff and the month of the school entry cutoff. Column 2 drops students born two months prior to the cutoff month, the cutoff month, or the month following the cutoff. Column 3 drops students born three months prior to the cutoff month, during the cutoff month, or the two months following the cutoff months. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10

Appendix Table 8: Two-Stage Least Squares Relationship Between Relative Age and Adolescent BMI, by Sex

	(1)	(2)	(3)	(4)	(5)
		WHO BMI Category			
Outcome →	BMI	Thin	Normal Weight	Overweight	Overweight
Panel A: Adolescent Girls					
1 SD ↑ Relative Age	-0.106***	0.007***	0.001	-0.008***	-0.003**
	(0.026)	(0.002)	(0.003)	(0.003)	(0.001)
F-Statistic	730.910	730.910	730.910	730.910	730.910
Mean	19.198	0.049	0.815	0.136	0.025
Observations	242,456	242,456	242,456	242,456	242,456
Panel B: Adolescent Boys					
1 SD ↑ Relative Age	-0.167***	0.002	0.015***	-0.016***	-0.007***
	(0.032)	(0.002)	(0.004)	(0.004)	(0.002)
F-Statistic	573.859	573.859	573.859	573.859	573.859
Mean	19.587	0.044	0.729	0.227	0.055
Observations	233,945	233,945	233,945	233,945	233,945

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The sample in Panel A is adolescent girls. The sample in Panel B is adolescent boys. The dependent variable in column 1 is the adolescent's body mass index. The dependent variable in column 2 is an indicator for whether the adolescent is classified as "thin," in column 3 for whether the adolescent is classified as "normal weight," in column 4 for whether the adolescent is classified as "overweight," and in column 5 for whether the adolescent is classified as "obese." The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10

Appendix Table 9: Two-Stage Least Squares Relationships Between Relative Age, Weight, and Height

	(1)	(2)
Outcome →	Weight (kg)	Height (cm)
1 SD ↑ Relative Age	-0.444***	-0.074
	(0.062)	(0.053)
F-Statistic	988.268	988.491
Mean	50.975	161.614
Observations	505,980	503,290

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the adolescent's weight (in kilograms) and in column 2 the adolescent's height (in centimeters). The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 10: Two-Stage Least Squares Relationship Between Relative Age and Dieting Behaviors, by Sex

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Adolescent Girls				Adolescent Boys			
		Not on a Diet				Not on a Diet		
Outcome →	Currently on a Diet	My Weight is Fine	Because I Need to Put on Weight	But I Should Lose Weight	Currently on a Diet	My Weight is Fine	Because I Need to Put on Weight	But I Should Lose Weight
1 SD ↑ Relative Age	-0.002	0.008**	-0.005**	0.000	-0.001	0.018***	-0.012***	-0.005
	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
F-Statistic	695.482	695.482	695.482	695.482	528.501	528.501	528.501	528.501
Mean	0.187	0.494	0.074	0.245	0.102	0.632	0.109	0.157
Observations	232,845	232,845	232,845	232,845	221,318	221,318	221,318	221,318

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in columns 1 and 5 is an indicator for whether the student reported currently being on a diet, in columns 2 and 6 for whether the student reported not having any reason to diet, in columns 3 and 7 for whether the student reported that while s/he isn't on a diet s/he should diet to gain weight, and in columns 4 and 8 for whether the student reported that while s/he isn't on a diet s/he should diet to lose weight. Columns 1-4 examine adolescent girls, and columns 5-8 examine adolescent boys. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Appendix Table 11: Two-Stage Least Squares Relationship Between Relative Age and Food Consumption, by Sex

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Adolescent Girls				Adolescent Boys			
Times Eaten →	Fruits	Vegetables	Sweets	Soda	Fruits	Vegetables	Sweets	Soda
1 SD ↑ Relative Age	0.043*	0.029	-0.068***	-0.058**	0.138***	0.089***	-0.030	-0.094***
	(0.023)	(0.022)	(0.022)	(0.024)	(0.027)	(0.026)	(0.026)	(0.028)
F-Statistic	874.54	872.95	873.821	873.379	683.256	681.694	682.356	683.225
Mean	5.191	5.001	3.998	2.897	4.676	4.500	3.880	3.597
Observations	292,404	291,974	292,037	292,122	277,381	276,739	276,778	276,962

Note: The dependent variable in columns 1 and 5 is the number of times a week the student reported eating fruits, in columns 2 and 6 the number of times per week the student reported eating vegetables, in columns 3 and 6 is the number of times per week the student reported eating sweets, and in columns 4 and 8 the number of times per week the student reported drinking sodas. Columns 1-4 examine adolescent girls, and columns 5-8 examine adolescent boys. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.
*** p < 0.01, ** p < 0.05, * p < 0.10

Appendix Table 12: Relationship Between Relative Age and Physical Activity, by Sex

	(1)	(2)	(3)	(4)	(5)	(6)
	Adolescent Girls			Adolescent Boys		
Outcome →	Number of Days Last Week Physically Active for at Least 60 Minutes	Number of Times Exercising Outside of School	Number of Hours Exercising Outside of School	Number of Days Last Week Physically Active for at Least 60 Minutes	Number of Times Exercising Outside of School	Number of Hours Exercising Outside of School
1 SD ↑ Relative Age	0.090***	0.114***	0.070***	0.162***	0.198***	0.137***
	(0.014)	(0.017)	(0.017)	(0.017)	(0.021)	(0.023)
F-Statistic	867.783	827.377	689.220	683.971	630.333	497.180
Mean	3.812	2.912	2.182	4.377	3.750	2.875
Observations	287,282	238,968	184,461	273,293	226,749	174,449

Source: Health Behaviour in School-Aged Children, 2002-2018

Note: The dependent variable in column 1 is the number of days the student reported being physically active for at least 60 minutes. The dependent variable in column 2 is the number of times the student reported exercising outside of school where s/he gets out of breath or sweats. The dependent variable in column 3 is the number of hours a week that the student reported exercising where s/he gets out of breath or sweats. The estimates are obtained using a two-stage least squares strategy shown in equation (3) where birth month relative to the school entry cutoff is an instrument for relative age and the average age of comparable classroom peers is used as an instrument for absolute age. The estimates utilize the sample weights. Standard errors, shown in parentheses, are clustered at the classroom level.

*** p < 0.01, ** p < 0.05, * p < 0.10