# The Social Dynamics of Adolescent Health and Achievement

# : The Role of Local Hierarchies in the School Context


By

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*"Trust in the Lord with all your heart, and lean not on your own understanding; In all your ways acknowledge Him, and He shall direct your paths."*
*Proverbs 3:5-6*

# Abstract


The Social Dynamics of Adolescent Health and Achievement: The Role of Local Hierarchies in the School Context

Jinho Kim

This dissertation contains three essays on social status and adolescent well-being. Using a quasi-experimental design, this dissertation uncovers consistent causal evidence for what I refer to as the *local-ladder* effect: conditional on attending a given school, a student's relative position in his/her school cohort with respect to student resources and characteristics significantly affects adolescent psychological health, social development, and educational achievement.

In the first chapter, using the National Longitudinal Study of Adolescent to Adult Health (Add Health), I examine the relationship between relative deprivation and adolescent health. Using classmates as a reasonable reference group for adolescents, this study shows that controlling for own parental income, students with higher relative deprivation are less likely to report excellent health status and more likely to have higher levels of depressive symptoms. This study also sheds new light on how relative deprivation influences population health. This study provides evidence showing that relative deprivation affects adolescent health through a combination of psychological and social pathways. My findings show that declines in future expectations (largely about educational attainment) play a more important role than concurrent psychological distress in linking relative deprivation to adolescent health. This study argues that adolescents who are relatively deprived tend to interpret their lower social status as a major obstacle to better future, which in turn, deteriorates their health outcomes. Moreover, this study demonstrates that relative deprivation harms adolescent health through major disadvantages in social relationships (largely with other students and friends), providing suggestive evidence of the potential roles of downward social stigma or discrimination by other students from families with relatively higher socioeconomic status. This study suggests that social inequality and stratification in our society may have an implication extended to population health in the next generation through socioeconomic stratification within schools.

In the second chapter, I examine whether and how cognitive ability affects adolescent psychological health outcomes. Although a large number of studies have documented the link between cognitive ability and adolescents' psychological health, relatively little is known about the underlying mechanisms behind the relationship. Social-psychological frameworks help us better understand how ability shapes adolescents' psychological health, by contextualizing the meaning of an individual's ability in reference to other students' ability in the school settings. Building on theories about status attainment and empirical evidence on relative-performance evaluation, I argue that the effects of ability rank on adolescent psychological health are largely driven by students at the top and bottom of the ability distribution due to differential rewards and penalties associated with status attainment/loss by relative position in the distribution. To evaluate this argument, I leverage a quasi-experimental research design and estimate the nonlinear effects of ability rank on adolescent depression. Using the Add Health data, this study shows that psychological consequences of ability rank are more pronounced among students at the top and bottom of the ability distribution while ability rank appears to have no impact in the middle of the distribution. In addition, this nonlinear nature of the relationship between ability rank and adolescent depression is found to be relevant only for male adolescents, reflecting gender differences in status attainment process and social integration patterns. Finally, this study provides evidence showing that social relationships (rather than psychological factors and future expectations) serve as the most likely and relevant mechanism of the rank effects on adolescent depression. The finding that ability rank is associated with self-perception on ability, but not self-esteem appears to support the argument that it may not be students' self-assessment but peer prejudice and discrimination that connect ability rank to depressive symptoms.

The third chapter, written jointly with Jason M. Fletcher, explores whether and how body mass affects psychological well-being and educational attainment among female adolescents enrolled in middle and high school in the United States. A large literature has shown that people, especially women, with higher body mass index (BMI) face a range of negative life outcomes, including lower human capital accumulation and worse mental health. While both biological and sociological theories would suggest these relationships, social scientists interested in uncovering the social effects of BMI have been forced to use absolute (i.e., biological) rather than relative (i.e., social) BMI in their analyses. However, absolute measures of body mass conflate biological and social effects, and more importantly, fail to operationalize sociological theories. This, in turn, leads

to mixed evidence on the links between BMI and adolescent outcomes as well as a lack of understanding of the social effects of BMI. This study uses the Add Health data, leverages a quasi-experimental research design, and utilizes a relative measure of body mass. Results show that women with high relative BMI in U.S. high schools face substantial mental health burdens that translate into lower levels of school attachment as well as higher levels of school dropout, even after adjusting for absolute BMI. A component of these effects is from classmate, but not teacher nor close-friend, discrimination. Results of this study suggest that there is a pure social effect of body mass on adolescent outcomes, and social context plays an important role in it. In other words, whether body mass (or excessive body fat) matters for your psychological well-being and educational attainment highly depends on where one is situated or by whom one is surrounded. Based on our results, we also argue that it is essential to operationalize sociological theories, in part by shifting away from the empirical focus on absolute BMI in the literature, to make further progress in understanding how BMI affects life outcomes.

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# Chapter 1. Introduction

## 1. Background and motivation

During the period of adolescence, peers serve as the most critical source of information and influence, as adolescents grow independent from parents and spend an increasing amount of time with peers. It has long been acknowledged that peers have substantial impacts on almost every aspect of adolescent development, and consequently, adult health and socioeconomic outcomes. Most peer effects literature documents the importance of having "good peers," especially within schools, showing that peer characteristics on average (e.g., peer-level socioeconomic status (SES) or ability) are strongly correlated with adolescent outcomes, such as educational attainment, physical and mental health, delinquent behavior, substance use, and so on (Coleman 1961; Legewie and DiPrete 2012; Raudenbush and Willms 1995; Ross 2012; Teitler and Weiss 2000). In light of this evidence, parents put considerable effort into exposing their child to a "better" peer group via neighborhood or school choice. Therefore, to the extent that school (or peer group) selection depends on parental SES, a peer context is a powerful source of intermediary structure of social stratification and inequality, which has an impact on adolescents' health and educational trajectories.

However, we know relatively little about stratification processes *within* schools—i.e., whether and how a peer group within a school is stratified and what are the consequences of those peer hierarchies. The key focus of the "broader" peer effects literature limits our understanding about the roles of peers in the structure of school-based local hierarchies. In order to have a more complete picture of the complex relationship between peer groups and adolescent development, we need to better understand how (conditional on attending a given school or selecting into a given peer group) school-based local hierarchies are created and how relative position in those hierarchies influences various adolescent outcomes. This dissertation intends to enhance our understanding of an overlooked aspect of stratification during the period of adolescence, a social-psychological process through which social hierarchies in the peer world of high school shape students' health and educational trajectories.

**2. Theoretical framework of influences of peer structure and hierarchy**

Several sociological theories have argued that social contexts (or reference groups) serve as a critical source of influence (Cooley 1902; Festinger 1954; Goffman 1963; Mead 1934). In particular, these theories have highlighted two theoretically distinct roles (though empirically difficult to disentangle) of peer structures and hierarchies.

First, focusing on a comparison function of reference group, social comparison theory and reflected self-appraisal (or looking-glass self) perspective are useful to understand the process by which individuals develop and maintain self-appraisal in social contexts (e.g., Crosnoe and Muller 2004; Crosnoe 2007). These sociological perspectives emphasize the importance of social contexts and interpersonal interactions in the self-analysis process (Alicke, Guenther, and Zell 2012): personal identity is constructed as well as maintained through comparing to and interacting with others in a given social environment. More specifically, social comparison theory posits that individuals construct a self-identity by comparing their beliefs, abilities, behaviors, and characteristics to those of others who belong to a reference group in their social environment (Festinger 1954; Suls and Wheeler 2000). Similarly, the reflected self-appraisal perspective indicates that individuals develop self-understanding by interpreting others' appraisals of one's beliefs, abilities, behaviors and characteristics (Cooley 1902).

Second, focusing on a normative function of reference group, the sociological tradition of social psychology explicitly focuses on the process of social stigmatization as well as its consequences (Link and Phelan 2001; Major and O'Brien 2005; Schafer and Ferraro 2011). Although there is some variability in the definition of stigma (Link and Phelan 2001), most scholars agree with the following: "people who are stigmatized have (or are believed to have) an attribute that marks them as different and leads them to be devalued in the eyes of others" (Major and O'Brien 2005:395). Therefore, a reference group sets and enforces group norms by delivering rewards or punishments for conformity or nonconformity. This may take a variety of different forms, such as labeling, negative stereotyping, exclusion, discrimination, and status loss (Link and Phelan 2001).

In general, these sociological theories suggest that what matters is not only who you are and what you have, but who your reference group is and what they have. Drawing on these social-psychological frameworks, I argue that relative position in school-based peer hierarchies affects various adolescent outcomes.

**3. Conceptualization of status and hierarchies in adolescence**

Despite different ways of conceptualization of social status and hierarchies (Martin 2009), high status people tend to be socially desirable and receive deference (Gould 2002; Rossman, Esparza, and Bonacich 2010). The school, in this sense, is hierarchical in nature. Within any school, students are differentiated by age, ability and academic achievement, either formally in groups or by individual test results or grades. In addition, for a regulative purpose, school rewards students for "good" behavior, which is typically related to scholastic achievement. Therefore, peer group structure and hierarchies in the school settings tend to be developed based on students' academic performance, more specifically, relative academic position in a reference group. Other studies indicate that not only student's own position but also parental socioeconomic position influence peer group structure and hierarchies in the school setting (Bannink, Pearce, and Hope 2016; Quon and McGrath 2014).

In addition to these somewhat conventional measures of social position (i.e., scholastic ability and parental SES), student standings within a peer group may also be based on other status-generating characteristics (e.g., Gorman, Kim, and Schimmelbusch 2002). There may be a range of gender-specific attributes with particular salience for young people, which predict adolescent status attainment and contribute to school-based local hierarchies. For instance, among female adolescents, position in the peer hierarchy is generally associated with physical appearance or body shape, whereas physical prowess and sports success consistently have been found to be the major predictor of status attainment among male adolescents (Cillessen and Rose 2005; Coleman 1961; Eder and Kinney 1995; McLaren and Kuh 2004; Meisinger et al. 2007; Paxton et al. 2005). In this dissertation, I examine various attributes of salient youth identities, such as (cognitive) ability, parental SES, as well as body weight (for female adolescents), which may contribute to peer group structures and creating school-based local hierarchies.

**4. Methodological challenges and empirical analyses**

Despite the significance of peer influences on adolescent outcomes, attempts to estimate this relationship face a variety of complex and interrelated challenges (e.g., Sacerdote 2014). One of the major challenges may be that students (or parents) sort into schools and neighborhoods in ways that make it difficult to disentangle self-selection effects from actual (causal) peer effects. In this dissertation, I adopt quasi-experimental research designs in order to address several methodological challenges to estimate causal effects of peers. More specifically, in order to account for selection into school, I compare students in different cohorts within the same school, while controlling for school fixed effects.

This cross-cohort empirical strategy is based strictly on the assumption that self-selection may operate to determine which school a student attends, but there are no remaining self-selection forces in choosing the grade-level in a school. This assumption is consistent with an environment where “good” and “bad” schools can be observed by parents but the attributes of specific cohorts in a school are more difficult to observe. The school-level fixed effects capture “good” versus “bad” school environments and rely on across-grade (within school) differences in peer composition to provide quasi-experimental variation for the analysis. In order to assess the validity of this research design, I conduct balancing tests to show whether within-school across-cohort characteristics (e.g., variation with respect to the mean and variance of a characteristic) are uncorrelated with predetermined student and parental attributes. I interpret no correlations as evidence that within-school cohort-to-cohort variation in peer characteristics is plausibly exogenous, and so is a student’s relative position in the peer distribution.

In addition, as a robustness check, to provide more stringent test of the causal effects of relative position in school-based local hierarchies, I use family fixed effects models to exploit exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school. Of the list of potential confounders (e.g., genetic endowments, family characteristics, parental ability, parenting styles, friends, schools, so on), family fixed effects models account for every part of each of components that is shared between siblings: for example, siblings have the same parents, similar abilities, similar friends, and go to similar schools. Family fixed effects models thus rule out important family background and childhood experience that are shared between siblings. In this dissertation, this supplementary analysis allows for comparison of adolescent health outcomes between two siblings who share measurable and unmeasurable family background characteristics (e.g., parental income) but have different relative deprivation scales (e.g., relative deprivation in terms of parental income) depending on the cohort composition (e.g., cohort distribution of parental income). Although a sibling comparison model is better at addressing several important possible threats to internal validity of this study (e.g., eliminating potential confounding such as family background characteristics and school selection), fixed effects estimates should be interpreted cautiously due to potential sibling spillover effects (Fletcher and Wolfe 2008).

In this dissertation, I use the National Longitudinal Study of Adolescent to Adult Health (Add Health), which provides a unique opportunity to examine the causal effect of relative position in school-based local hierarchies with respect on a broader range of adolescent outcomes. First and foremost, the cross-cohort strategy, as described above, requires data on multiple cohorts from the same schools. Therefore, one of the major features of Add Health that the survey covers multiple cohorts within the same school is essential for the identification strategy of my study. In addition, the longitudinal nature of the data allows me to link the relative position during high school to adult outcomes in later life, and reduces concerns about reverse causality issues as well. Lastly, Add Health contains a nationally representative sample of adolescents in the United States, which improves the external validity of the findings of this dissertation.

**5. Overview of the chapters**

This dissertation consists of three chapters. The first chapter investigates the relationship between relative deprivation and adolescent psychological health. This chapter is motivated by lack of evidence on the effects of relative deprivation adolescent health and limited evidence on the mechanisms. Specifically, this chapter investigates how a student's relative position in terms of family SES (or relative deprivation) carries significant social meaning that affects social integration, interpersonal functioning and psychological health status. This chapter also sheds new light on how relative deprivation influences population health, by exploring relatively understudied potential mechanisms of the effect of relative deprivation—e.g., future expectations and social relationship. This chapter provides evidence that social inequality and stratification in our society may have an implication extended to population health in the next generation through socioeconomic stratification within schools.

The second chapter examines how local hierarchies with respect to (cognitive) ability influences students' psychological well-being. While it is well-documented that ability is highly correlated with students' psychological health (Beaujean, Parker, and Qiu 2013; Deary, Weiss, and Batty 2010; Emerson, Einfeld, and Stancliffe 2010; Gunnell et al. 2009; Zammit et al. 2004), its underlying mechanisms remain understudied. Building on theories about status attainment and empirical evidence on relative-performance evaluation, this chapter explores potential nonlinearity in the relationship between ability rank and adolescent psychological health: the effects of ability rank may be largely driven by students at the top and bottom of the ability distribution due to differential rewards and penalties associated with status attainment/loss by relative position in the distribution. In addition, given gender differences in status attainment process and social integration patterns, this chapter investigates whether the rank effects differ between male and female adolescents.

In the third chapter, I argue that in addition to conventional sources of status hierarchy in adolescence (e.g., ability and family SES), relative standing in terms of other salient youth characteristics like body weight also contributes to creating a local hierarchy which has an impact on adolescent outcomes. This chapter also intends to operationalize social theories that suggest the negative consequences of excessive body weight on human capital accumulation and worse mental health. While both biological and sociological theories would suggest these relationships, social scientists interested in uncovering the social effects of BMI have been forced to use absolute (i.e., biological) rather than relative (i.e., social) BMI in their analyses. Focusing on “relative” body weight while controlling for “absolute” body weight, this chapter disentangles the social effects of BMI on adolescent outcomes. In addition, this chapter also identifies a particular pathway linking relative body mass, psychological well-being, and educational attainment. This chapter suggests that in order to operationalize social theories of the effects of excessive body weight, a student’s relative position is of clear conceptual interest because it solely conveys a social channel through which body weight shapes adolescent outcomes.

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# Chapter 2. Understanding the Relationship between Relative Deprivation and Adolescent Health

Jinho Kim

## ABSTRACT

Although a large number of studies have documented the link between relative deprivation and health outcomes, gaps of knowledge in the literature still remain. Two main research gaps involve lack of evidence on health implications of relative deprivation among adolescents and limited evidence on the mechanisms. In order to fill these gaps, using a large, nationally representative longitudinal survey of U.S. adolescents, this study investigates whether relative deprivation influences adolescent health. Using classmates as a reasonable reference group for adolescents, this study computes the measure of relative deprivation (e.g., Yitzhaki Index), based on one's own and peers' parental income. Findings show that controlling for own parental income, students with higher relative deprivation are less likely to report excellent health status and more likely to have higher levels of depressive symptoms. This study also sheds new light on the mechanisms through which relative deprivation shapes adolescent health. This study provides evidence that relative deprivation affects adolescent health through the combination of psychological and social pathways. Results suggest that declines in future expectations (largely about educational attainment) play a more important role than concurrent psychological distress in linking relative deprivation to adolescent health. This study argues that adolescents who are relatively deprived tend to interpret their lower social status as a major obstacle to better future, which in turn, deteriorates their health outcomes. Moreover, this study demonstrates that relative deprivation harms adolescent health through major disadvantages in social relationships (largely with other students and friends), providing suggestive evidence of the potential roles of downward social stigma or discrimination by other students from families with relatively higher socioeconomic status. This study suggests that social inequality and stratification in our society may have an implication extended to population health in the next generation through socioeconomic stratification within schools.

Keywords: Relative Deprivation; Stratification; Inequality; Health; Depression; Social Relationship; Social Comparison; Social Stigma; Discrimination; Adolescence

## 1. Introduction

Socioeconomic status (SES) is one of the most important determinant of health and well-being (Marmot 2004; Phelan et al. 2004). In both aggregate and individual studies, SES, whether assessed by income, education, or occupation, is linked to various health outcomes including mortality and morbidity (Adler, Boyce, and Chesney 1994; Adler and Ostrove 1999; Marmot 2002; Reiss 2013). Among several potential mechanisms linking SES to health outcomes, it is not surprising that low SES may affect an individual's health by limiting access to health-related material resources such as affordable, nutritious foods, safe neighborhoods, and economic security (Laaksonen 2005; Sacker et al. 2001).

However, evidence from the early and mid-1990s has demonstrated that SES is important to health not only for those in poverty, but at all levels of SES, suggesting the important role of relative deprivation in population health (Adler et al. 1994; Marmot and Wilkinson 2001; Wilkinson 1997). This line of research thus argues that beyond the direct relationship between SES and power to purchase goods and services to maintain health, an individual's SES relative to SES of other people affects his or her health status (relative income hypothesis) (Deaton 2001; Marmot 2004; Subramanyam et al. 2009). In recent years, the relationship between relative deprivation and health draws more attention, as absolute poverty has been declining in most countries but income inequality and relative deprivation have been rising (Piketty 2014; Subramanian 2004).

Despite compelling evidence that the relative deprivation is consequential for health outcomes, there are still knowledge gaps about this relationship. While previous studies have focused largely on adult populations, little is known about the effects of relative deprivation on adolescent health. This study argues that aside from the lack of evidence for adolescents there are several other reasons why it is important and useful to assess the relationship between relative deprivation and adolescent health. First, the analysis of relative deprivation and adolescent health provides the ideal opportunity to address several important empirical and conceptual limitations that prior studies contain. For example, while the definition of reference group for social comparison still remains contentious in the literature (Adjaye-Gbewonyo and Kawachi 2012; Lhila and Simon 2010; Mangyo and Park 2011), the school (or classroom), as a bounded social institution, is arguably the most obvious frame of reference for adolescents (Coleman 1961; Crosnoe 2011).

In addition, the analysis of relative deprivation and adolescent health can provide valuable insights into our understanding of how the effect of relative deprivation operates to influence population health. While the theories of relative deprivation have focused almost exclusively on psychological distress resulting from invidious social comparisons as the primary mechanism, focusing on adolescence, a unique and important developmental period marked by formation of identity and future expectations and greater dependence on friends, brings new aspects of potential mechanisms of the effect of relative deprivation. Last but not least, the analysis of relative deprivation and adolescent health may also provide clearer implications for policy since schoolmates and classmates, the most sensible reference group for adolescents, are often subject to direct policy influence (e.g., Billings, Deming, and Rockoff 2014; Cook and Ludwig 2006).

In this study, I examine whether and how relative deprivation influences adolescent health. Specifically, I analyze the link between the measure of relative deprivation (e.g., Yitzhaki Index), computed based on one’s own and their peers’ parental income, and adolescent health outcomes including self-rated health and depressive symptoms. I also explore a range of potential pathways through which relative deprivation affects adolescent health. In particular, I investigate several mechanisms focusing on psychological factors (such as concurrent psychological distress and future expectations), social factors (such as social relationships in the school and friendship network), and behavioral factors (such as adverse health behaviors as a means of self-medication). Finally, to further validate the findings of this study, I perform a series of robustness checks involving alternative measures of outcome variables, estimation models, empirical specifications, etc.

## 2. Background

### *2.1 Socioeconomic status, social position, and health*

There is considerable evidence from various countries and settings that SES, whether assessed by income, wealth, educational attainment, or occupation class, is linked to various health outcomes including physical and mental health, well-being, longevity, and disability (Adler et al. 1994; Adler and Ostrove 1999; Marmot 2002; Phelan et al. 2004; Reiss 2013). The mechanisms that underlie this link involve material and social-psychological factors of affluence and social position. First, it is well-known that there are socioeconomic class gradients in experience of, and exposure to, a wide range of physical risk factors for health (Huurre, Aro, and Rahkonen 2003). For instance, low SES may affect an individual's health by limiting access to health-related material resources such as nutritious foods, safe neighborhoods, and economic security (absolute income hypothesis). Second, beyond this direct relationship between SES and power to purchase goods and services to maintain health, researchers have suggested that an individual's position relative to others in the reference group based on SES influences his or her health status (relative income hypothesis) (Marmot and Wilkinson 2001; Wilkinson 1997).

A large body of literature has documented that health differentials occur at all levels of the SES hierarchy, not limited to the bottom SES group, suggesting the importance of relative deprivation (Deaton 2001; Eibner and Evans 2005; Eibner, Sturm, and Gresenz 2004; Marmot

2004; Salti 2010; Subramanyam et al. 2009). In other words, over and above absolute material resources, SES may be important for health since it is the basis of social comparisons between an individual and one's reference group (Adler et al. 2000; Goodman et al. 2001, 2003; Singh-Manoux, Marmot, and Adler 2005). Prior studies have thus sought to understand whether and how relative deprivation in SES (or relative position in the SES hierarchy) have an impact on physical and psychological health, independent of the effects of absolute SES—i.e., why two individuals with a similar level of material resources (such as household income) may differ in health status if one is surrounded by more affluent people and the other is surrounded by less affluent.

Relative deprivation is an important measure of equitable distribution of resources at the individual level, reflecting conditions of widening economic disparities despite remarkable reductions in absolute poverty in our society. The concept of relative deprivation differs from other SES measures in that relative deprivation explicitly involves a reference group with respect to the SES distribution to which individuals compare themselves. Therefore, relative deprivation captures the fact that in unequal society an individual who already secured a fixed standard of the income required to meet basic subsistence needs can still feel deprived due to inability to maintain the same standard of living as others. Aggregating individuals' relative deprivation (as measured by Yitzhaki Index) is both theoretically and empirically equivalent to the Gini coefficient, the most common measure of income inequality at the contextual level (Yitzhaki 1979).

The theory of relative deprivation argue that people have a natural tendency to make upward rather than downward social comparisons (e.g., Merton 1957; Runciman 1966; Stouffer et al. 1949). In Runciman's (1966) early descriptions of relative deprivation, he wrote that "The magnitude of a relative deprivation is the extent of the difference between the desired situation and that of the person desiring it (p. 10)." Therefore, according to the theory, relative deprivation can affect health largely through psychosocial stress (e.g., anxiety, shame, frustration, and injustice) generated by upward social comparison (Wilkinson 1996). Consequently, those who feel relatively deprived may have poor physical and mental health due to an increased likelihood of their engaging in drinking and smoking, as maladaptive coping strategies to alleviate these negative emotions (Eibner and Evans 2005; Marmot and Wilkinson 2001; Ritterman et al. 2009).

In accordance with this perspective, relative deprivation is commonly measured by the Yitzhaki Index, which combines the information about both the rank of an individual within the reference group and the extent of the inequality between the individual and better-off members in that given group (Adjaye-Gbewonyo and Kawachi 2012). Using the Yitzhaki Index, a large body of prior research has documented the association between relative deprivation and several health outcomes including physical and psychological health, functional disability, mortality, and health behaviors (Åberg Yngwe et al. 2003, 2012; Eibner and Evans 2005; Elgar et al. 2016; Jin and Tam 2015; Kuo and Chiang 2013; Marmot, Shipley, and Rose 1984; Saito et al. 2014; Salti 2010; Subramanyam et al. 2009), though some studies have noted mixed findings that may be attributable to the variation in model specifications (e.g., a functional form of absolute income and individual-level heterogeneity) (Jones and Wildman 2008; Kondo et al. 2009).

***2.2 Relative deprivation and adolescent outcomes***

Despite compelling evidence that relative deprivation is a crucial determinant of health in recent decades, there still remain significant gaps in existing research on the link between relative deprivation and health. One of the most important research gaps is about whether and how relative deprivation influences adolescent health. While previous studies have focused largely on adult populations, only a few studies have documented the link between relative deprivation and adolescent outcomes. Recent studies have examined whether adolescents' subjective (or perceived) social status is associated with health and health behaviors[1] (Ritterman et al. 2009; Sweeting and Hunt 2014, 2015). Another study finds that relative deprivation based on parental education (as a proxy for family income) is positively associated with alcohol consumption, binge drinking, and smoking for male adolescents (Balsa, French, and Regan 2014). Although these studies have advanced our understanding of implications of SES position for adolescent health and social problems, I am not aware of studies that directly examined whether and how relative deprivation influences adolescent health.

In fact, there are several reasons why it is important and useful to assess the relationship between relative deprivation and adolescent health. First, the analysis of relative deprivation and adolescent health provides the ideal opportunity to address several important empirical and conceptual limitations that prior studies contain. A major challenge in examining the relative deprivation hypothesis is related to the identification of appropriate reference groups to which individuals compare themselves (Mangyo and Park 2011). Following the social psychology literature, the vast majority of prior studies has defined reference groups based on demographic similarity (e.g., age, gender, and race/ethnicity) and/or geographic proximity (Singer 1981). However, there exist multiple reference groups, and the relative importance of different types of reference groups may differ across individuals (Alderson and Katz-Gerro 2016). The composition of reference groups can substantially differ in different contexts: the reference group at workplace (i.e., coworkers) are different from the reference group at home (i.e., family members and relatives). In addition, there is no clear consensus on which levels of geographic aggregation is the most

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[1] Some studies have argued that subjective (or self-perceived) social status is more important than objective measure (e.g., Yitzhaki Index) (Siahpush et al. 2006). However, whether the relationship between "subjective" social status and adolescent health is causal remains unclear since subjective social status could be endogenous due to reverse causality and unmeasured factors affecting both subjective social status and adolescent health (e.g., Nobles, Weintraub, and Adler 2013). For example, various factors such as individual, parental, and neighborhood characteristics may influence an individual's self-perception about social status as well as adolescent health.

appropriate for social comparison. Limited by specific data sets, most of the literature has defined the community at the state-, county-, or neighborhood-level (e.g., census tracts).

Unlike adults, however, fellow students attending the same school or school cohort may be a relatively clearly defined and the most salient reference groups among adolescents (e.g., Balsa, French, and Regan 2014; Crosnoe and Muller 2004; Crosnoe 2007). Social interactions at the school- or classroom-level on a daily basis offer an important opportunity for students to gather information for social comparison (Balsa et al. 2014; Coleman 1961; Giordano 2003; Sacerdote 2014). In addition, the fact that students share similar demographic characteristics (e.g., age) allows for greater influence among themselves (Mangyo and Park 2011; Urberg, Değirmencioğlu, and Pilgrim 1997). In particular, classmates may comprise an important frame of reference for adolescents since they are more likely to be aware of socioeconomic and financial standing of their peers' parents than of others living far away and to compare it to their parents' own standing through casual interaction and observation.

Although a group of close friendship or best friends may serve as an alternative reference group, a wider group of peers such as classmates and schoolmates may be more relevant to the examination of relative deprivation among adolescents. A clear advantage of a wider peer group over close friendship is that the members of a wider peer network such as schoolmates and classmates tend to remain more stable (Schneider and Stevenson 1999; Urberg et al. 1995), providing a more consistent comparison point against which adolescents compare themselves. Adolescents' friendship network is shown to be considerably unstable and fluid: adolescents aged between 11 and 15 maintain less than 65% of their friendships across a school year and tend to lose more old friends than they form new ones (Berndt and Hoyle 1985; Chan and Poulin 2007;

Neckerman 1996; Poulin and Chan 2010). The evidence suggests that a close friendship group may not be stable enough to serve as a workable reference group.

Second, the analysis of relative deprivation and adolescent health may provide great promise for better understanding the effect of relative deprivation on health, by bringing rather new aspects of potential mechanisms. The theories of relative deprivation have focused almost exclusively on psychological distress resulting from invidious social comparisons as the primary mechanism linking relative deprivation to physical, psychological, and behavioral dimensions of health (Merton and Kitt 1950; Runciman 1966; Stouffer et al. 1949). However, sociological theories, such as status characteristics theory (SCT) (Berger et al. 1977; Berger, Rosenholtz, and Zelditch 1980), propose that relative deprivation may involve stigma and status processes to affect an individual's health (Phelan et al. 2014). Link and Phelan (2001) argue that "when people are labeled, set apart, and linked to undesirable characteristics, a rationale is constructed for devaluing, rejecting, and excluding them (pp. 370-371)." Therefore, students with higher relative deprivation (or lower relative position) may be treated as low status or stigmatized, and therefore, suffer lack of access to social status and social rejection (Goffman 1963). These negative social processes—i.e., labeling, stereotyping, social exclusion, and discrimination—may worsen especially in the school as a bounded social institution and yield more deleterious consequences of students' health (e.g., Crosnoe 2011).

By focusing on adolescent population, the relative deprivation literature could also extend consequences of social comparison beyond psychological distress. For example, unfavorable social comparison may affect future expectations about SES attainment as well as life chances (Davis and Wu 2014; Finkelstein et al. 2007). Several studies have suggested that people tend to use their reference group as a source of information to form future expectations (Clark, Kristensen, and Westergard-Nielsen 2009; Senik 2004). Students who are relatively deprived may see their future more negatively, while interpreting their relative deprivation as a major obstacle to better future (e.g., educational attainment, health, longevity, etc.). This specific potential pathway of development of future expectations may be highly relevant for adolescent health and worth pursuing in the relative deprivation literature since (1) adolescence is an important developmental stage for identity formation and future expectations and (2) the link between future expectations and adolescent health is well-established (McDade et al. 2011; Nguyen et al. 2012; Whitehead et al. 2015).

In addition, identifying relative deprivation as a risk factor for adolescent health helps fill a gap in divergent findings regarding the SES-health relationship among adolescents (e.g., West 1997). It is interesting that while there is a well-established inverse graded relationship between SES and infant, child, and adult health, this gradient is relatively inconsistent among adolescents (Hanson and Chen 2007; Spencer 2006; West 1997). These inconsistent patterns among adolescents have been shown across several health outcomes such as respiratory health, smoking, obesity, mental health, and asthma (Starfield et al. 2002; Torsheim et al. 2004; West 1997; West and Sweeting 2004). A line of research has suggested that in adolescence other influences associated with the school, the peer group and youth culture may cut across the influence of social class to promote “equalization” in adolescent health (West 1997). A broad review of the literature has also confirmed that youth is characterized by relative equality in health status (Hanson and Chen 2007). However, the analysis of relative deprivation focusing on adolescent population considers a plausible alternative hypothesis: relative, rather than absolute, deprivation may be the key factor with respect to adolescent health. In other words, the inconsistent SES gradients in adolescent health may be attributable to the inability of absolute parental SES to reflect social structures and hierarchies in adolescence that may have a more significant impact on adolescent health (Ritterman et al. 2009).

Last but not least, findings of relative deprivation and adolescent health may be more policy-relevant. Again, unlike adults, the definition and identification of a reference group is relatively clearer and easier: classmates and schoolmates are arguably the most sensible and salient reference group for adolescents. Since classmates and schoolmates are the policy tool over which policy-makers have the most control (e.g., Billings, Deming, and Rockoff 2014; Cook and Ludwig 2006), a better understanding of how relative deprivation is formed at the school-level and how it influences adolescent health would provide policymakers with a useful information to develop relevant interventions (e.g., school-based intervention efforts).

### *2.3 Mechanisms*

Relative deprivation can affect adolescent health through multiple mechanisms. This study focuses on three broad mechanisms through which relative deprivation influences self-rated health and psychological well-being among adolescents: (1) psychological mechanisms, (2) social mechanisms, and (3) self-medication as more proximate mechanisms.

#### 2.3.1 Psychological mechanisms

First, the most well-known ramification of relative deprivation is the production of negative deprivation feelings led by invidious social comparison, which the relative deprivation theory has viewed as the prime mechanism underlying the relationship between relative deprivation and health (Wilkinson 1996). According to the theory, those who are lower in the social hierarchy tend to have a feeling of stress and frustration stemming from invidious upward social comparisons, which in turn, deteriorates their psychological health (such as self-esteem, a sense of well-being and happiness, and depression) (McEwen & Seeman,1999; Wilkinson,1996). This psychological strain may affect physical health directly through a biological process (neuro-endocrine response) that may trigger hormone fluctuations and immunologic changes (Wilkinson and Pickett 2006).

Among adolescents, relative deprivation may arise from comparison with other students in the school, in particular with same-aged peers and their families. Schools that bring together students for long periods of time are an important venue through which adolescents learn the standard of living of peers and other families (Coleman 1961; Crosnoe 2011). Adolescents growing up in a family that is relatively worse off than their school peers may suffer from feelings of unfairness, inferiority and shame, loss of self-esteem, and life dissatisfaction due to their relatively lower position in the social hierarchy (Bourdieu 1984) and inability to imitate the life-style of their better-off peers (Bannink, Pearce, and Hope 2016; Marmot and Wilkinson 2001; Pettigrew 2016; Wilkinson 1996). Consequently, the psychological distress caused by invidious social comparison should affect self-rated health (e.g., Kuo and Chiang 2013).

Despite these well-established psychological pathways, however, little is known about how relative deprivation may affect other dimensions of psychological resources associated with health outcomes. For example, among adolescents, feelings of relative deprivation may have further psychological impact on future expectations and aspirations. Relative deprivation may lead to stress and anger not only because the person feels relatively deprived of current access to material resources, but also they feel deprived of the opportunities to fulfill their potential and to control life circumstances (Blau and Blau 1982; Runciman 1966). In other words, among adolescents with higher relative deprivation, a psychological strain and distress may thus be driven by perceived goal blockage and lowered future expectations (Akers and Sellers 2012; Webber 2007).

Existing evidence suggests that an increase in delinquent behavior among adolescents with higher relative deprivation can be explained possibly by their feelings of injustice and unfairness as well as diminished future expectations (Baron 2003, 2006; Harris, Duncan, and Boisjoly 2002; Napoletano et al. 2015; Nieuwenhuis et al. 2017). These negative psychological processes triggered by experience of relative deprivation may be relevant particularly for adolescent health because adolescence is a critical period in human life where they aspire to their future by developing lifestyle expectations and setting educational and occupational goals that will shape their future lives in adulthood. In sum, relative deprivation may affect adolescent health not only through dissatisfaction of *current* socioeconomic position, but a decrease in *future* expectations about life chances and hopefulness about the future.

### 2.3.2 Social mechanisms

Relative deprivation may also be harmful to health for reasons other than invidious social comparison or diminished future expectations. A possible debate in the sociological literature can center around the question of sources of psychological distress among people with higher relative deprivation, that is, whether psychological distress is primarily attributable to an individual's own social comparison or to social exclusion and discrimination exerted by others in the reference group. Sociological theories such as status characteristics theory (SCT) (Berger et al. 1977, 1980) postulate that relative deprivation may affect an individual's health through stigma and status processes (Phelan et al. 2014). Link and Phelan (2001) argue that "when people are labeled, set apart, and linked to undesirable characteristics, a rationale is constructed for devaluing, rejecting, and excluding them (pp. 370-371)." Therefore, treated as low status or stigmatized, individuals who are relatively deprived may suffer lack of access to social status, and consequently, social rejection (Goffman 1963); it is well-known that the quality of social relationships is strongly associated with physical and psychological health (House, Landis, and Umberson 1988; Umberson et al. 1996; Umberson and Karas Montez 2010).

These negative social processes—i.e., labeling, stereotyping, social exclusion, and discrimination—may be pronounced more in a bounded social institution like schools. Emerging school-based hierarchies and ranking systems among adolescents may lead to the power imbalances in social relationships, where bullying and social exclusion can occur. During adolescence, economic disparities that underscore status differences among individuals may create a major disadvantage among impoverished students in the relationship market while conferring power to more affluent students (Hjalmarsson and Mood 2015). Those with higher relative deprivation may experience both covert (e.g., bullying) and overt (e.g., ignoring, excluding, gossiping) forms of negative appraisals by groups of peers (particularly those who see economic deprivation as an undesirable trait), which in turn, could lead to low self-esteem and psychological distress (Rusch et al. 2011). These social pathways of relative deprivation rather highlight more a relatively overlooked role of relative deprivation in promoting *downward* social prejudices from those at the top of the hierarchy (Wilkinson 2005; Wilkinson and Pickett 2006), rather than *upward* social comparison from those at the bottom of the hierarchy (Festinger 1954; Merton 1957).

Teachers may also discriminate against students with higher relative deprivation by considering them less capable than other students and thus having lower expectations for them (Patterson, Hale, and Stessman 2007; Ready and Wright 2011). As a result, students from lower SES families often experience a lower level of interaction with teachers and low-quality student-teacher relationships (García et al. 2010; Miller Jr., J. W., Kuykendall, J. A., y Thomas 2013; Siegel-Hawley and Frankenberg 2012). Despite these conceptually distinct sources of psychological distress arising from relative deprivation (i.e., social comparison vs. social exclusion), however, it might be difficult to fully disentangle independent influences of each because a psychological impact of relative deprivation somewhat combines the effects of both mechanisms.

### 2.3.3 Self-medication

As a more proximate pathway linking relative deprivation to health, higher relative deprivation may lead to poor health through maladaptive coping responses such as self-medication (e.g., smoking, heavy alcohol use, and less healthy diet). As a result of psychosocial distress (anger, stress, and frustration) arising from invidious social comparison and disrupted social relationships, those with higher relative deprivation may be more likely to engage in self-medication to cope with such stressors (Elgar et al. 2005, 2016; Kassel, Stroud, and Paronis 2003; Sentenac et al. 2017). Existing evidence supports examination of relative deprivation as a cause of substance abuse. As coping devices, the use of tobacco and alcohol is known to stabilize fluctuations in psychological state or mood caused by stressors. For example, there is a burgeoning evidence that smokers are more likely to smoke when stressed, and they believe that smoking reduces stresses (Kassel et al. 2003; McKee et al. 2011). In addition to smoking, binge drinking, a common form of alcohol abuse, has been used as a way to relieve stress (Grzywacz and Almeida 2008).

## *2.4 The present study*

The present study uses the National Longitudinal Study of Adolescent to Adult Health (Add Health) to examine whether relative deprivation affects adolescent health. First, I calculate relative deprivation using the information of parental income among students within the same school cohort. I use several indices representing the concepts of relative deprivation (i.e., Yitzhaki Index, Deaton Index, inverse percentile rank, and d-measure), though the most of my analysis relies on Yitzhaki Index (Yitzhaki 1979), the most commonly used measure of relative deprivation. Then, I analyze the extent to which relative deprivation relates to adolescent health outcomes including self-rated health and depressive symptoms. In order to isolate the effect of *relative* deprivation, over and above the effect of *absolute* deprivation, I control for students' own parental income. This study also controls for school fixed effects to remove important selection effects into reference group and to leverage across-cohort variation in the parental income distribution. A series of robustness checks are performed to test the sensitivity of the findings of this study.

This study also sheds light on potential mechanisms of the effects of relative deprivation on adolescent health. Based on theoretical and empirical literature, this study proposes three mechanisms: psychological mechanisms (concurrent psychological distress and future expectations), social mechanisms (school attachment, social relationships, and friendship network), and self-medication mechanisms (cigarette smoking and binge drinking). It is worth noting that these mechanisms are not mutually exclusive, and therefore, it might be difficult to empirically disentangle influences of each mechanism. However, examination of all these potential mechanisms simultaneously may provide us new insights into what it means to be relatively deprived for both disadvantaged and advantaged adolescents and how relative deprivation influences adolescent health. This analysis consists of two parts. First, I explore whether relative deprivation is associated with sets of proposed mechanism variables. Then, I examine the extent to which the inclusion of these mechanism variables (measured in Wave 1) attenuates the coefficient of the effect of relative deprivation on adolescent health (measured in Wave 2).

## 3. Data and methods

### *3.1 Data*

The data used in this study come from the restricted version of Add Health. Add Health is a school-based, longitudinal study of the health-related behaviors of adolescents and their outcomes in young adulthood. Beginning with an in-school questionnaire administered to a nationally representative sample of students in grades 7 through 12 in 1994-1995, the study follows up with participants via a series of in-home interviews approximately one year (Wave 2), six years (Wave 3), and thirteen years later (Wave 4). Other sources of data include questionnaires for parents, siblings, fellow students, and school administrators. By design, the Add Health survey included a sample stratified by region, urbanicity, school type, ethnic mix, and size.

An unusual feature of Add Health is that the survey covers multiple cohorts within the same school. This feature is essential for the identification strategy of this study, allowing for comparison of students in different cohorts within the same school while accounting for selection into schools. Of the 20,745 individuals who completed the Wave 1 survey, 14,736 respondents were followed up in Wave 2. Because the explanatory variable of interest, i.e., relative deprivation, is computed based on classmates' parental income in the same school, I dropped 653 respondents who had missing values on school identification code and grade level. Furthermore, I dropped 5,999 respondents who either have missing values on own parental income (3,283) or attend the grades where missingness on parental income is greater than 70 percent (2,716), leaving 8,084 students[2]. As a robustness check, I confirm that using different thresholds of sample restriction for grade-level missingness on parental income information also yields consistent results. Finally, nonresponse to one or more control variables leaves an analytic sample of 8,011. The final analytic sample sizes slightly differ across models due to different levels of missingness on each dependent variable.

[2] In order to maximize the available sample, I imputed Wave 1 family income and mother's education level for about 2,500 respondents. I employed single imputation techniques and included in our estimation models a dummy variable identifying the cases with imputed values. I used the following variables in the imputation process: age, gender, race/ethnicity, test score, rural status, and parental socioeconomic status (if available).

### *3.2 Measures*

### <u>3.2.1 Dependent and mechanism variables</u>

The main dependent variable of this study is a measure of excellent self-rated health (measured in Wave 2). Respondents reported on their general health (in general, how is your health?), and their responses were coded as "poor/fair/good/very good" (0) or "excellent" (1). Self-rated health is a widely used, valid measure of general physical health status (Ferraro and Farmer 1999), and is found to predict future health outcomes including mortality and morbidity (Jylhä 2009). This study also uses a measure of depressive symptoms (measured in Wave 2), which was based on a 19-item self-report measure of the Center for Epidemiological Studies Depression Scale (CES-D)[3] (Meier 2007). The CES-D assesses respondents' feelings, thoughts, and physical conditions during the past week. Each question had four response categories: 0 = never or rarely; 1 = sometimes; 2 = a lot of the time; and 3 = most of the time or all of the time. The standardized average of the responses to these 19 items served as the final scale (Cronbach's alpha = 0.87 for Wave 2). Since the outcome variables of interest were available in both Wave 1 and Wave 2, I present results for both waves. However, in the mechanism analysis, I rely on Wave 2 outcomes to establish the temporal ordering between the outcomes and mechanism variables, though the use of Wave 2 outcomes reduces the sample size due to attrition. Finally, a large set of potential mechanism variables (measured in Wave 1) are used in the analysis. A detailed description about these mechanism variables is presented in Table A1 in the Appendix.

[3] 19 items include: (1) You were bothered by things that usually don't bother you; (2) You didn't feel like eating, your appetite was poor; (3) You felt that you could not shake off the blues, even with help from your family and your friends; (4) You felt that you were just as good as other people (reverse-coded); (5) You had trouble keeping your mind on what you were doing; (6) You felt depressed; (7) You felt that you were too tired to do things; (8) You felt hopeful about the future (reverse-coded); (9) You thought your life had been a failure; (10) You felt fearful; (11) You were happy (reverse-coded); (12) You talked less than usual; (13) You felt lonely; (14) People were unfriendly to you; (15) You enjoyed life (reverse-coded); (16) You felt sad; (17) You felt that people disliked you; (18) It was hard to get started doing things; and (19) You felt life was not worth living.

### 3.2.2 Relative deprivation measures

The key independent variable is an individual's family-level income deprivation relative to the reference group. There are two important issues associated with computing the measure of relative deprivation: (1) the choice of an appropriate reference group and (2) the definition of relative deprivation. First, as argued in the Background, while there is no clear consensus on the definition of reference group in the literature, classmates in the school settings tend to comprise an important and obvious frame of reference for adolescents. Therefore, it can be believed that the standard of living among classmates is salient in influencing the adolescent's perception of referenced others and their relative social position among them. Second, in this study, I use four different measures of relative deprivation—i.e., Yitzhaki Index, Deaton Index, inverse percentile rank, and d-measure, all of which have been motivated by different theoretical and empirical concerns. I introduce each measure in greater detail below.

First, I compute Yitzhaki Index, a mathematical expression of Runciman's theory (1966). Runciman (1966) defines the conditions for an individual to feel relatively deprived: "We can roughly say that a person is relatively deprived of X when (1) he does not have X; (2) he sees some other person or persons who have X, which may include himself at some previous or expected time, as having X; (3) he wants X; and (4) he sees it as feasible that he should have X (Runciman 1966, p. 10). Therefore, drawing on Runciman's theory (1966), the Yitzhaki Index can be expressed as follows:

$$Yitzhaki_{ir} = \frac{1}{N_r} \times \sum_{j} (y_{jr} - y_{ir}) \ \forall \, y_{jr} > y_{ir}$$

where $N_r$ is the total number of students in reference group $r$. This equation can be rewritten as follows:

$$Yitzhaki_{ir} = \left[E\left(y_{jr}|y_{jr} > y_{ir}\right) - y_{ir}\right] \times prob(y_{jr} > y_{ir})$$

Intuitively, student $i$ feels deprived whenever he or she meets peers whose parents have a higher income, and the amount of $i$'s deprivation is proportional to the difference between $y_{ir}$ and $y_{jr}$. The amount of relative deprivation increases as the difference between $y_{jr}$ and $y_{ir}$ or the probability of coming into contact with student *j* increases. Therefore, this measure of relative deprivation indicates whether there are many people in student $i$'s reference group with parental income greater than $y_i$ and how large are the income gaps between student *i* and those above *i* in the parental income distribution. In short, the Yitzhaki Index is a "upward-looking" measure of relative deprivation.

One potential disadvantage of using the Yitzhaki Index is that the measure may be sensitive to changes in the scale of SES measures. In other words, doubling the incomes of everyone in a reference group will double every individual's relative deprivation. In order to get around this shortcoming, I also use another set of models that involved alternative definitions of relative deprivation. Deaton (2001) improves the Yitzhaki Index by normalizing it using the average income in the reference group, $\mu$ (i.e., $Y_{-igs}$). Therefore, the Deaton's relative deprivation measure assumes students consider the proportion of total parental income for classmates who are higher on the income distribution instead of the sum of the absolute parental income. The Deaton Index can be expressed as follows:

$$Deaton_{ir} = \frac{1}{\mu N_r} \times \sum_{j} (y_{jr} - y_{ir}) \; \forall \, y_{jr} > y_{ir}$$

Defining relative deprivation in terms of the mean parental income for a student's classmates yields a relative deprivation index that is insensitive to changes in the scale in which parental income is expressed.

In addition to the Yitzhaki and Deaton measures of relative deprivation, motivated by Runciman's theory (1966), I also use two additional measures of relative deprivation: ordinal rank and d-measure. The ordinal rank—i.e., inverse percentile rank in terms of parental income—is useful in examining a positional effect, not considering the distance between a student's affluence and all the affluence scores above her. To make the ordinal rank comparable across school cohorts of different size, I standardize the absolute ordinal rank by dividing it by number of students in each school cohort. Percentile ranks can be calculated as follows:

$$Percentile\ rank_{ir} = \frac{absolute\ rank_{ir} - 1}{number\ of\ students\ in\ grade\ r} \cdots (1)$$

Finally, I use another measure of relative deprivation, proposed by Stewart (2006). This proposed measure is created based on the assumption that within the SES distribution of a reference group there is the deprivation line, a point where relative deprivation perfectly offsets relative satisfaction: for those above the deprivation line, negative effects are assumed not to be felt. While this measure seems to capture an additional dimension of relative deprivation, its core assumption still remains questionable (Adjaye-Gbewonyo and Kawachi 2012). This alternative measure can be calculated as follows:

$$d - measure_{ir} = \frac{1}{(z_r)^2} \times \sum_j \left(y_{jr} - y_{ir}\right)^2 = \frac{(z_r - y_{ir})^2}{(z_r)^2} \quad \forall\, y_{ir} < z_r$$

where $z_r$ is the deprivation line, crudely defined as the mean in the distribution of parental income among classmates by assuming that satisfaction and deprivation are proportional. $y_{ir}$ is the parental income of student $i$ in group $r$ (note that for this example $y_{ir} < y_{ir}$), $y_{jr}$ is the parental income of student $j$ in group $r$.

***3.3 Analytic approach***

In this research, I estimate the following equation:

$$Y_{is} = \alpha_0 + \alpha_1 INC_{is} + \alpha_2 RD_{is} + X_{is}\gamma + W_{is}\delta + Z_{-igs}\theta + \tau_s + \varepsilon_{is} \cdots (1)$$

where the subscript *g* references the student's grade and *s* represents her school. *Y* is an outcome measure. I estimate the equation using ordinary least squares (OLS) regression. *INC* is a student's (absolute) parental income. It is worth noting that, in this specification, coefficient for a student's (absolute) parental income, $\alpha_1$, does not necessarily yield causal estimates because this analysis cannot dismiss possible correlation between parental income and unobservable characteristics that may also predict the outcome measures. The main purpose of controlling for students' parental income is to isolate the effect of relative deprivation—i.e., to examine whether relative deprivation has an impact on adolescent health even after absolute levels of affluence are controlled. $RD_{is}$ is the relative deprivation measure as defined above, and therefore, $\alpha_2$, is the coefficient of interest.

The set of covariates includes a vector of student characteristics measured at the individual ($X_{is}$) and family level ($W_{is}$), and a vector capturing the average demographic characteristics of the student's classmates ($Z_{-igs}$). In order to account for the unobserved heterogeneity of systematic self-selection into schools, I control for school fixed effects ($\tau_s$). In addition, school fixed effects could also capture some important measures of environmental factors (at the school- and neighborhood-level) that may influence both students' relative deprivation and health outcomes. Robust standard errors are clustered at the school level in all models.

My empirical specification yields a causal effect of relative deprivation only if the following assumption is met: conditional on attending a given school and a student's own parental income, the assignment of peers (i.e., classmates) is exogenously determined by the student's birth year. In order to provide the most stringent test of the causal effects of relative deprivation, this study exploits exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school:

$$Y_{if} = \beta_0 + \beta_1 RD_{if} + X_{if}\mu + Z_{-igs}\rho + \varphi_f + \varepsilon_{if} \cdots (2)$$

where $\varphi_f$ is a set of family dummies. Note that the vector $W_{is}$ in Equation (1) is omitted due to the fact that family characteristics are shared by siblings, and only individual-level variables that vary within families ($X_{if}$) remain in Equation (2). In this model, since siblings have the same parental income, within-sibling variation in relative deprivation should come from their assignment in different grades, which is strictly dictated by their birth year.

**4. Results**

Summary statistics are presented in Table 1. About half of the respondents were female, and the average age in the analytic sample ranged from 12 to 21, with a mean of 15.55. Approximately 65 percent of the respondents were non-Hispanic White, while 19 percent were Black, 13 percent were Hispanic, and 4 percent were identified as other racial/ethnic groups.

(Table 1 about here)

Before examining the effects of relative deprivation on adolescent health, I start by showing evidence of whether conditional on attending a given school the cohort composition with regard to parental income is quasi-exogenous. I conduct a simple, intuitive empirical test that mimics analyses often conducted in the randomized control trials. Specifically, I first examine whether the cohort mean parental income is correlated with predetermined student characteristics by running regression of several important student characteristics on cohort mean parental income. Then, I examine whether controlling for school fixed effects removes statistically significant correlations. The disappearance of the associations is interpreted as evidence that within-school cohort-to-cohort variation in parental income distribution is plausibly exogenous.

(Figure 1 about here)

Figure 1 plots correlations between school-cohort mean ability and individual-level characteristics (Table A2 in the Appendix shows the full results). Each dot is the coefficient from a separate regression, and is labeled with the name of dependent variable. School fixed effects are controlled for only in the right panel of Figure 1. As shown in the left panel of Figure 1, cohort mean parental income is significantly correlated with literally all individual characteristics. However, when controlling for school fixed effects (the right panel of Figure 1), all these associations disappear, indicating that while there is strong systematic school selection, conditional on attending a given school, cohort-to-cohort variation in parental income distribution is plausibly exogenous (or quasi-random).

***4.1 Relative deprivation and adolescent health***

Table 2 presents OLS estimates of the relationship between relative deprivation and excellent self-rated health (Models 1-4 for Wave 1 outcome and Models 5-8 for Wave 2 outcome). Four different measures of relative deprivation are used in order to assess the sensitivity of the findings. All models include individual demographic controls, family-level controls, student's own parental income, and grade as well as school fixed effects. Models 1-4 shows that all measures of relative deprivation except d-measure are significantly associated with a lower level of excellent self-rated health in Wave 1 even net of own parental income, indicating that students with higher relative deprivation are less likely to report excellent health status[4]. The results are consistent when using Wave 2 self-rated health (Models 5-8). In Table 3, I find very consistent results for depressive symptoms: higher relative deprivation increases adolescents' depressive symptoms. In addition,

[4] I compute VIF (Variance inflation factor) to test multicollinearity between parental income and relative deprivation measures. As a rule of thumb, a variable whose VIF values are greater than 10 may be problematic. I find that VIFs for all variables were below the rule-of-thumb cutoff of 10 (1.24 for parental income vs. 1.13 for Yitzhaki Index) with a mean VIF of 2.30, suggesting that multicollinearity is not of primary concern (results not shown)

relative deprivation has a significant impact on adolescents' self-esteem (Table A3 in the Appendix).

(Table 2 about here)

(Table 3 about here)

In order to confirm the validity of the findings of this study, I discuss results for a series of robustness checks. First, instead of using excellent self-rated health, I use different operationalization of self-rated health—i.e., self-rated scale ranging from 1-5, a binary variable indicating very good health, and a binary variable indicating good health. In Table A4 in the Appendix, results demonstrate that the findings of this study are not sensitive to the choice of alternative measures of self-rated health. Then, with a binary outcome of interest (i.e., excellent health status), I estimate a nonlinear model (i.e., logit model), instead of a linear probability model. Table A5 in the Appendix suggest that the results are robust to alternative estimation models. Using different thresholds of sample restrictions (20-50 percent) for grade-level missingness on family income information also yields consistent results (Table A6 in the Appendix).

In addition, I show results of sensitivity checks with respect to alternative methods of controlling for (absolute) parental income in Table A7 in the Appendix. By allowing for a more flexible functional form of income (i.e., quadratic polynomials, cubic polynomials, and income dummies), I confirm that coefficients of relative deprivation are not an artifact of a highly non-linear relationship between parental income and adolescent health (Jones and Wildman 2008). Throughout the rest of the paper, however, I control for parental income for the linear term because results are robust to different methods of controlling for parental income and the goodness-of-fit statistics (including AIC and BIC) suggest that the linear controls for parental income are preferable, showing that allowing for nonlinearities does not improve model fit.

I further address the possibility of contextual-level confounders. In the baseline model, I include separate fixed effects for schools and cohorts, allowing for comparisons of students with the same absolute parental income who belong to different cohorts in the same school. The school fixed effects control for observed and unobserved factors that affect selection into schools. However, school-cohort specific confounding factors cannot be captured by these separate school and cohort fixed effects. An alternative specification might be to include school by grade fixed effects rather than school fixed effects and grade fixed effects. A disadvantage of using this specification is that relative and absolute ability would be confounded more explicitly, whereby in order for a student to have a higher relative deprivation than another student in the same school-grade, he or she must have a lower parental income. Thus, the effects of relative deprivation would be uncovered in part based on the functional form assumptions we make about the effects of absolute parental income. Despite this limitation, I show that the results of this study are robust to controls for several important grade-level characteristics as well as school-by-grade fixed effects (Table A8 in the Appendix).

Given the fact that social position is multidimensional in nature and adolescents may belong to multiple social hierarchies (Sweeting et al. 2011), I examine whether the rank effects found in this study are robust to controlling for rank measures of other salient characteristics for young people. In this supplementary analysis, I control for two additional rank measures created based on body mass index (BMI) and cognitive ability. As shown in Table A9 in the Appendix, even after controlling for these rank measures, the coefficients for the effects of relative deprivation remain almost identical and statistically significant. However, it is worth noting that these two rank measures appear to have an impact on adolescent self-rated health independently from the effects of relative deprivation.

Finally, in order to provide more stringent test of the causal effects of relative deprivation, this study exploits exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school. This strategy allows for comparison of health outcomes between two siblings who have the same parental income but the different relative deprivation scale depending on the cohort distribution of parental income. Additionally, control for family fixed effects would address the remaining possibility of shared unobserved heterogeneity at the family level. Although a sibling comparison model is better at addressing several important possible threats to internal validity of this study (i.e., eliminating potential confounding such as family background characteristics and school selection), it could produce biased estimates in case of violation of the central assumption that there are no spillovers between siblings (Fletcher and Wolfe 2008). In Table A10 in the Appendix, family-fixed effects models produce qualitatively similar results: after controlling for shared unobserved heterogeneity at the family level, relative deprivation still has an impact on adolescent self-rated health. However, these fixed effects estimates should be interpreted cautiously due to potential sibling spillover effects.

### *4.2 Mechanisms*

In order to shed light on potential mechanisms through which relative deprivation affects adolescent health, I estimate several auxiliary regression models. I begin by examining the relationship between relative deprivation and a large set of mechanism variables (all measured in Wave 1). In Table 4, I present results for regressions of those mechanism variables on relative deprivation. The mechanism variables, list in the first column, are used as an outcome and the coefficient of relative deprivation and number of observations are presented[5]. Full results with all coefficients are available in Tables A11-A13 in the Appendix[6].

(Table 4 about here)

First, Panel A of Table 4 presents results for psychological factors including concurrent psychological distress and future expectations. Not surprisingly, results demonstrate that relative deprivation strongly predicts adolescents' self-esteem and depressive symptoms (measured in Wave 1). Findings also show that the relative deprivation is negatively associated with educational expectations and hopefulness about future: students with higher relative deprivation are more likely to report a lower level of educational expectations and be pessimistic about their future. Second, Panel B of Table 4 shows whether relative deprivation is associated with social relationship and friendship network in the school settings. Results provide strong evidence on the relationship between relative deprivation and school attachment and relationship with friends. Specifically, students with higher relative deprivation are more likely to report school detachment and poor relationship with friends. Relative deprivation is also found to be strongly associated with friendship network measures such as friend nominations received and sent and centrality, suggesting that students with higher relative deprivation experience social network disadvantage in the school setting. Third, Panel C of Table 4 presents results of the relationship between relative deprivation and self-medication including cigarette smoking and binge drinking. Results show that relative deprivation is associated with cigarette smoking but not binge drinking.

[5] I confirm that using the common sample across mechanism variable yields substantially identical results (results not shown).
[6] For the composite measures (i.e., life chances expectations, school attachment, relationship with friends, and relationship with teachers), results of the associations between relative deprivation and each item used to create the composite measure are available in Tables A14-A15 in the Appendix.

Finally, I explore whether the effects of relative rank on adolescent health (both self-rated health and depressive symptoms) are explained by mechanism variables proposed by this study. These analyses are presented as a sequence of nested models. Specifically, I investigate whether the coefficient for the relative deprivation effect disappears when sets of variables that may mediate the relationship between relative deprivation and adolescent health is added in the baseline model. The key interest of this analysis is to examine whether the inclusion of these variables changes the estimated coefficient of the effect of relative deprivation.

Table 5 shows results for self-rated health status as an outcome. Model 1 presents baseline result (from Model 5 of Table 2). In Model 2, both psychological factors measured in Wave 1, i.e., self-esteem and depressive symptoms, are strongly associated with excellent self-rated health in Wave 2, and the inclusion of these psychological factors reduces the effects of relative deprivation by 22 percent. However, considering that psychological distress is likely to be driven by both invidious social comparison and disadvantage in social relationships, the actual mediating effect of psychological distress caused directly by social comparison could be smaller than the one found in this study. Models 3-5 show that although educational and life chances expectations and feelings of hopefulness in the future are associated with excellent self-rated health, only the inclusion of educational expectation significantly changes the coefficient of relative deprivation. As shown in Model 6, when all measures of future expectations are included, the effects of relative deprivation are attenuated by 33 percent, leading to statistical insignificance.

In Models 7-8, sets of social relationship and friendship network measures are shown to be strongly associated with adolescents' self-rated health. When all measures of social relationship and friendship network are included simultaneously (Model 9), the effects of relative deprivation are reduced by 26 percent, though the coefficient still remains statistically significant. Lastly, I examine whether self-medication (cigarette smoking and binge drinking) plays a mediating role in the relationship between relative deprivation and adolescent health. In Model 10, results show that cigarette smoking, but not binge drinking, is negatively associated with the likelihood of excellent self-rated health. However, I find no evidence that these risky health behaviors mediate the effect of relative deprivation on adolescent health. Model 11 shows that when all mechanism variables are included in the model simultaneously, the effects of relative deprivation are attenuated by almost 50 percent. Figure 2 illustrates how much of the effects of relative deprivation are explained by each set of mechanism variables.

(Figure 2 about here)

There are several interesting findings to note in this analysis, First, it is interesting that future expectations (particularly about educational attainment) contributes more to explaining the link between relative deprivation and adolescent health than concurrent psychological distress. Second, the finding that school-based social relationship explains a fair amount of the effects of relative deprivation is new and intriguing. Third, unlike prior literature, there is no evidence that adverse health behaviors explain the link between relative deprivation and health. In sum, these findings suggest that the effects of relative deprivation on adolescents' self-rated health are attributable to the combination of psychological and social factors.

(Table 6 about here)

Finally, as shown in Table 6, I perform the same mediation analysis using depressive symptoms in Wave 2 as an outcome. Results are qualitatively similar, though there are some interesting findings. For adolescent depressive symptoms, the mediating roles of psychological factors such as self-esteem (48 percent) and future expectations (64 percent) are shown to be more pronounced than social factors (36 percent). In addition, the effects of relative deprivation on psychological health (rather than on self-rated health) are better explained by the mechanism variables proposed by this study: nearly 80 percent of the effects of relative deprivation on adolescent depressive symptoms is attenuated once all mechanism variables are taken into account. Figure 3 plots percentage reduction in the effects of relative deprivation due to the inclusion of sets of mechanism variables.

(Figure 3 about here)

## 5. Discussion and conclusion

Although a large number of studies have documented the link between relative deprivation and health outcomes, gaps remain in the literature. Two main research gaps involve lack of evidence on the effects of relative deprivation adolescent health and limited evidence on the mechanisms. In order to add to the existing literature, using a large, nationally representative longitudinal survey of U.S. adolescents, this study investigates the relationship between relative deprivation and adolescent health. Using classmates as a reasonable reference group for adolescents, this study computes Yitzhaki Index, the most commonly used measure of relative deprivation (Adjaye-Gbewonyo and Kawachi 2012). This study shows that controlling for own parental income, students with higher relative deprivation (i.e., a higher score on Yitzhaki Index) are less likely to report excellent health status and more likely to have higher levels of depressive symptoms. These findings are significantly robust to various measures of relative deprivation, motivated by different theoretical and empirical concerns. In addition, the findings of this study are reinforced through a series of robustness checks involving alternative measures of outcome variables, estimation models, empirical specifications, etc.

In addition, this study sheds new light on how relative deprivation influences adolescent health. This study underscores relatively understudied potential mechanisms of the effect of relative deprivation—e.g., future expectations and social relationship. This study provides evidence that relative deprivation affects adolescent health through the combination of psychological and social pathways. Surprisingly, my findings suggest that declines in future expectations (largely about educational attainment) play more important roles than concurrent psychological distress in mediating the link between relative deprivation and adolescent health. This finding suggests that psychological distress is not the only negative consequence of invidious social comparison affecting adolescent health. Adolescents who are relative deprived tend to use their own experience of relatively lower social status to form their future expectations, which deteriorates adolescent health status. Moreover, this study demonstrates that relative deprivation harms adolescent health through disadvantages in social relationship (largely with other students and friends), indicating that there might be *downward* social stigma or discrimination by other students at the upper tail of the distribution.

The findings of this study lend strong support to the theory of relative deprivation which is derived from a fundamental sociological concept that social contexts influence individual outcomes. In particular, focusing on health consequences of relative deprivation among adolescents, this study contributes to the existing literature in several ways. First, I address several empirical limitations and important gaps in current knowledge of the link between relative deprivation and health. Unlike prior literature on relative deprivation, this study uses a more clearly defined reference group, i.e., classmates. This study argues that the standard of living among classmates is salient in influencing the adolescent's perception of referenced others and their relative social position among them, and consequently, adolescent health. In addition, this study reduces the concern about the possibility of reverse causality (i.e., the positive effect of health on income), by using parental income as a basis of relative deprivation.

Second, this study enhances our understanding of how socioeconomic status might have an impact on adolescent health. Analyzing adolescent health through the lens of relative deprivation, rather than material (absolute) deprivation, may help clarify the apparent contradictions in the literate on the link between socioeconomic factors and health—i.e., the inconsistency of the SES/health gradient in youth (West 1997; West and Sweeting 2004). The findings of this study suggest that the effects of socioeconomic factors on adolescent health may operate through disadvantages in psychological and social resources rather than material resources. In addition, this study considers additional mechanisms behind the effect of relative deprivation that have largely ignored in the prior literature: future expectations and social relationships. Since the vast majority of prior studies have focused on concurrent psychological distress and unhealthy behaviors (as a coping strategy to mitigate psychological distress) as potential mechanisms, this study adds new insights on how relative deprivation may affect an individual's health.

Third, another contribution of this study centers around the use of longitudinal data and the adoption of a more rigorous research method. In particular, while focusing on school-cohort as a reference group among adolescents, this study addresses selection bias by using school fixed effects. This approach allows us to identify within-school across-cohort variation in the distribution of parental income, which is likely to be quasi-exogenous under the assumption that parents and their children sort across schools based on the characteristics of the school, but not those of the child's cohort. In addition, a series of robustness test are conducted to assess the validity of the findings of this study. Importantly, exploiting exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school, family fixed effects models yield qualitatively similar results.

The results of this study contain theoretical and policy implications. This study suggests that social inequality and stratification in our society may have an implication extended to population health in the next generation through socioeconomic stratification within schools. Among adolescents, emerging school-based social hierarchies and ranking systems may heighten relative deprivation to deteriorate physical and mental health especially among those at the lower end of the SES distribution, thereby contributing to health inequalities. In the longer-term, relative deprivation in the school settings may serve as a mechanism for intergenerational transmission of social disadvantages (Haas 2006). The finding that relative deprivation is linked with declines in future expectations particularly about educational attainment also provides evidence for the claim that relative deprivation contributes to hampering social mobility (Wegener 1991).

The findings of this study may be useful for future researchers and policy-makers developing interventions to improve adolescent health. Relative deprivation provides an important policy target for such interventions and an indicator for predicting the risk of poor physical and mental health. Therefore, monitoring relative deprivation, rather than mere poverty levels, may help schools identify at-risk adolescents and take effective measures to improve their health. Furthermore, evidence on detailed mechanisms underlying the links between relative deprivation and adolescent health help develop interventions for adolescent health. Since a student's psychological distress is found to help explain the link between relative deprivation and health, a direct solution may be to reduce negative feelings of being at relatively lower status through psychological support and counseling services. It may also be important for teachers to help relatively impoverished adolescents feel hopeful about their future, particularly about their future educational trajectories (e.g., college aspirations). Since the findings of this study emphasize the importance of social relationships in the school settings, school-based programs to promote the social integration of low-status students and their families may be useful. More fundamental efforts to narrow socioeconomic gaps among students (e.g., redistributive policies) may further help reduce psychological and social disadvantages of those having a higher level of relative deprivation.

Finally, this study offers an implication for parental school choice and educational policy. Attending schools with higher SES has long been believed to beneficial for adolescent health and educational outcomes. Popular policy responses to this claim may be to mix rich and poor kids in schools and classrooms (e.g., social or neighborhood mixing), such that poor kids benefit from interacting with higher SES students and families. However, this study rather documents a possible trade-off between school socioeconomic composition and rank position—i.e., students attending a school with higher SES composition should be ranked lower, suggesting that the rank of a child is another (often neglected) factor for parents to consider when choosing a school. Therefore, moving to a wealthier neighborhood or school may have differential health consequences for different students depending on their own SES levels. Since the net effects for an individual student should depend on the extent to which benefits of attending schools with higher SES composition (e.g., average peer quality, teacher quality, and school resources) are offset by drawbacks of having lower relative SES position (as found in this study), more research is required to better gauge the trade-off between contextual effects and rank effects.

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**7. Tables**

***Table 1. Summary statistics, National Longitudinal Study of Adolescent to Adult Health (N = 8,011)***

| | Mean | SD | Min | Max |
|---|---|---|---|---|
| ***Relative deprivation*** | | | | |
| Yitzhaki Index | 0.155 | 0.146 | 0.0 | 2.1 |
| Deaton Index | 0.348 | 0.262 | 0.0 | 1.5 |
| Inverse percentile rank | 0.513 | 0.300 | 0.0 | 1.0 |
| d-measure | 0.140 | 0.221 | 0.0 | 1.0 |
| ***Dependent variables*** | | | | |
| Self-rated health = Excellent (W2) | 0.296 | 0.456 | 0.0 | 1.0 |
| Self-rated health = Excellent (W1) | 0.282 | 0.450 | 0.0 | 1.0 |
| Depressive symptoms (W2) | -0.071 | 0.983 | -1.5 | 5.9 |
| Depressive symptoms (W1) | -0.082 | 0.975 | -1.5 | 5.6 |
| ***Mechanism variables*** | | | | |
| Self-esteem | 0.049 | 0.987 | -5.6 | 1.7 |
| I want to go to college | 4.462 | 1.002 | 1.0 | 5.0 |
| I will likely go to college | 4.167 | 1.120 | 1.0 | 5.0 |
| Life chances expectations | 0.043 | 0.711 | -4.2 | 0.8 |
| Hopeful for future | 1.810 | 0.985 | 0.0 | 3.0 |
| School attachment | 0.030 | 0.812 | -2.6 | 1.2 |
| Relationship with students | -0.004 | 0.612 | -2.9 | 1.3 |
| Relationship with teachers | -0.013 | 0.762 | -2.7 | 1.3 |
| Friend nominations received | 4.663 | 3.235 | 0.0 | 27.0 |
| Friend nominations sent | 4.596 | 2.536 | 0.0 | 10.0 |
| Isolate | 0.033 | 0.140 | 0.0 | 1.0 |
| Centrality | 0.827 | 0.521 | 0.0 | 3.9 |
| Cigarette smoking | 4.066 | 9.304 | 0.0 | 30.0 |
| Binge drinking | 10.940 | 38.728 | 0.0 | 300.0 |
| ***Control variables*** | | | | |
| Female | 0.502 | 0.500 | 0.0 | 1.0 |
| Age | 15.553 | 1.557 | 12.0 | 21.0 |
| White | 0.649 | 0.477 | 0.0 | 1.0 |
| Black | 0.185 | 0.388 | 0.0 | 1.0 |
| Hispanic | 0.125 | 0.331 | 0.0 | 1.0 |
| Other race/ethnicity | 0.042 | 0.200 | 0.0 | 1.0 |
| Standardized PVT score | 0.137 | 0.910 | -5.6 | 2.5 |
| First-born | 0.514 | 0.500 | 0.0 | 1.0 |
| Grade 7 | 0.182 | 0.386 | 0.0 | 1.0 |
| Grade 8 | 0.184 | 0.388 | 0.0 | 1.0 |
| Grade 9 | 0.227 | 0.419 | 0.0 | 1.0 |
| Grade 10 | 0.214 | 0.410 | 0.0 | 1.0 |
| Grade 11 | 0.162 | 0.368 | 0.0 | 1.0 |
| Grade 12 | 0.032 | 0.175 | 0.0 | 1.0 |
| Mother's education | 13.261 | 2.189 | 0.0 | 17.0 |
| Family income | 0.451 | 0.462 | 0.0 | 10.0 |

| | | | | |
|---|---|---|---|---|
| Rural | 0.290 | 0.454 | 0.0 | 1.0 |
| Missing family information dummy | 0.080 | 0.271 | 0.0 | 1.0 |
| Observations | 8011 | | | |

*Note.* Family income and maternal education contain imputed values and parent missing data dummy reflects this missingness.

*Table 2. Relative deprivation and self-rated health*

| | (1) Self-rated health = Excellent (W1) | (2) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (4) Self-rated health = Excellent (W1) | (5) Self-rated health = Excellent (W2) | (6) Self-rated health = Excellent (W2) | (7) Self-rated health = Excellent (W2) | (8) Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.130*** | | | | -0.133** | | | |
| | (0.041) | | | | (0.053) | | | |
| Deaton Index | | -0.047* | | | | -0.054* | | |
| | | (0.024) | | | | (0.029) | | |
| Inverse percentile rank | | | -0.044* | | | | -0.069*** | |
| | | | (0.023) | | | | (0.025) | |
| d-measure | | | | -0.029 | | | | -0.051* |
| | | | | (0.026) | | | | (0.030) |
| Female | -0.071*** | -0.071*** | -0.071*** | -0.071*** | -0.079*** | -0.079*** | -0.079*** | -0.079*** |
| | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) | (0.011) |
| Age | 0.002 | 0.002 | 0.002 | 0.001 | 0.013 | 0.013 | 0.014 | 0.013 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) | (0.008) |
| Black | 0.050*** | 0.049*** | 0.049*** | 0.048*** | 0.060*** | 0.059*** | 0.061*** | 0.059*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.019) | (0.019) | (0.019) | (0.019) |
| Hispanic | -0.010 | -0.011 | -0.011 | -0.011 | -0.011 | -0.011 | -0.011 | -0.011 |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.022) | (0.022) | (0.022) | (0.022) |
| Other race/ethnicity | 0.045** | 0.044** | 0.045** | 0.043** | 0.041 | 0.041 | 0.043 | 0.040 |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.029) | (0.029) | (0.029) | (0.029) |
| Standardized PVT score | -0.013* | -0.013* | -0.013* | -0.012* | -0.002 | -0.002 | -0.002 | -0.002 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) |
| First-born | 0.013 | 0.013 | 0.013 | 0.012 | 0.004 | 0.004 | 0.005 | 0.004 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.010) | (0.010) | (0.010) | (0.010) |
| Grade 8 | 0.009 | 0.009 | 0.009 | 0.010 | -0.045** | -0.046** | -0.046** | -0.045** |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.022) | (0.021) | (0.021) | (0.021) |
| Grade 9 | -0.017 | -0.017 | -0.016 | -0.015 | -0.075** | -0.075** | -0.075** | -0.074** |
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.030) | (0.031) | (0.030) | (0.031) |
| Grade 10 | -0.018 | -0.021 | -0.020 | -0.019 | -0.105*** | -0.108*** | -0.109*** | -0.107*** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.028) | (0.028) | (0.028) | (0.028) | (0.034) | (0.034) | (0.034) | (0.034) |
| Grade 11 | -0.008 | -0.009 | -0.007 | -0.006 | -0.094** | -0.095** | -0.094** | -0.093** |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.037) | (0.037) | (0.037) | (0.038) |
| Grade 12 | 0.007 | 0.004 | 0.006 | 0.008 | -0.114** | -0.117** | -0.116** | -0.115** |
| | (0.039) | (0.039) | (0.039) | (0.039) | (0.050) | (0.050) | (0.050) | (0.050) |
| Mother's education | 0.008*** | 0.008*** | 0.008*** | 0.009*** | 0.011*** | 0.011*** | 0.011*** | 0.012*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Family income | 0.018 | 0.024* | 0.022 | 0.032*** | 0.024 | 0.029* | 0.019 | 0.036** |
| | (0.012) | (0.012) | (0.013) | (0.012) | (0.016) | (0.016) | (0.015) | (0.015) |
| Rural | 0.018 | 0.018 | 0.018 | 0.018 | 0.003 | 0.003 | 0.003 | 0.004 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.018) | (0.018) | (0.018) | (0.018) |
| Missing family information dummy | -0.049*** | -0.048*** | -0.048*** | -0.049*** | -0.075*** | -0.074*** | -0.073*** | -0.075*** |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.018) | (0.018) | (0.018) | (0.018) |
| Constant | 0.183* | 0.173 | 0.182* | 0.158 | 0.052 | 0.043 | 0.067 | 0.029 |
| | (0.107) | (0.107) | (0.107) | (0.107) | (0.135) | (0.136) | (0.137) | (0.134) |
| Observations | 10495 | 10495 | 10495 | 10495 | 8011 | 8011 | 8011 | 8011 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 3. Relative deprivation and depressive symptoms***

| | (1) Depressive symptoms (W1) | (2) Depressive symptoms (W1) | (3) Depressive symptoms (W1) | (4) Depressive symptoms (W1) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | 0.180* | | | | 0.233** | | | |
| | (0.091) | | | | (0.107) | | | |
| Deaton Index | | 0.167*** | | | | 0.223*** | | |
| | | (0.049) | | | | (0.056) | | |
| Inverse percentile rank | | | 0.118*** | | | | 0.204*** | |
| | | | (0.040) | | | | (0.048) | |
| d-measure | | | | 0.171*** | | | | 0.209*** |
| | | | | (0.061) | | | | (0.062) |
| Female | 0.281*** | 0.280*** | 0.280*** | 0.281*** | 0.269*** | 0.268*** | 0.268*** | 0.269*** |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.025) | (0.025) | (0.025) | (0.025) |
| Age | 0.130*** | 0.127*** | 0.128*** | 0.128*** | 0.106*** | 0.103*** | 0.103*** | 0.104*** |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.018) | (0.017) | (0.017) | (0.017) |
| Black | 0.073** | 0.065** | 0.070** | 0.065* | 0.096** | 0.085** | 0.087** | 0.087** |
| | (0.032) | (0.032) | (0.032) | (0.033) | (0.040) | (0.041) | (0.040) | (0.041) |
| Hispanic | 0.062* | 0.058 | 0.062* | 0.059 | 0.100*** | 0.096*** | 0.098*** | 0.097*** |
| | (0.037) | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) | (0.036) |
| Other race/ethnicity | 0.025 | 0.020 | 0.022 | 0.022 | 0.171*** | 0.164*** | 0.163*** | 0.170*** |
| | (0.043) | (0.043) | (0.043) | (0.043) | (0.057) | (0.057) | (0.057) | (0.057) |
| Standardized PVT score | -0.161*** | -0.159*** | -0.160*** | -0.159*** | -0.155*** | -0.152*** | -0.152*** | -0.152*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.014) | (0.014) | (0.014) | (0.014) |
| First-born | -0.012 | -0.014 | -0.013 | -0.013 | -0.001 | -0.004 | -0.005 | -0.002 |
| | (0.017) | (0.017) | (0.017) | (0.018) | (0.020) | (0.020) | (0.020) | (0.020) |
| Grade 8 | -0.058 | -0.057 | -0.056 | -0.057 | 0.009 | 0.011 | 0.013 | 0.010 |
| | (0.038) | (0.038) | (0.038) | (0.038) | (0.048) | (0.048) | (0.048) | (0.048) |
| Grade 9 | -0.064 | -0.057 | -0.062 | -0.060 | -0.022 | -0.015 | -0.019 | -0.019 |
| | (0.062) | (0.061) | (0.061) | (0.061) | (0.071) | (0.070) | (0.069) | (0.069) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Grade 10 | -0.190** | -0.180** | -0.184** | -0.182** | -0.104 | -0.091 | -0.093 | -0.095 |
| | (0.074) | (0.074) | (0.074) | (0.074) | (0.080) | (0.079) | (0.079) | (0.078) |
| Grade 11 | -0.231*** | -0.218** | -0.227*** | -0.223*** | -0.209** | -0.193** | -0.202** | -0.202** |
| | (0.086) | (0.085) | (0.085) | (0.085) | (0.092) | (0.091) | (0.091) | (0.090) |
| Grade 12 | -0.470*** | -0.452*** | -0.463*** | -0.458*** | -0.414*** | -0.392*** | -0.404*** | -0.401*** |
| | (0.094) | (0.093) | (0.092) | (0.093) | (0.125) | (0.124) | (0.124) | (0.123) |
| Mother's education | -0.022*** | -0.020*** | -0.021*** | -0.021*** | -0.020*** | -0.017*** | -0.017*** | -0.019*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | -0.038 | -0.018 | -0.022 | -0.034 | -0.039 | -0.010 | 0.003 | -0.037 |
| | (0.027) | (0.026) | (0.026) | (0.023) | (0.030) | (0.029) | (0.029) | (0.027) |
| Rural | -0.049** | -0.049** | -0.049** | -0.049** | -0.018 | -0.018 | -0.018 | -0.018 |
| | (0.024) | (0.024) | (0.024) | (0.024) | (0.032) | (0.032) | (0.032) | (0.032) |
| Missing family information dummy | 0.191*** | 0.188*** | 0.188*** | 0.189*** | 0.145*** | 0.139*** | 0.138*** | 0.141*** |
| | (0.034) | (0.034) | (0.034) | (0.034) | (0.043) | (0.042) | (0.043) | (0.042) |
| Constant | -1.830*** | -1.857*** | -1.866*** | -1.818*** | -1.560*** | -1.599*** | -1.645*** | -1.542*** |
| | (0.200) | (0.200) | (0.199) | (0.200) | (0.236) | (0.236) | (0.235) | (0.236) |
| Observations | 10490 | 10490 | 10490 | 10490 | 8010 | 8010 | 8010 | 8010 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 4. Relative deprivation and Wave 1 mechanism variables***

| | (1) Yitzhaki Index | (2) Observations |
|---|---|---|
| **Panel A. Psychological factors** | | |
| *Concurrent psychological distress* | | |
| Self-esteem | -0.206** | 10489 |
| | (0.087) | |
| Depressive symptoms | 0.180* | 10490 |
| | (0.091) | |
| *Future expectations* | | |
| I want to go to college | -0.279** | 10457 |
| | (0.116) | |
| I will likely go to college | -0.788*** | 10448 |
| | (0.140) | |
| Life chances expectations | -0.116 | 10458 |
| | (0.080) | |
| Hopeful about future | -0.204** | 10476 |
| | (0.084) | |
| **Panel B. Social relationship** | | |
| *Social relationship in the school* | | |
| School attachment | -0.198*** | 10490 |
| | (0.063) | |
| Relationship with friends | -0.100** | 10492 |
| | (0.047) | |
| Relationship with teachers | -0.052 | 10492 |
| | (0.079) | |
| *Friendship network* | | |
| Friend nominations received | -1.149*** | 10499 |
| | (0.330) | |
| Friend nominations sent | -0.500** | 10499 |
| | (0.216) | |
| Isolate | 0.004 | 10499 |
| | (0.011) | |
| Centrality | -0.207*** | 10499 |
| | (0.053) | |
| **Panel C. Self-medication** | | |
| Cigarette smoking | 2.012** | 10431 |
| | (0.840) | |
| Binge drinking | 8.436 | 10479 |
| | (5.230) | |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 5. Regressions of Wave 2 self-rated health on relative deprivation and mechanism variables***

| | (1) Self-rated health = Excellent (W2) | (2) Self-rated health = Excellent (W2) | (3) Self-rated health = Excellent (W2) | (4) Self-rated health = Excellent (W2) | (5) Self-rated health = Excellent (W2) | (6) Self-rated health = Excellent (W2) | (7) Self-rated health = Excellent (W2) | (8) Self-rated health = Excellent (W2) | (9) Self-rated health = Excellent (W2) | (10) Self-rated health = Excellent (W2) | (11) Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.133$^{**}$ | -0.104$^{*}$ | -0.096$^{*}$ | -0.123$^{**}$ | -0.120$^{**}$ | -0.089 | -0.111$^{**}$ | -0.115$^{**}$ | -0.099$^{*}$ | -0.120$^{**}$ | -0.068 |
| | (0.053) | (0.053) | (0.055) | (0.053) | (0.053) | (0.055) | (0.054) | (0.053) | (0.054) | (0.054) | (0.054) |
| Self-esteem | | 0.084$^{***}$ | | | | | | | | | 0.066$^{***}$ |
| | | (0.007) | | | | | | | | | (0.007) |
| Depressive symptoms | | -0.015$^{**}$ | | | | | | | | | 0.005 |
| | | (0.006) | | | | | | | | | (0.007) |
| I want to go to college | | | 0.010 | | | 0.007 | | | | | 0.000 |
| | | | (0.007) | | | (0.006) | | | | | (0.006) |
| I will likely go to college | | | 0.042$^{***}$ | | | 0.033$^{***}$ | | | | | 0.018$^{***}$ |
| | | | (0.006) | | | (0.006) | | | | | (0.006) |
| Life chances expectations | | | | 0.079$^{***}$ | | 0.066$^{***}$ | | | | | 0.042$^{***}$ |
| | | | | (0.007) | | (0.007) | | | | | (0.007) |
| Hopeful about future | | | | | 0.042$^{***}$ | 0.030$^{***}$ | | | | | 0.007 |
| | | | | | (0.005) | (0.005) | | | | | (0.006) |
| School attachment | | | | | | | 0.054$^{***}$ | | 0.049$^{***}$ | | 0.025$^{***}$ |
| | | | | | | | (0.007) | | (0.007) | | (0.007) |
| Relationship with students | | | | | | | 0.024$^{***}$ | | 0.022$^{**}$ | | 0.009 |
| | | | | | | | (0.009) | | (0.009) | | (0.009) |
| Relationship with teachers | | | | | | | 0.037$^{***}$ | | 0.039$^{***}$ | | 0.010 |
| | | | | | | | (0.007) | | (0.007) | | (0.007) |
| Friend | | | | | | | | 0.005$^{**}$ | 0.005$^{**}$ | | 0.004$^{**}$ |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| nominations received | | | | | | | | | | | |
| | | | | | | | | (0.002) | (0.002) | | (0.002) |
| Friend nominations sent | | | | | | | | -0.013$^{**}$ | -0.012$^{**}$ | | -0.011$^{**}$ |
| | | | | | | | | (0.006) | (0.005) | | (0.005) |
| Isolate | | | | | | | | -0.072$^{***}$ | -0.063$^{**}$ | | -0.056$^{*}$ |
| | | | | | | | | (0.027) | (0.028) | | (0.028) |
| Centrality | | | | | | | | 0.090$^{***}$ | 0.070$^{**}$ | | 0.058$^{**}$ |
| | | | | | | | | (0.028) | (0.027) | | (0.027) |
| Missing network data dummy | | | | | | | | -0.011 | -0.002 | | 0.008 |
| | | | | | | | | (0.014) | (0.013) | | (0.013) |
| Cigarette smoking | | | | | | | | | | -0.006$^{***}$ | -0.004$^{***}$ |
| | | | | | | | | | | (0.000) | (0.000) |
| Binge drinking | | | | | | | | | | -0.000 | 0.000 |
| | | | | | | | | | | (0.000) | (0.000) |
| Female | -0.079$^{***}$ | -0.044$^{***}$ | -0.093$^{***}$ | -0.079$^{***}$ | -0.078$^{***}$ | -0.089$^{***}$ | -0.082$^{***}$ | -0.084$^{***}$ | -0.086$^{***}$ | -0.080$^{***}$ | -0.065$^{***}$ |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) | (0.011) |
| Age | 0.013 | 0.020$^{**}$ | 0.020$^{**}$ | 0.014$^{*}$ | 0.015$^{*}$ | 0.022$^{**}$ | 0.016$^{*}$ | 0.016$^{*}$ | 0.018$^{**}$ | 0.017$^{**}$ | 0.025$^{***}$ |
| | (0.008) | (0.009) | (0.009) | (0.008) | (0.008) | (0.009) | (0.008) | (0.008) | (0.008) | (0.008) | (0.009) |
| Black | 0.060$^{***}$ | 0.047$^{**}$ | 0.051$^{**}$ | 0.067$^{***}$ | 0.055$^{***}$ | 0.056$^{***}$ | 0.064$^{***}$ | 0.068$^{***}$ | 0.070$^{***}$ | 0.036$^{*}$ | 0.040$^{**}$ |
| | (0.019) | (0.018) | (0.019) | (0.019) | (0.019) | (0.019) | (0.019) | (0.020) | (0.020) | (0.019) | (0.019) |
| Hispanic | -0.011 | -0.008 | -0.012 | -0.005 | -0.008 | -0.004 | -0.012 | -0.012 | -0.013 | -0.018 | -0.012 |
| | (0.022) | (0.023) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.023) | (0.023) | (0.022) | (0.023) |
| Other race/ethnicity | 0.041 | 0.046 | 0.027 | 0.045 | 0.044 | 0.035 | 0.041 | 0.046 | 0.045 | 0.032 | 0.041 |
| | (0.029) | (0.029) | (0.029) | (0.029) | (0.028) | (0.029) | (0.029) | (0.028) | (0.029) | (0.030) | (0.029) |
| Standardized PVT score | -0.002 | -0.010 | -0.009 | -0.004 | -0.007 | -0.013$^{*}$ | -0.002 | -0.004 | -0.003 | -0.005 | -0.012 |
| | (0.007) | (0.008) | (0.008) | (0.008) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.007) | (0.008) |
| First-born | 0.004 | 0.005 | 0.005 | 0.005 | 0.004 | 0.005 | 0.004 | 0.007 | 0.006 | 0.004 | 0.007 |
| | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) |
| Grade 8 | -0.045$^{**}$ | -0.045$^{**}$ | -0.051$^{**}$ | -0.040$^{*}$ | -0.047$^{**}$ | -0.049$^{**}$ | -0.041$^{*}$ | -0.050$^{**}$ | -0.044$^{**}$ | -0.044$^{**}$ | -0.045$^{**}$ |
| | (0.022) | (0.021) | (0.022) | (0.021) | (0.022) | (0.021) | (0.021) | (0.022) | (0.021) | (0.021) | (0.020) |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade 9 | -0.075$^{**}$ | -0.063$^{**}$ | -0.077$^{**}$ | -0.057$^{*}$ | -0.074$^{**}$ | -0.068$^{**}$ | -0.067$^{**}$ | -0.084$^{***}$ | -0.072$^{**}$ | -0.060$^{**}$ | -0.049$^{*}$ |
| | (0.030) | (0.029) | (0.031) | (0.031) | (0.030) | (0.031) | (0.029) | (0.031) | (0.030) | (0.030) | (0.030) |
| Grade 10 | -0.105$^{***}$ | -0.099$^{***}$ | -0.117$^{***}$ | -0.088$^{**}$ | -0.110$^{***}$ | -0.109$^{***}$ | -0.100$^{***}$ | -0.115$^{***}$ | -0.105$^{***}$ | -0.094$^{***}$ | -0.091$^{***}$ |
| | (0.034) | (0.034) | (0.036) | (0.035) | (0.034) | (0.036) | (0.034) | (0.034) | (0.034) | (0.034) | (0.034) |
| Grade 11 | -0.094$^{**}$ | -0.092$^{**}$ | -0.112$^{***}$ | -0.075$^{*}$ | -0.099$^{***}$ | -0.105$^{***}$ | -0.085$^{**}$ | -0.105$^{***}$ | -0.092$^{**}$ | -0.076$^{**}$ | -0.084$^{**}$ |
| | (0.037) | (0.037) | (0.040) | (0.038) | (0.037) | (0.039) | (0.037) | (0.038) | (0.037) | (0.037) | (0.038) |
| Grade 12 | -0.114$^{**}$ | -0.133$^{***}$ | -0.146$^{***}$ | -0.105$^{**}$ | -0.125$^{**}$ | -0.148$^{***}$ | -0.123$^{**}$ | -0.126$^{**}$ | -0.131$^{***}$ | -0.108$^{**}$ | -0.144$^{***}$ |
| | (0.050) | (0.049) | (0.051) | (0.050) | (0.050) | (0.052) | (0.049) | (0.049) | (0.048) | (0.050) | (0.050) |
| Mother's education | 0.011$^{***}$ | 0.010$^{***}$ | 0.007$^{***}$ | 0.011$^{***}$ | 0.010$^{***}$ | 0.007$^{**}$ | 0.011$^{***}$ | 0.010$^{***}$ | 0.010$^{***}$ | 0.011$^{***}$ | 0.007$^{***}$ |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Family income | 0.024 | 0.022 | 0.023 | 0.022 | 0.026 | 0.022 | 0.023 | 0.023 | 0.022 | 0.021 | 0.017 |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) | (0.015) | (0.016) | (0.016) | (0.016) | (0.016) | (0.015) |
| Rural | 0.003 | 0.002 | 0.003 | 0.006 | 0.004 | 0.005 | 0.005 | 0.006 | 0.007 | 0.001 | 0.005 |
| | (0.018) | (0.018) | (0.019) | (0.017) | (0.017) | (0.017) | (0.017) | (0.018) | (0.017) | (0.018) | (0.017) |
| Missing family information dummy | -0.075$^{***}$ | -0.056$^{***}$ | -0.068$^{***}$ | -0.070$^{***}$ | -0.069$^{***}$ | -0.062$^{***}$ | -0.061$^{***}$ | -0.071$^{***}$ | -0.059$^{***}$ | -0.068$^{***}$ | -0.047$^{***}$ |
| | (0.018) | (0.018) | (0.019) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) |
| Constant | 0.052 | -0.055 | -0.207 | 0.024 | -0.034 | -0.248$^{*}$ | -0.003 | -0.013 | -0.037 | 0.014 | -0.207 |
| | (0.135) | (0.137) | (0.141) | (0.133) | (0.138) | (0.144) | (0.134) | (0.136) | (0.134) | (0.133) | (0.138) |
| Observations | 8011 | 8002 | 7976 | 7978 | 7994 | 7961 | 8005 | 8011 | 8005 | 7954 | 7903 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 6. Regressions of Wave 2 depressive symptoms on relative deprivation and mechanism variables***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) | (11) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | 0.233$^{**}$ | 0.121 | 0.119 | 0.212$^{**}$ | 0.174$^{*}$ | 0.083 | 0.156 | 0.207$^{*}$ | 0.150 | 0.192$^{*}$ | 0.051 |
| | (0.107) | (0.097) | (0.103) | (0.103) | (0.102) | (0.096) | (0.107) | (0.107) | (0.107) | (0.105) | (0.097) |
| Self-esteem | | -0.390$^{***}$ | | | | | | | | | -0.281$^{***}$ |
| | | (0.010) | | | | | | | | | (0.012) |
| I want to go to college | | | -0.018 | | | -0.004 | | | | | 0.011 |
| | | | (0.016) | | | (0.015) | | | | | (0.013) |
| I will likely go to college | | | -0.135$^{***}$ | | | -0.097$^{***}$ | | | | | -0.041$^{***}$ |
| | | | (0.017) | | | (0.016) | | | | | (0.013) |
| Life chances expectations | | | | -0.261$^{***}$ | | -0.216$^{***}$ | | | | | -0.100$^{***}$ |
| | | | | (0.018) | | (0.017) | | | | | (0.015) |
| Hopeful about future | | | | | -0.207$^{***}$ | -0.176$^{***}$ | | | | | -0.067$^{***}$ |
| | | | | | (0.011) | (0.011) | | | | | (0.010) |
| School attachment | | | | | | | -0.134$^{***}$ | | -0.131$^{***}$ | | -0.036$^{*}$ |
| | | | | | | | (0.019) | | (0.019) | | (0.019) |
| Relationship with students | | | | | | | -0.208$^{***}$ | | -0.209$^{***}$ | | -0.147$^{***}$ |
| | | | | | | | (0.020) | | (0.020) | | (0.019) |
| Relationship with teachers | | | | | | | -0.213$^{***}$ | | -0.210$^{***}$ | | -0.123$^{***}$ |
| | | | | | | | (0.016) | | (0.017) | | (0.015) |
| Friend nominations received | | | | | | | | 0.008$^{**}$ | 0.009$^{**}$ | | 0.011$^{***}$ |
| | | | | | | | | (0.004) | (0.004) | | (0.003) |
| Friend | | | | | | | | -0.007 | -0.011 | | -0.011 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| nominations sent | | | | | | | | | | | |
| | | | | | | | | (0.012) | (0.012) | | (0.011) |
| Isolate | | | | | | | | 0.031 | -0.010 | | -0.057 |
| | | | | | | | | (0.077) | (0.073) | | (0.069) |
| Centrality | | | | | | | | -0.099 | -0.016 | | -0.007 |
| | | | | | | | | (0.062) | (0.056) | | (0.052) |
| Missing network data dummy | | | | | | | | 0.119*** | 0.081*** | | 0.058** |
| | | | | | | | | (0.025) | (0.025) | | (0.024) |
| Cigarette smoking | | | | | | | | | | 0.012*** | 0.004*** |
| | | | | | | | | | | (0.001) | (0.001) |
| Binge drinking | | | | | | | | | | 0.001*** | 0.000 |
| | | | | | | | | | | (0.000) | (0.000) |
| Female | 0.269*** | 0.123*** | 0.310*** | 0.269*** | 0.264*** | 0.288*** | 0.298*** | 0.279*** | 0.302*** | 0.271*** | 0.192*** |
| | (0.025) | (0.020) | (0.026) | (0.025) | (0.024) | (0.024) | (0.023) | (0.025) | (0.023) | (0.025) | (0.020) |
| Age | 0.106*** | 0.086*** | 0.084*** | 0.105*** | 0.101*** | 0.077*** | 0.102*** | 0.096*** | 0.097*** | 0.097*** | 0.070*** |
| | (0.018) | (0.016) | (0.017) | (0.017) | (0.016) | (0.016) | (0.017) | (0.017) | (0.017) | (0.018) | (0.015) |
| Black | 0.096** | 0.163*** | 0.122*** | 0.069* | 0.120*** | 0.116*** | 0.087** | 0.085** | 0.086** | 0.149*** | 0.162*** |
| | (0.040) | (0.034) | (0.040) | (0.040) | (0.039) | (0.038) | (0.038) | (0.041) | (0.038) | (0.039) | (0.034) |
| Hispanic | 0.100*** | 0.084** | 0.094** | 0.073** | 0.084** | 0.063* | 0.100*** | 0.104*** | 0.102*** | 0.119*** | 0.084** |
| | (0.036) | (0.034) | (0.036) | (0.035) | (0.034) | (0.034) | (0.036) | (0.036) | (0.036) | (0.037) | (0.035) |
| Other race/ethnicity | 0.171*** | 0.155*** | 0.211*** | 0.159*** | 0.159*** | 0.179*** | 0.175*** | 0.169*** | 0.177*** | 0.204*** | 0.174*** |
| | (0.057) | (0.053) | (0.057) | (0.058) | (0.054) | (0.054) | (0.054) | (0.056) | (0.054) | (0.059) | (0.051) |
| Standardized PVT score | -0.155*** | -0.127*** | -0.137*** | -0.149*** | -0.127*** | -0.110*** | -0.154*** | -0.148*** | -0.150*** | -0.144*** | -0.112*** |
| | (0.014) | (0.013) | (0.014) | (0.014) | (0.013) | (0.014) | (0.013) | (0.015) | (0.013) | (0.014) | (0.012) |
| First-born | -0.001 | -0.002 | -0.001 | -0.002 | 0.000 | -0.000 | 0.002 | -0.001 | 0.005 | 0.002 | 0.004 |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.019) | (0.019) | (0.020) | (0.020) | (0.021) | (0.020) | (0.021) |
| Grade 8 | 0.009 | -0.001 | 0.038 | -0.004 | 0.017 | 0.036 | -0.021 | 0.022 | -0.014 | 0.003 | 0.007 |
| | (0.048) | (0.045) | (0.047) | (0.047) | (0.048) | (0.046) | (0.044) | (0.048) | (0.044) | (0.047) | (0.042) |
| Grade 9 | -0.022 | -0.080 | -0.000 | -0.070 | -0.021 | -0.029 | -0.078 | 0.009 | -0.061 | -0.058 | -0.091* |
| | (0.071) | (0.058) | (0.069) | (0.065) | (0.063) | (0.060) | (0.062) | (0.071) | (0.062) | (0.066) | (0.052) |
| Grade 10 | -0.104 | -0.146** | -0.055 | -0.154** | -0.084 | -0.072 | -0.156** | -0.065 | -0.136** | -0.126* | -0.134** |
| | (0.080) | (0.064) | (0.080) | (0.074) | (0.073) | (0.070) | (0.069) | (0.079) | (0.068) | (0.076) | (0.058) |

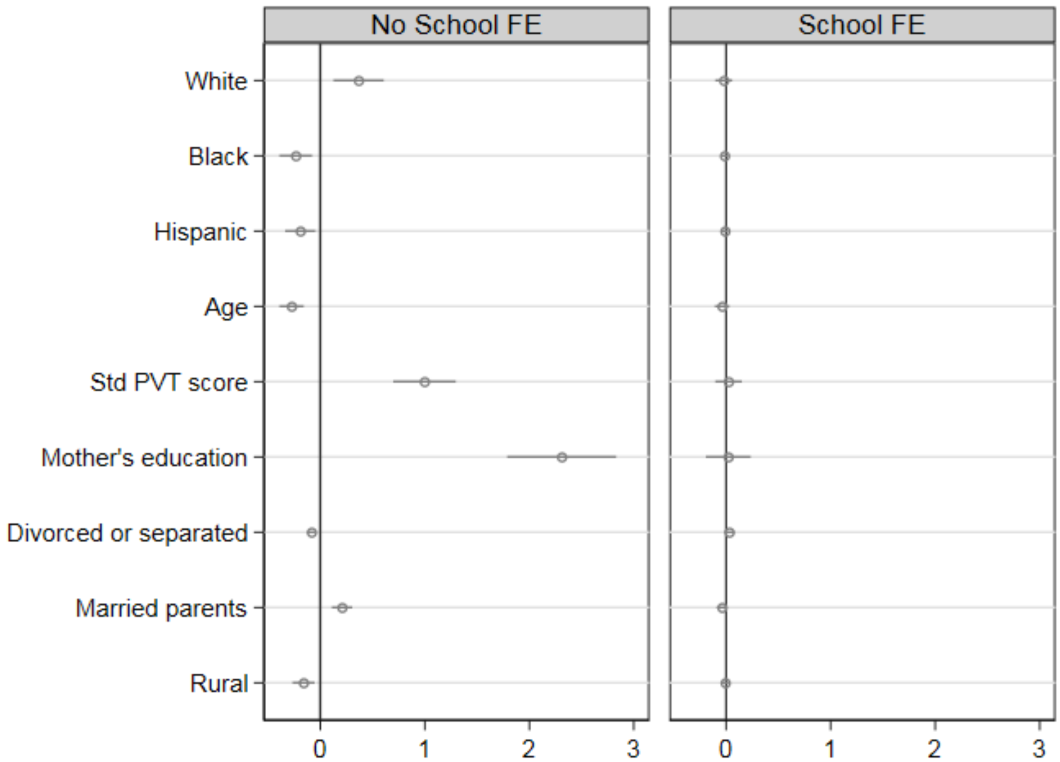
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade 11 | -0.209$^{**}$ | -0.229$^{***}$ | -0.136 | -0.262$^{***}$ | -0.185$^{**}$ | -0.150$^{*}$ | -0.277$^{***}$ | -0.172$^{*}$ | -0.258$^{***}$ | -0.255$^{***}$ | -0.224$^{***}$ |
| | (0.092) | (0.078) | (0.093) | (0.087) | (0.084) | (0.081) | (0.082) | (0.092) | (0.082) | (0.088) | (0.071) |
| Grade 12 | -0.414$^{***}$ | -0.355$^{***}$ | -0.292$^{**}$ | -0.441$^{***}$ | -0.367$^{***}$ | -0.272$^{**}$ | -0.405$^{***}$ | -0.379$^{***}$ | -0.390$^{***}$ | -0.443$^{***}$ | -0.297$^{***}$ |
| | (0.125) | (0.103) | (0.123) | (0.115) | (0.113) | (0.110) | (0.115) | (0.125) | (0.113) | (0.124) | (0.093) |
| Mother's education | -0.020$^{***}$ | -0.013$^{***}$ | -0.008$^{*}$ | -0.018$^{***}$ | -0.014$^{***}$ | -0.006 | -0.016$^{***}$ | -0.019$^{***}$ | -0.016$^{***}$ | -0.019$^{***}$ | -0.007 |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.004) | (0.005) | (0.004) | (0.005) | (0.004) |
| Family income | -0.039 | -0.028 | -0.035 | -0.031 | -0.047$^{*}$ | -0.036 | -0.033 | -0.040 | -0.034 | -0.035 | -0.026 |
| | (0.030) | (0.028) | (0.029) | (0.030) | (0.025) | (0.025) | (0.032) | (0.029) | (0.032) | (0.029) | (0.028) |
| Rural | -0.018 | -0.013 | -0.017 | -0.027 | -0.016 | -0.023 | -0.020 | -0.016 | -0.017 | -0.014 | -0.010 |
| | (0.032) | (0.032) | (0.034) | (0.030) | (0.029) | (0.028) | (0.029) | (0.032) | (0.029) | (0.031) | (0.028) |
| Missing family information dummy | 0.145$^{***}$ | 0.075$^{*}$ | 0.113$^{***}$ | 0.132$^{***}$ | 0.128$^{***}$ | 0.093$^{**}$ | 0.087$^{**}$ | 0.138$^{***}$ | 0.086$^{**}$ | 0.125$^{***}$ | 0.035 |
| | (0.043) | (0.039) | (0.042) | (0.040) | (0.042) | (0.038) | (0.042) | (0.043) | (0.042) | (0.043) | (0.039) |
| Constant | -1.560$^{***}$ | -1.222$^{***}$ | -0.783$^{***}$ | -1.507$^{***}$ | -1.183$^{***}$ | -0.553$^{**}$ | -1.504$^{***}$ | -1.401$^{***}$ | -1.452$^{***}$ | -1.478$^{***}$ | -0.868$^{***}$ |
| | (0.236) | (0.227) | (0.232) | (0.225) | (0.225) | (0.222) | (0.242) | (0.232) | (0.236) | (0.234) | (0.215) |
| Observations | 8010 | 8003 | 7976 | 7977 | 7993 | 7960 | 8005 | 8010 | 8005 | 7953 | 7902 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

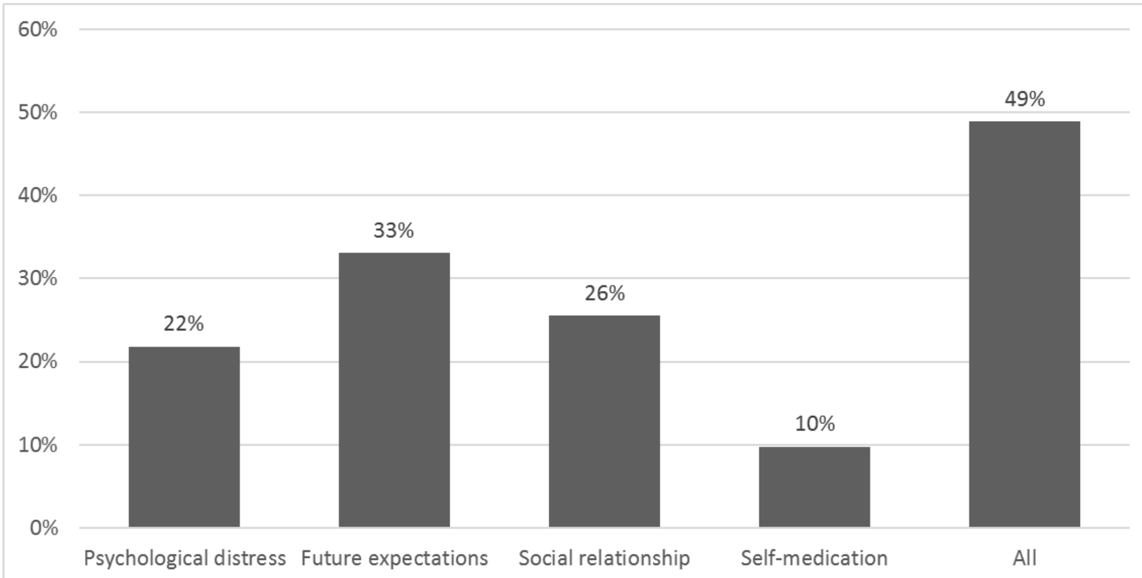
## 8. Figures

***Figure 1. Balancing tests of grade-level mean parental income***



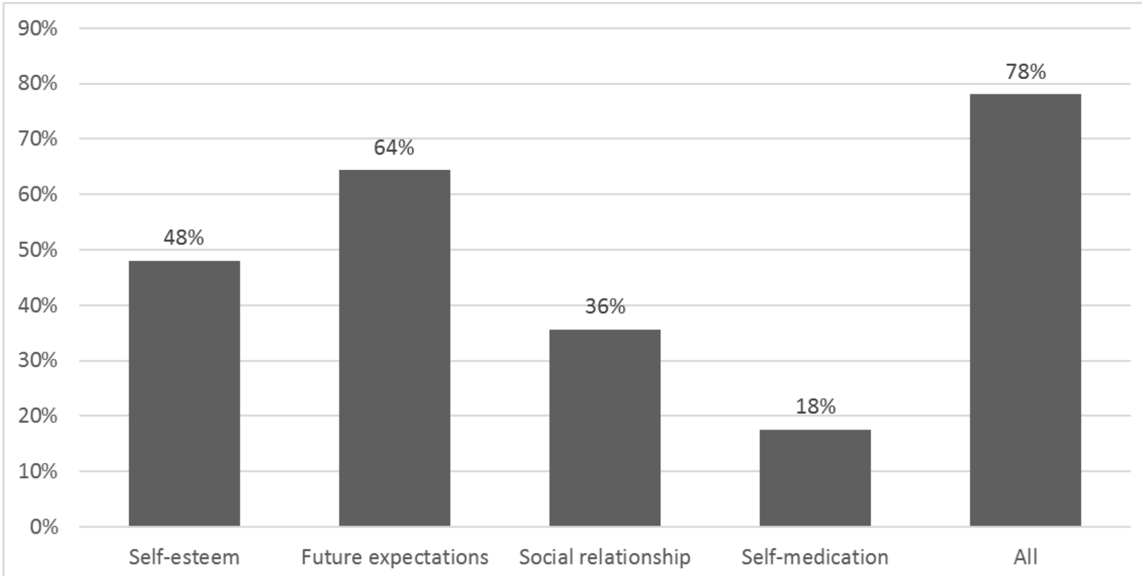

*Note*: Each dot is the coefficient from a separate regression that includes a set of grade dummies. Robust standard errors are clustered at the school level. The spikes present 90% confidence intervals.

***Figure 2. Percentage reduction in the effects of relative deprivation on Wave 2 self-rated health***




*Note*: Percentage changes are computed based on the results shown in Table 5.

***Figure 3. Percentage reduction in the effects of relative deprivation on Wave 2 depressive symptoms***




*Note*: Percentage changes are computed based on the results shown in Table 6.

## 9. Appendix tables

***Table A1. Description of potential mechanism variables***

| Variables | Description | Range |
|---|---|---|
| ***1. Psychological factors*** | | |
| *1.1. Concurrent psychological distress* | | |
| Self-esteem | Average of six items: (1) I have a lot of good qualities; (2) I have a lot to be proud of; (3) I like myself just the way I am; (4) I feel like I am doing everything just about right; (5) I feel socially accepted; and (6) I feel loved and wanted. | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| Depressive symptoms | Average of a 19-item self-report measure of the Center for Epidemiological Studies Depression Scale (CES-D): (1) You were bothered by things that usually don't bother you; (2) You didn't feel like eating, your appetite was poor; (3) You felt that you could not shake off the blues, even with help from your family and your friends; (4) You felt that you were just as good as other people (reverse-coded); (5) You had trouble keeping your mind on what you were doing; (6) You felt depressed; (7) You felt that you were too tired to do things; (8) You felt hopeful about the future (reverse-coded); (9) You thought your life had been a failure; (10) You felt fearful; (11) You were happy (reverse-coded); (12) You talked less than usual; (13) You felt lonely; (14) People were unfriendly to you; (15) You enjoyed life (reverse-coded); (16) You felt sad; (17) You felt that people disliked you; (18) It was hard to get started doing things; and (19) You felt life was not worth living. | 0 = never or rarely; 1 = sometimes; 2 = a lot of the time; 3 = most of the time or all of the time |
| *1.2. Educational expectations* | | |
| I want to go to college | "On a scale of 1 to 5, where 1 is low and 5 is high, how much do you want to go to college?" | 1 – 5 |
| I will likely go to college | "On a scale of 1 to 5, where 1 is low and 5 is high, how likely is it that you will go to college?" | 1 – 5 |
| *1.3. Life chances* | | |

| | | |
|---|---|---|
| *expectations* | | |
| Life chances expectations (mortality and health) | A composite measure of the following items: (1) What do you think are the chances that you will live to age 35?; (2) What do you think are the chances that you will be killed by age 21?; (3) What do you think are the chances that you will get HIV or AIDS? | 1 = almost no chance; 2 = some chance, but probably not; 3 = a 50-50 chance; 4 = a good chance; 5 = almost certain |
| *1.4. Hopefulness about future* | | |
| Hopeful about future | "How often was the following true during the last week? You felt hopeful about the future." | 0 = never or rarely; 1 = sometimes; 2 = a lot of the time; 3 = most of the time or all of the time |
| ***2. Social relationships*** | | |
| *2.1. Social relationships in the school* | | |
| School attachment | A composite measure of the following items: (1) Do you feel like being part of school?; Are you happy to be at school?; (3) Do you feel close to people at school? | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| Relationship with friends | A composite measure of the following items: (1) How often the respondent had trouble getting along with other students?; (2) How much the respondent agrees that friends care about her?; (3) How much the respondent feels that students at school are prejudiced? | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| Relationship with teachers | A composite measure of the following items: (1) How often the respondent had trouble getting along with teachers?; (2) How much the respondent agrees that teachers care about them?; (3) How much the respondent feels that teachers at school treat students fairly? | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| *2.2. Friendship network* | | |
| Friend nominations received (In-degree) | Number of nominations that each individual received from other high school classmates | 0 – 27 |
| Friend nominations sent (Out-degree) | Number of nominations that each individual sent to other high school classmates | 0 – 10 |
| Isolate | 1 if no friends are nominated and no nominations are received | 0 – 1 |
| Centrality | A measure of how many friends a respondent has, weighted by those friends' popularity | 0 – 3.9 |
| ***3. Self-medication*** | | |

| | | |
|---|---|---|
| Smoking | "During the past 30 days, on how many days did you smoke cigarettes?" | 0 – 30 |
| Binge drinking | "Over the past 12 months, on how many days did you drink five or more drinks in a row?" | 0 – 300 |

***Table A2. Balancing tests of grade-level parental income distribution***

| | (1) Grade-level mean family income | (2) Grade-level mean family income | (3) Grade-level standard deviation family income | (4) Grade-level standard deviation family income |
|---|---|---|---|---|
| School fixed effects | No | Yes | No | Yes |
| White | 0.367** | -0.021 | 0.085* | 0.002 |
| | (0.146) | (0.049) | (0.050) | (0.016) |
| Black | -0.234** | -0.014 | -0.054 | -0.016 |
| | (0.095) | (0.021) | (0.036) | (0.010) |
| Hispanic | -0.191** | -0.010 | -0.063*** | -0.002 |
| | (0.087) | (0.018) | (0.023) | (0.008) |
| Age | -0.274*** | -0.038 | -0.103*** | -0.025 |
| | (0.070) | (0.042) | (0.027) | (0.018) |
| Standardized PVT score | 0.997*** | 0.024 | 0.385*** | 0.029 |
| | (0.181) | (0.077) | (0.082) | (0.034) |
| Mother's education | 2.310*** | 0.021 | 1.082*** | 0.025 |
| | (0.315) | (0.130) | (0.189) | (0.072) |
| Divorced or separated | -0.083*** | 0.031 | -0.023** | -0.003 |
| | (0.022) | (0.029) | (0.010) | (0.012) |
| Married parents | 0.208*** | -0.039 | 0.052*** | 0.005 |
| | (0.059) | (0.031) | (0.018) | (0.012) |
| Rural | -0.160** | -0.008 | -0.062 | -0.008 |
| | (0.064) | (0.020) | (0.040) | (0.009) |

*Note.* Each cell contains coefficients from separate regressions that include a set of grade dummies. Robust standard errors are clustered at the school level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

***Table A3. Relative deprivation and self-esteem***

| | (1) Self-esteem (W1) | (3) Self-esteem (W1) | (3) Self-esteem (W1) | (4) Self-esteem (W1) | (5) Self-esteem (W2) | (6) Self-esteem (W2) | (7) Self-esteem (W2) | (8) Self-esteem (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.206** | | | | -0.255** | | | |
| | (0.087) | | | | (0.110) | | | |
| Deaton Index | | -0.121** | | | | -0.165*** | | |
| | | (0.048) | | | | (0.058) | | |
| Inverse percentile rank | | | -0.094** | | | | -0.146*** | |
| | | | (0.039) | | | | (0.051) | |
| d-measure | | | | -0.109* | | | | -0.125** |
| | | | | (0.055) | | | | (0.059) |
| Female | -0.357*** | -0.356*** | -0.356*** | -0.357*** | -0.298*** | -0.297*** | -0.297*** | -0.298*** |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Age | -0.068*** | -0.067*** | -0.067*** | -0.068*** | -0.071*** | -0.069*** | -0.069*** | -0.070*** |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.019) | (0.019) | (0.019) | (0.019) |
| Black | 0.175*** | 0.178*** | 0.175*** | 0.176*** | 0.163*** | 0.168*** | 0.166*** | 0.164*** |
| | (0.038) | (0.038) | (0.037) | (0.038) | (0.034) | (0.034) | (0.034) | (0.034) |
| Hispanic | -0.055 | -0.054 | -0.056 | -0.055 | -0.116*** | -0.114*** | -0.116*** | -0.115*** |
| | (0.040) | (0.040) | (0.040) | (0.040) | (0.040) | (0.039) | (0.040) | (0.040) |
| Other race/ethnicity | -0.043 | -0.041 | -0.042 | -0.043 | -0.102* | -0.099* | -0.098* | -0.104* |
| | (0.046) | (0.046) | (0.046) | (0.046) | (0.056) | (0.056) | (0.056) | (0.056) |
| Standardized PVT score | 0.088*** | 0.087*** | 0.087*** | 0.087*** | 0.104*** | 0.103*** | 0.103*** | 0.104*** |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.014) | (0.014) | (0.014) | (0.014) |
| First-born | -0.008 | -0.007 | -0.007 | -0.008 | 0.001 | 0.003 | 0.003 | 0.001 |
| | (0.021) | (0.022) | (0.022) | (0.021) | (0.023) | (0.023) | (0.023) | (0.023) |
| Grade 8 | -0.005 | -0.005 | -0.006 | -0.005 | -0.042 | -0.043 | -0.044 | -0.042 |
| | (0.037) | (0.037) | (0.037) | (0.037) | (0.045) | (0.044) | (0.045) | (0.044) |
| Grade 9 | -0.088 | -0.091 | -0.088 | -0.088 | -0.101 | -0.105 | -0.101 | -0.100 |
| | (0.068) | (0.068) | (0.068) | (0.068) | (0.067) | (0.066) | (0.067) | (0.066) |
| Grade 10 | -0.014 | -0.021 | -0.019 | -0.019 | -0.009 | -0.018 | -0.016 | -0.014 |
| | (0.073) | (0.073) | (0.073) | (0.073) | (0.079) | (0.079) | (0.079) | (0.079) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Grade 11 | 0.057 | 0.049 | 0.056 | 0.054 | 0.132 | 0.123 | 0.130 | 0.131 |
| | (0.084) | (0.084) | (0.084) | (0.084) | (0.095) | (0.095) | (0.095) | (0.095) |
| Grade 12 | 0.257*** | 0.246*** | 0.253*** | 0.252*** | 0.168 | 0.154 | 0.163 | 0.163 |
| | (0.088) | (0.088) | (0.088) | (0.088) | (0.134) | (0.132) | (0.133) | (0.132) |
| Mother's education | 0.023*** | 0.022*** | 0.022*** | 0.023*** | 0.014*** | 0.012** | 0.012** | 0.014*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | 0.043** | 0.040** | 0.040** | 0.054*** | 0.043* | 0.034 | 0.027 | 0.059*** |
| | (0.020) | (0.019) | (0.019) | (0.018) | (0.023) | (0.021) | (0.021) | (0.020) |
| Rural | 0.035 | 0.035 | 0.035 | 0.035 | -0.002 | -0.002 | -0.002 | -0.001 |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.024) | (0.024) | (0.024) | (0.024) |
| Missing family information dummy | -0.180*** | -0.178*** | -0.178*** | -0.179*** | -0.161*** | -0.158*** | -0.157*** | -0.159*** |
| | (0.034) | (0.034) | (0.034) | (0.034) | (0.043) | (0.043) | (0.044) | (0.043) |
| Constant | 0.971*** | 0.972*** | 0.984*** | 0.941*** | 1.147*** | 1.157*** | 1.188*** | 1.110*** |
| | (0.242) | (0.240) | (0.237) | (0.240) | (0.265) | (0.264) | (0.266) | (0.264) |
| Observations | 10489 | 10489 | 10489 | 10489 | 8011 | 8011 | 8011 | 8011 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A4. Robustness check: Different operationalization of self-rated health measure*

| | (1) Self-rated health = Excellent (W1) (Baseline) | (3) Self-rated health scale = 1 to 5 (W1) | (3) Self-rated health ≥ Very good (W1) | (4) Self-rated health ≥ Good (W1) | (5) Self-rated health = Excellent (W2) (Baseline) | (6) Self-rated health scale = 1 to 5 (W2) | (7) Self-rated health ≥ Very good (W2) | (8) Self-rated health ≥ Good (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.130$^{***}$ | -0.315$^{***}$ | -0.150$^{***}$ | -0.038$^{*}$ | -0.133$^{**}$ | -0.330$^{***}$ | -0.146$^{***}$ | -0.052$^{**}$ |
| | (0.041) | (0.088) | (0.046) | (0.022) | (0.053) | (0.100) | (0.054) | (0.026) |
| Female | -0.071$^{***}$ | -0.176$^{***}$ | -0.080$^{***}$ | -0.024$^{***}$ | -0.079$^{***}$ | -0.185$^{***}$ | -0.077$^{***}$ | -0.025$^{***}$ |
| | (0.010) | (0.020) | (0.010) | (0.005) | (0.011) | (0.020) | (0.010) | (0.005) |
| Age | 0.002 | -0.045$^{***}$ | -0.026$^{***}$ | -0.018$^{***}$ | 0.013 | -0.015 | -0.012 | -0.014$^{***}$ |
| | (0.007) | (0.014) | (0.008) | (0.004) | (0.008) | (0.017) | (0.008) | (0.005) |
| Black | 0.050$^{***}$ | 0.061$^{**}$ | 0.034$^{**}$ | -0.021$^{**}$ | 0.060$^{***}$ | 0.084$^{**}$ | 0.034$^{*}$ | -0.011 |
| | (0.013) | (0.030) | (0.015) | (0.010) | (0.019) | (0.039) | (0.018) | (0.012) |
| Hispanic | -0.010 | -0.071$^{**}$ | -0.028$^{*}$ | -0.030$^{***}$ | -0.011 | -0.093$^{**}$ | -0.052$^{**}$ | -0.027$^{**}$ |
| | (0.019) | (0.034) | (0.015) | (0.009) | (0.022) | (0.039) | (0.021) | (0.012) |
| Other race/ethnicity | 0.045$^{**}$ | 0.037 | -0.013 | 0.003 | 0.041 | 0.048 | 0.007 | -0.000 |
| | (0.019) | (0.042) | (0.022) | (0.012) | (0.029) | (0.060) | (0.035) | (0.014) |
| Standardized PVT score | -0.013$^{*}$ | 0.011 | 0.021$^{***}$ | 0.003 | -0.002 | 0.027$^{*}$ | 0.026$^{***}$ | 0.003 |
| | (0.007) | (0.014) | (0.007) | (0.003) | (0.007) | (0.014) | (0.007) | (0.004) |
| First-born | 0.013 | 0.021 | 0.013 | -0.003 | 0.004 | -0.015 | -0.017 | -0.001 |
| | (0.009) | (0.020) | (0.010) | (0.005) | (0.010) | (0.019) | (0.010) | (0.005) |
| Grade 8 | 0.009 | 0.086$^{**}$ | 0.056$^{***}$ | 0.020$^{*}$ | -0.045$^{**}$ | -0.033 | -0.001 | 0.014 |
| | (0.017) | (0.035) | (0.018) | (0.010) | (0.022) | (0.046) | (0.023) | (0.010) |
| Grade 9 | -0.017 | 0.047 | 0.024 | 0.035$^{**}$ | -0.075$^{**}$ | -0.090$^{*}$ | -0.030 | 0.016 |
| | (0.026) | (0.051) | (0.026) | (0.016) | (0.030) | (0.053) | (0.027) | (0.015) |
| Grade 10 | -0.018 | 0.099 | 0.061$^{*}$ | 0.050$^{***}$ | -0.105$^{***}$ | -0.069 | 0.010 | 0.029 |
| | (0.028) | (0.060) | (0.034) | (0.019) | (0.034) | (0.062) | (0.033) | (0.018) |
| Grade 11 | -0.008 | 0.135$^{*}$ | 0.078$^{*}$ | 0.059$^{**}$ | -0.094$^{**}$ | -0.043 | 0.015 | 0.036$^{*}$ |
| | (0.033) | (0.075) | (0.040) | (0.023) | (0.037) | (0.070) | (0.038) | (0.019) |
| Grade 12 | 0.007 | 0.235$^{***}$ | 0.142$^{***}$ | 0.083$^{***}$ | -0.114$^{**}$ | 0.001 | 0.066 | 0.044 |
| | (0.039) | (0.079) | (0.042) | (0.025) | (0.050) | (0.096) | (0.050) | (0.031) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mother's education | 0.008$^{***}$ | 0.022$^{***}$ | 0.011$^{***}$ | 0.003$^{**}$ | 0.011$^{***}$ | 0.026$^{***}$ | 0.011$^{***}$ | 0.003$^{**}$ |
| | (0.002) | (0.004) | (0.002) | (0.001) | (0.003) | (0.006) | (0.003) | (0.001) |
| Family income | 0.018 | 0.019 | 0.002 | -0.002 | 0.024 | 0.037 | 0.015 | -0.003 |
| | (0.012) | (0.030) | (0.014) | (0.009) | (0.016) | (0.032) | (0.015) | (0.009) |
| Rural | 0.018 | 0.046 | 0.024 | 0.002 | 0.003 | -0.001 | -0.002 | -0.003 |
| | (0.014) | (0.030) | (0.016) | (0.006) | (0.018) | (0.031) | (0.015) | (0.006) |
| Missing family information dummy | -0.049$^{***}$ | -0.121$^{***}$ | -0.045$^{***}$ | -0.024$^{**}$ | -0.075$^{***}$ | -0.160$^{***}$ | -0.070$^{***}$ | -0.016 |
| | (0.015) | (0.033) | (0.017) | (0.011) | (0.018) | (0.035) | (0.017) | (0.011) |
| Constant | 0.183$^{*}$ | 4.331$^{***}$ | 0.946$^{***}$ | 1.180$^{***}$ | 0.052 | 3.996$^{***}$ | 0.799$^{***}$ | 1.134$^{***}$ |
| | (0.107) | (0.223) | (0.118) | (0.057) | (0.135) | (0.264) | (0.128) | (0.067) |
| Observations | 10495 | 10495 | 10495 | 10495 | 8011 | 8011 | 8011 | 8011 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A5. Robustness check: Nonlinear models (Odd ratios from logistic regression)*

| | (1) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (4) Self-rated health = Excellent (W1) | (5) Self-rated health = Excellent (W2) | (6) Self-rated health = Excellent (W2) | (7) Self-rated health = Excellent (W2) | (8) Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | 0.504$^{***}$ | | | | 0.491$^{***}$ | | | |
| | (0.108) | | | | (0.123) | | | |
| Deaton Index | | 0.775$^{**}$ | | | | 0.752$^{**}$ | | |
| | | (0.085) | | | | (0.095) | | |
| Inverse percentile rank | | | 0.792$^{**}$ | | | | 0.708$^{***}$ | |
| | | | (0.075) | | | | (0.077) | |
| d-measure | | | | 0.845 | | | | 0.755$^{**}$ |
| | | | | (0.099) | | | | (0.102) |
| Female | 0.697$^{***}$ | 0.698$^{***}$ | 0.698$^{***}$ | 0.697$^{***}$ | 0.677$^{***}$ | 0.677$^{***}$ | 0.677$^{***}$ | 0.677$^{***}$ |
| | (0.032) | (0.032) | (0.032) | (0.031) | (0.035) | (0.035) | (0.035) | (0.035) |
| Age | 1.010 | 1.012 | 1.011 | 1.008 | 1.066 | 1.068 | 1.070$^{*}$ | 1.066 |
| | (0.036) | (0.036) | (0.036) | (0.036) | (0.043) | (0.043) | (0.043) | (0.043) |
| Black | 1.279$^{***}$ | 1.274$^{***}$ | 1.272$^{***}$ | 1.264$^{***}$ | 1.330$^{***}$ | 1.328$^{***}$ | 1.335$^{***}$ | 1.325$^{***}$ |
| | (0.099) | (0.098) | (0.098) | (0.098) | (0.118) | (0.118) | (0.118) | (0.117) |
| Hispanic | 0.946 | 0.944 | 0.941 | 0.940 | 0.947 | 0.946 | 0.946 | 0.944 |
| | (0.088) | (0.088) | (0.088) | (0.088) | (0.100) | (0.100) | (0.100) | (0.099) |
| Other race/ethnicity | 1.264$^{*}$ | 1.260$^{*}$ | 1.261$^{*}$ | 1.250$^{*}$ | 1.228 | 1.225 | 1.236 | 1.217 |
| | (0.155) | (0.155) | (0.155) | (0.153) | (0.176) | (0.175) | (0.177) | (0.174) |
| Standardized PVT score | 0.938$^{**}$ | 0.938$^{**}$ | 0.938$^{**}$ | 0.940$^{**}$ | 0.991 | 0.990 | 0.988 | 0.991 |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.032) | (0.032) | (0.032) | (0.032) |
| First-born | 1.068 | 1.067 | 1.068 | 1.063 | 1.021 | 1.021 | 1.024 | 1.019 |
| | (0.048) | (0.048) | (0.048) | (0.048) | (0.052) | (0.052) | (0.052) | (0.052) |
| Grade 8 | 1.047 | 1.048 | 1.046 | 1.049 | 0.808$^{**}$ | 0.806$^{**}$ | 0.801$^{**}$ | 0.806$^{**}$ |
| | (0.092) | (0.092) | (0.092) | (0.092) | (0.077) | (0.077) | (0.076) | (0.077) |
| Grade 9 | 0.915 | 0.914 | 0.920 | 0.923 | 0.692$^{**}$ | 0.692$^{**}$ | 0.693$^{**}$ | 0.696$^{**}$ |
| | (0.121) | (0.121) | (0.121) | (0.122) | (0.099) | (0.099) | (0.099) | (0.100) |
| Grade 10 | 0.913 | 0.898 | 0.900 | 0.906 | 0.595$^{***}$ | 0.587$^{***}$ | 0.586$^{***}$ | 0.591$^{***}$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.141) | (0.139) | (0.140) | (0.140) | (0.102) | (0.100) | (0.100) | (0.101) |
| Grade 11 | 0.957 | 0.951 | 0.961 | 0.966 | 0.633** | 0.630** | 0.632** | 0.637** |
| | (0.174) | (0.173) | (0.175) | (0.176) | (0.127) | (0.127) | (0.127) | (0.128) |
| Grade 12 | 1.032 | 1.016 | 1.028 | 1.036 | 0.569** | 0.560** | 0.564** | 0.566** |
| | (0.216) | (0.213) | (0.216) | (0.217) | (0.151) | (0.149) | (0.150) | (0.150) |
| Mother's education | 1.041*** | 1.042*** | 1.041*** | 1.045*** | 1.057*** | 1.057*** | 1.053*** | 1.059*** |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.014) | (0.014) | (0.014) | (0.014) |
| Family income | 1.077 | 1.111* | 1.098* | 1.154*** | 1.110 | 1.137** | 1.087 | 1.173*** |
| | (0.060) | (0.061) | (0.062) | (0.059) | (0.074) | (0.074) | (0.074) | (0.071) |
| Rural | 1.094 | 1.095 | 1.094 | 1.096 | 1.013 | 1.015 | 1.015 | 1.016 |
| | (0.067) | (0.067) | (0.067) | (0.067) | (0.071) | (0.071) | (0.071) | (0.071) |
| Missing family information dummy | 0.770*** | 0.773*** | 0.773*** | 0.770*** | 0.669*** | 0.672*** | 0.674*** | 0.671*** |
| | (0.065) | (0.065) | (0.065) | (0.065) | (0.068) | (0.069) | (0.069) | (0.068) |
| Observations | 10487 | 10487 | 10487 | 10487 | 7996 | 7996 | 7996 | 7996 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A6. Robustness check: Sample restrictions depending on missingness on parental income information*

| | (1)<br>Self-rated health = Excellent (W1) | (3)<br>Self-rated health = Excellent (W1) | (3)<br>Self-rated health = Excellent (W1) | (4)<br>Self-rated health = Excellent (W1) | (5)<br>Self-rated health = Excellent (W2) | (6)<br>Self-rated health = Excellent (W2) | (7)<br>Self-rated health = Excellent (W2) | (8)<br>Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Sample restrictions for grade-level missingness on parental income information | > 20% | > 30% (Baseline) | > 40% | > 50% | > 20% | > 30% (Baseline) | > 40% | > 50% |
| Yitzhaki Index | -0.142$^{***}$ | -0.130$^{***}$ | -0.108$^{***}$ | -0.095$^{***}$ | -0.097 | -0.133$^{**}$ | -0.089$^{**}$ | -0.081$^{**}$ |
| | (0.047) | (0.041) | (0.033) | (0.031) | (0.069) | (0.053) | (0.042) | (0.038) |
| Female | -0.076$^{***}$ | -0.071$^{***}$ | -0.070$^{***}$ | -0.066$^{***}$ | -0.078$^{***}$ | -0.079$^{***}$ | -0.075$^{***}$ | -0.073$^{***}$ |
| | (0.011) | (0.010) | (0.009) | (0.010) | (0.013) | (0.011) | (0.009) | (0.009) |
| Age | -0.002 | 0.002 | 0.001 | 0.003 | 0.011 | 0.013 | 0.017$^{**}$ | 0.019$^{**}$ |
| | (0.008) | (0.007) | (0.006) | (0.005) | (0.010) | (0.008) | (0.008) | (0.007) |
| Black | 0.027 | 0.050$^{***}$ | 0.043$^{***}$ | 0.046$^{***}$ | 0.072$^{***}$ | 0.060$^{***}$ | 0.053$^{***}$ | 0.046$^{***}$ |
| | (0.017) | (0.013) | (0.012) | (0.012) | (0.024) | (0.019) | (0.017) | (0.016) |
| Hispanic | -0.012 | -0.010 | -0.006 | -0.009 | 0.013 | -0.011 | -0.020 | -0.020 |
| | (0.023) | (0.019) | (0.018) | (0.017) | (0.027) | (0.022) | (0.019) | (0.018) |
| Other race/ethnicity | 0.030 | 0.045$^{**}$ | 0.009 | 0.004 | 0.051$^{*}$ | 0.041 | 0.012 | 0.010 |
| | (0.022) | (0.019) | (0.021) | (0.018) | (0.030) | (0.029) | (0.022) | (0.018) |
| Standardized PVT score | -0.018$^{**}$ | -0.013$^{*}$ | -0.013$^{**}$ | -0.015$^{***}$ | -0.004 | -0.002 | -0.000 | -0.001 |
| | (0.007) | (0.007) | (0.005) | (0.005) | (0.009) | (0.007) | (0.007) | (0.006) |
| First-born | 0.016 | 0.013 | 0.014 | 0.017$^{**}$ | 0.008 | 0.004 | 0.009 | 0.009 |
| | (0.011) | (0.009) | (0.009) | (0.008) | (0.013) | (0.010) | (0.011) | (0.010) |
| Grade 8 | 0.021 | 0.009 | 0.001 | 0.002 | -0.021 | -0.045$^{**}$ | -0.052$^{***}$ | -0.057$^{***}$ |
| | (0.021) | (0.017) | (0.014) | (0.014) | (0.027) | (0.022) | (0.019) | (0.018) |
| Grade 9 | -0.002 | -0.017 | -0.030 | -0.031 | -0.066$^{*}$ | -0.075$^{**}$ | -0.063$^{**}$ | -0.073$^{***}$ |
| | (0.032) | (0.026) | (0.023) | (0.022) | (0.034) | (0.030) | (0.028) | (0.026) |
| Grade 10 | 0.007 | -0.018 | -0.029 | -0.030 | -0.082$^{**}$ | -0.105$^{***}$ | -0.093$^{***}$ | -0.108$^{***}$ |
| | (0.036) | (0.028) | (0.025) | (0.024) | (0.039) | (0.034) | (0.033) | (0.029) |
| Grade 11 | 0.003 | -0.008 | 0.000 | -0.008 | -0.079$^{*}$ | -0.094$^{**}$ | -0.092$^{**}$ | -0.098$^{***}$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.042) | (0.033) | (0.028) | (0.027) | (0.047) | (0.037) | (0.036) | (0.033) |
| Grade 12 | 0.019 | 0.007 | -0.012 | -0.014 | -0.168*** | -0.114** | -0.106** | -0.116*** |
| | (0.047) | (0.039) | (0.035) | (0.032) | (0.060) | (0.050) | (0.044) | (0.041) |
| Mother's education | 0.009*** | 0.008*** | 0.008*** | 0.008*** | 0.014*** | 0.011*** | 0.011*** | 0.011*** |
| | (0.003) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.002) |
| Family income | 0.028* | 0.018 | 0.013 | 0.010 | 0.039* | 0.024 | 0.019* | 0.014 |
| | (0.016) | (0.012) | (0.010) | (0.010) | (0.023) | (0.016) | (0.011) | (0.011) |
| Rural | 0.020 | 0.018 | 0.011 | 0.014 | 0.007 | 0.003 | 0.003 | 0.001 |
| | (0.016) | (0.014) | (0.013) | (0.013) | (0.017) | (0.018) | (0.017) | (0.017) |
| Missing family information dummy | -0.070*** | -0.049*** | -0.039*** | -0.040*** | -0.086*** | -0.075*** | -0.080*** | -0.078*** |
| | (0.017) | (0.015) | (0.014) | (0.013) | (0.019) | (0.018) | (0.016) | (0.015) |
| Constant | 0.216* | 0.183* | 0.200** | 0.173** | 0.023 | 0.052 | -0.023 | -0.035 |
| | (0.123) | (0.107) | (0.090) | (0.082) | (0.160) | (0.135) | (0.124) | (0.115) |
| Observations | 7282 | 10495 | 13077 | 14252 | 5674 | 8011 | 9792 | 10506 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A7. Robustness check: Higher order controls of absolute parental income***

| | (1) Self-rated health = Excellent (W1) | (2) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (4) Self-rated health = Excellent (W1) | (5) Self-rated health = Excellent (W2) | (6) Self-rated health = Excellent (W2) | (7) Self-rated health = Excellent (W2) | (8) Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Parental income controls | Linear (Baseline) | Quadratic | Cubic | Income dummies | Linear (Baseline) | Quadratic | Cubic | Income dummies |
| Yitzhaki Index | -0.130*** | -0.088** | -0.092** | -0.132*** | -0.133** | -0.050 | -0.061 | -0.067 |
| | (0.041) | (0.044) | (0.047) | (0.048) | (0.053) | (0.065) | (0.067) | (0.068) |
| Family income | 0.018 | 0.054** | 0.048 | | 0.024 | 0.098*** | 0.081 | |
| | (0.012) | (0.022) | (0.040) | | (0.016) | (0.036) | (0.052) | |
| Family income square | | -0.005* | -0.002 | | | -0.011*** | -0.004 | |
| | | (0.003) | (0.015) | | | (0.004) | (0.017) | |
| Family income cubic | | | -0.000 | | | | -0.001 | |
| | | | (0.001) | | | | (0.001) | |
| Female | -0.071*** | -0.071*** | -0.071*** | -0.072*** | -0.079*** | -0.079*** | -0.079*** | -0.080*** |
| | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) | (0.011) |
| Age | 0.002 | 0.002 | 0.002 | 0.001 | 0.013 | 0.014 | 0.013 | 0.014 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) | (0.008) |
| Black | 0.050*** | 0.051*** | 0.051*** | 0.049*** | 0.060*** | 0.062*** | 0.061*** | 0.063*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.019) | (0.019) | (0.019) | (0.019) |
| Hispanic | -0.010 | -0.009 | -0.009 | -0.007 | -0.011 | -0.009 | -0.010 | -0.010 |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.022) | (0.022) | (0.022) | (0.023) |
| Other race/ethnicity | 0.045** | 0.046** | 0.046** | 0.041** | 0.041 | 0.042 | 0.042 | 0.043 |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.029) | (0.029) | (0.029) | (0.030) |
| Standardized PVT score | -0.013* | -0.013* | -0.013* | -0.013** | -0.002 | -0.003 | -0.003 | -0.001 |
| | (0.007) | (0.007) | (0.007) | (0.006) | (0.007) | (0.007) | (0.008) | (0.007) |
| First-born | 0.013 | 0.013 | 0.013 | 0.015 | 0.004 | 0.005 | 0.005 | 0.007 |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.010) | (0.010) | (0.010) | (0.011) |
| Grade 8 | 0.009 | 0.009 | 0.009 | 0.011 | -0.045** | -0.046** | -0.046** | -0.050** |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.022) | (0.021) | (0.021) | (0.021) |
| Grade 9 | -0.017 | -0.017 | -0.017 | -0.014 | -0.075** | -0.075** | -0.074** | -0.075** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.030) | (0.030) | (0.030) | (0.030) |
| Grade 10 | -0.018 | -0.019 | -0.019 | -0.014 | -0.105$^{***}$ | -0.107$^{***}$ | -0.107$^{***}$ | -0.111$^{***}$ |
| | (0.028) | (0.028) | (0.028) | (0.028) | (0.034) | (0.034) | (0.034) | (0.033) |
| Grade 11 | -0.008 | -0.010 | -0.009 | -0.005 | -0.094$^{**}$ | -0.096$^{**}$ | -0.095$^{**}$ | -0.097$^{***}$ |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.037) | (0.038) | (0.037) | (0.037) |
| Grade 12 | 0.007 | 0.005 | 0.006 | 0.011 | -0.114$^{**}$ | -0.116$^{**}$ | -0.115$^{**}$ | -0.116$^{**}$ |
| | (0.039) | (0.039) | (0.039) | (0.038) | (0.050) | (0.050) | (0.049) | (0.049) |
| Mother's education | 0.008$^{***}$ | 0.007$^{***}$ | 0.007$^{***}$ | 0.007$^{***}$ | 0.011$^{***}$ | 0.010$^{***}$ | 0.011$^{***}$ | 0.011$^{***}$ |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Rural | 0.018 | 0.018 | 0.018 | 0.018 | 0.003 | 0.003 | 0.003 | 0.003 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.018) | (0.018) | (0.018) | (0.018) |
| Missing family information dummy | -0.049$^{***}$ | -0.048$^{***}$ | -0.048$^{***}$ | -0.045$^{***}$ | -0.075$^{***}$ | -0.073$^{***}$ | -0.073$^{***}$ | -0.075$^{***}$ |
| | (0.015) | (0.015) | (0.015) | (0.016) | (0.018) | (0.018) | (0.018) | (0.019) |
| Constant | 0.183$^{*}$ | 0.165 | 0.167 | 0.248$^{**}$ | 0.052 | 0.014 | 0.019 | 0.023 |
| | (0.107) | (0.106) | (0.107) | (0.109) | (0.135) | (0.137) | (0.135) | (0.136) |
| Observations | 10495 | 10495 | 10495 | 10495 | 8011 | 8011 | 8011 | 8011 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects. In Columns 4 and 8, the coefficients for a complete set of 165 dummy variables for each discrete level of income (in thousands of dollars) are omitted.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A8. Robustness check: Addressing contextual-level confounders***

| | (1) Self-rated health = Excellent (W1) | (2) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (4) Self-rated health = Excellent (W2) | (5) Self-rated health = Excellent | (6) Self-rated health = Excellent |
|---|---|---|---|---|---|---|
| Grade-level controls | No | Yes | No | No | Yes | No |
| School-by-grade FE | No | No | Yes | No | No | Yes |
| Yitzhaki Index | -0.130*** | -0.132** | -0.142** | -0.133** | -0.202*** | -0.199*** |
| | (0.041) | (0.054) | (0.057) | (0.053) | (0.067) | (0.068) |
| Grade-level Parental income | | 0.007 | | | 0.157 | |
| | | (0.075) | | | (0.121) | |
| Grade-level White | | -0.017 | | | -0.213* | |
| | | (0.121) | | | (0.117) | |
| Grade-level Black | | 0.144 | | | -0.070 | |
| | | (0.135) | | | (0.138) | |
| Grade-level Female | | 0.021 | | | 0.023 | |
| | | (0.078) | | | (0.077) | |
| Grade-level Standardized PVT score | | 0.007 | | | 0.088** | |
| | | (0.036) | | | (0.040) | |
| Grade-level Mother's education | | 0.017 | | | 0.023 | |
| | | (0.021) | | | (0.025) | |
| Female | -0.071*** | -0.071*** | -0.070*** | -0.079*** | -0.079*** | -0.078*** |
| | (0.010) | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) |
| Age | 0.002 | 0.002 | 0.001 | 0.013 | 0.014 | 0.015* |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.009) |
| Black | 0.050*** | 0.047*** | 0.048*** | 0.060*** | 0.060*** | 0.059*** |
| | (0.013) | (0.013) | (0.013) | (0.019) | (0.019) | (0.019) |
| Hispanic | -0.010 | -0.010 | -0.012 | -0.011 | -0.013 | -0.013 |
| | (0.019) | (0.019) | (0.019) | (0.022) | (0.022) | (0.023) |
| Other race/ethnicity | 0.045** | 0.045** | 0.048** | 0.041 | 0.038 | 0.041 |
| | (0.019) | (0.019) | (0.019) | (0.029) | (0.029) | (0.030) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Standardized PVT score | -0.013$^{*}$ | -0.013$^{*}$ | -0.013$^{*}$ | -0.002 | -0.004 | -0.003 |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| First-born | 0.013 | 0.013 | 0.014 | 0.004 | 0.005 | 0.007 |
| | (0.009) | (0.009) | (0.009) | (0.010) | (0.010) | (0.011) |
| Grade 8 | 0.009 | 0.007 | | -0.045$^{**}$ | -0.051$^{**}$ | |
| | (0.017) | (0.017) | | (0.022) | (0.021) | |
| Grade 9 | -0.017 | -0.016 | | -0.075$^{**}$ | -0.091$^{***}$ | |
| | (0.026) | (0.026) | | (0.030) | (0.033) | |
| Grade 10 | -0.018 | -0.017 | | -0.105$^{***}$ | -0.125$^{***}$ | |
| | (0.028) | (0.029) | | (0.034) | (0.039) | |
| Grade 11 | -0.008 | -0.005 | | -0.094$^{**}$ | -0.115$^{***}$ | |
| | (0.033) | (0.035) | | (0.037) | (0.042) | |
| Grade 12 | 0.007 | 0.006 | | -0.114$^{**}$ | -0.151$^{***}$ | |
| | (0.039) | (0.041) | | (0.050) | (0.054) | |
| Mother's education | 0.008$^{***}$ | 0.008$^{***}$ | 0.008$^{***}$ | 0.011$^{***}$ | 0.011$^{***}$ | 0.011$^{***}$ |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) |
| Family income | 0.018 | 0.017 | 0.015 | 0.024 | 0.010 | 0.011 |
| | (0.012) | (0.014) | (0.014) | (0.016) | (0.017) | (0.017) |
| Rural | 0.018 | 0.017 | 0.016 | 0.003 | 0.004 | 0.002 |
| | (0.014) | (0.014) | (0.014) | (0.018) | (0.018) | (0.018) |
| Missing family information dummy | -0.049$^{***}$ | -0.049$^{***}$ | -0.049$^{***}$ | -0.075$^{***}$ | -0.073$^{***}$ | -0.071$^{***}$ |
| | (0.015) | (0.015) | (0.015) | (0.018) | (0.018) | (0.019) |
| Constant | 0.183$^{*}$ | -0.062 | 0.191 | 0.052 | -0.163 | -0.029 |
| | (0.107) | (0.285) | (0.125) | (0.135) | (0.321) | (0.154) |
| Observations | 10495 | 10495 | 10495 | 8011 | 8011 | 8011 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A9. Robustness check: Controlling for rank measures of other characteristics*

| | (1) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (3) Self-rated health = Excellent (W1) | (4) Self-rated health = Excellent (W1) | (5) Self-rated health = Excellent (W2) | (6) Self-rated health = Excellent (W2) | (7) Self-rated health = Excellent (W2) | (8) Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.130$^{***}$ | -0.120$^{***}$ | -0.125$^{***}$ | -0.115$^{***}$ | -0.133$^{**}$ | -0.131$^{**}$ | -0.134$^{**}$ | -0.132$^{**}$ |
| | (0.041) | (0.041) | (0.041) | (0.042) | (0.053) | (0.053) | (0.054) | (0.054) |
| BMI percentile rank | | -0.172$^{***}$ | | -0.178$^{***}$ | | -0.182$^{***}$ | | -0.187$^{***}$ |
| | | (0.017) | | (0.016) | | (0.016) | | (0.015) |
| PVT percentile rank | | | 0.093$^{**}$ | 0.090$^{**}$ | | | 0.034 | 0.039 |
| | | | (0.043) | (0.043) | | | (0.049) | (0.049) |
| Female | -0.071$^{***}$ | -0.070$^{***}$ | -0.070$^{***}$ | -0.069$^{***}$ | -0.079$^{***}$ | -0.077$^{***}$ | -0.079$^{***}$ | -0.077$^{***}$ |
| | (0.010) | (0.010) | (0.010) | (0.010) | (0.011) | (0.011) | (0.011) | (0.011) |
| Age | 0.002 | 0.005 | -0.002 | 0.002 | 0.013 | 0.017$^{**}$ | 0.014 | 0.018$^{**}$ |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.008) | (0.009) | (0.009) | (0.009) |
| Black | 0.050$^{***}$ | 0.059$^{***}$ | 0.045$^{***}$ | 0.055$^{***}$ | 0.060$^{***}$ | 0.068$^{***}$ | 0.051$^{***}$ | 0.060$^{***}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.019) | (0.019) | (0.019) | (0.020) |
| Hispanic | -0.010 | -0.002 | -0.014 | -0.005 | -0.011 | -0.000 | -0.014 | -0.003 |
| | (0.019) | (0.019) | (0.020) | (0.020) | (0.022) | (0.023) | (0.023) | (0.024) |
| Other race/ethnicity | 0.045$^{**}$ | 0.032$^{*}$ | 0.038$^{*}$ | 0.027 | 0.041 | 0.039 | 0.035 | 0.034 |
| | (0.019) | (0.019) | (0.020) | (0.019) | (0.029) | (0.028) | (0.029) | (0.029) |
| Standardized PVT score | -0.013$^{*}$ | -0.012$^{*}$ | -0.046$^{***}$ | -0.044$^{***}$ | -0.002 | 0.000 | -0.014 | -0.014 |
| | (0.007) | (0.007) | (0.015) | (0.016) | (0.007) | (0.007) | (0.019) | (0.018) |
| First-born | 0.013 | 0.016$^{*}$ | 0.015 | 0.018$^{*}$ | 0.004 | 0.008 | 0.002 | 0.006 |
| | (0.009) | (0.009) | (0.010) | (0.009) | (0.010) | (0.010) | (0.011) | (0.011) |
| Grade 8 | 0.009 | 0.000 | 0.023 | 0.013 | -0.045$^{**}$ | -0.048$^{**}$ | -0.039$^{*}$ | -0.042$^{*}$ |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.022) | (0.023) | (0.022) | (0.023) |
| Grade 9 | -0.017 | -0.025 | 0.005 | -0.006 | -0.075$^{**}$ | -0.078$^{**}$ | -0.072$^{**}$ | -0.073$^{**}$ |
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.030) | (0.032) | (0.032) | (0.033) |
| Grade 10 | -0.018 | -0.027 | 0.010 | -0.003 | -0.105$^{***}$ | -0.114$^{***}$ | -0.103$^{***}$ | -0.111$^{***}$ |
| | (0.028) | (0.028) | (0.028) | (0.029) | (0.034) | (0.036) | (0.036) | (0.037) |
| Grade 11 | -0.008 | -0.023 | 0.022 | 0.003 | -0.094$^{**}$ | -0.107$^{***}$ | -0.097$^{**}$ | -0.107$^{**}$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.033) | (0.033) | (0.033) | (0.034) | (0.037) | (0.039) | (0.039) | (0.041) |
| Grade 12 | 0.007 | -0.011 | 0.045 | 0.022 | -0.114** | -0.135*** | -0.110** | -0.128** |
| | (0.039) | (0.040) | (0.039) | (0.040) | (0.050) | (0.051) | (0.051) | (0.053) |
| Mother's education | 0.008*** | 0.008*** | 0.008*** | 0.008*** | 0.011*** | 0.011*** | 0.012*** | 0.012*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) | (0.003) |
| Family income | 0.018 | 0.017 | 0.016 | 0.016 | 0.024 | 0.023 | 0.023 | 0.023 |
| | (0.012) | (0.012) | (0.012) | (0.012) | (0.016) | (0.016) | (0.016) | (0.016) |
| Rural | 0.018 | 0.020 | 0.015 | 0.017 | 0.003 | 0.002 | -0.000 | -0.003 |
| | (0.014) | (0.014) | (0.015) | (0.015) | (0.018) | (0.018) | (0.018) | (0.019) |
| Missing family information dummy | -0.049*** | -0.057*** | -0.049*** | -0.059*** | -0.075*** | -0.081*** | -0.072*** | -0.079*** |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.018) | (0.019) | (0.018) | (0.020) |
| Constant | 0.183* | 0.214* | 0.175 | 0.205* | 0.052 | 0.069 | 0.019 | 0.050 |
| | (0.107) | (0.110) | (0.110) | (0.114) | (0.135) | (0.140) | (0.138) | (0.143) |
| Observations | 10495 | 10220 | 10077 | 9808 | 8011 | 7795 | 7700 | 7489 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A10. Robustness check: Family fixed effects models*

| | (1)<br>Self-rated health = Excellent (W1) | (2)<br>Self-rated health = Excellent (W1) | (3)<br>Self-rated health = Excellent (W1) | (4)<br>Self-rated health = Excellent (W1) | (5)<br>Self-rated health = Excellent (W2) | (6)<br>Self-rated health = Excellent (W2) | (7)<br>Self-rated health = Excellent (W2) | (8)<br>Self-rated health = Excellent (W2) |
|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.715*** | | | | -0.592** | | | |
| | (0.170) | | | | (0.263) | | | |
| Deaton Index | | -0.509** | | | | -0.391* | | |
| | | (0.210) | | | | (0.211) | | |
| Inverse percentile rank | | | -0.268 | | | | -0.275 | |
| | | | (0.206) | | | | (0.206) | |
| d-measure | | | | -0.668** | | | | -0.652** |
| | | | | (0.325) | | | | (0.326) |
| Female | -0.132*** | -0.133*** | -0.135*** | -0.135*** | -0.085*** | -0.086*** | -0.088*** | -0.088*** |
| | (0.032) | (0.032) | (0.032) | (0.032) | (0.032) | (0.032) | (0.032) | (0.032) |
| Age | -0.015 | -0.013 | -0.013 | -0.013 | -0.009 | -0.008 | -0.009 | -0.008 |
| | (0.025) | (0.025) | (0.025) | (0.025) | (0.026) | (0.026) | (0.026) | (0.026) |
| Standardized PVT score | -0.027 | -0.026 | -0.021 | -0.023 | 0.033 | 0.034 | 0.038* | 0.037 |
| | (0.024) | (0.024) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) | (0.023) |
| First-born | 0.013 | 0.011 | 0.013 | 0.011 | -0.009 | -0.010 | -0.009 | -0.011 |
| | (0.029) | (0.029) | (0.029) | (0.029) | (0.030) | (0.030) | (0.030) | (0.030) |
| Grade 8 | 0.069 | 0.068 | 0.077 | 0.074 | -0.083 | -0.086 | -0.079 | -0.082 |
| | (0.062) | (0.061) | (0.062) | (0.062) | (0.065) | (0.065) | (0.065) | (0.065) |
| Grade 9 | 0.090 | 0.095 | 0.111 | 0.107 | 0.015 | 0.014 | 0.026 | 0.024 |
| | (0.075) | (0.075) | (0.075) | (0.075) | (0.077) | (0.077) | (0.076) | (0.077) |
| Grade 10 | 0.116 | 0.113 | 0.116 | 0.116 | 0.028 | 0.021 | 0.027 | 0.027 |
| | (0.091) | (0.091) | (0.092) | (0.092) | (0.097) | (0.097) | (0.097) | (0.098) |
| Grade 11 | 0.070 | 0.068 | 0.076 | 0.075 | 0.000 | -0.006 | 0.005 | 0.004 |
| | (0.113) | (0.113) | (0.115) | (0.114) | (0.120) | (0.121) | (0.121) | (0.121) |
| Grade 12 | 0.178 | 0.172 | 0.186 | 0.180 | -0.006 | -0.017 | 0.001 | -0.003 |
| | (0.138) | (0.138) | (0.141) | (0.140) | (0.145) | (0.145) | (0.147) | (0.147) |
| Constant | 0.612* | 0.658* | 0.618* | 0.572 | 0.573 | 0.603* | 0.621* | 0.562 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (0.344) | (0.347) | (0.360) | (0.348) | (0.355) | (0.360) | (0.374) | (0.359) |
| Observations | 2344 | 2344 | 2344 | 2344 | 2192 | 2192 | 2192 | 2192 |

*Note.* In all models, robust standard errors are clustered at the family level. All models include family fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A11. Relative deprivation and psychological health and future expectations***

| | (1) Self-esteem | (2) Depressive symptoms | (3) I want to go to college | (4) I will likely go to college | (5) Life chances expectations | (6) Hopeful about future |
|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.206** | 0.180* | -0.279** | -0.788*** | -0.116 | -0.204** |
| | (0.087) | (0.091) | (0.116) | (0.140) | (0.080) | (0.084) |
| Female | -0.357*** | 0.281*** | 0.174*** | 0.275*** | 0.000 | -0.018 |
| | (0.027) | (0.022) | (0.020) | (0.023) | (0.016) | (0.024) |
| Age | -0.068*** | 0.130*** | -0.119*** | -0.160*** | -0.026** | -0.060*** |
| | (0.016) | (0.015) | (0.018) | (0.021) | (0.010) | (0.017) |
| Black | 0.175*** | 0.073** | 0.222*** | 0.176*** | -0.086*** | 0.125*** |
| | (0.038) | (0.032) | (0.037) | (0.041) | (0.023) | (0.034) |
| Hispanic | -0.055 | 0.062* | 0.040 | 0.013 | -0.066** | -0.074* |
| | (0.040) | (0.037) | (0.053) | (0.055) | (0.033) | (0.042) |
| Other race/ethnicity | -0.043 | 0.025 | 0.243*** | 0.313*** | -0.030 | -0.030 |
| | (0.046) | (0.043) | (0.036) | (0.046) | (0.037) | (0.052) |
| Standardized PVT score | 0.088*** | -0.161*** | 0.115*** | 0.148*** | 0.032*** | 0.163*** |
| | (0.012) | (0.013) | (0.016) | (0.017) | (0.008) | (0.015) |
| First-born | -0.008 | -0.012 | 0.008 | 0.004 | 0.010 | 0.011 |
| | (0.021) | (0.017) | (0.022) | (0.022) | (0.012) | (0.019) |
| Grade 8 | -0.005 | -0.058 | 0.142*** | 0.181*** | -0.036 | 0.088** |
| | (0.037) | (0.038) | (0.040) | (0.042) | (0.026) | (0.040) |
| Grade 9 | -0.088 | -0.064 | 0.139** | 0.169*** | -0.164*** | 0.077 |
| | (0.068) | (0.062) | (0.067) | (0.061) | (0.041) | (0.064) |
| Grade 10 | -0.014 | -0.190** | 0.227*** | 0.351*** | -0.140*** | 0.186** |
| | (0.073) | (0.074) | (0.079) | (0.084) | (0.047) | (0.071) |
| Grade 11 | 0.057 | -0.231*** | 0.343*** | 0.536*** | -0.138** | 0.242*** |
| | (0.084) | (0.086) | (0.091) | (0.096) | (0.054) | (0.087) |
| Grade 12 | 0.257*** | -0.470*** | 0.433*** | 0.883*** | -0.061 | 0.434*** |
| | (0.088) | (0.094) | (0.112) | (0.117) | (0.060) | (0.096) |
| Mother's education | 0.023*** | -0.022*** | 0.049*** | 0.080*** | 0.009** | 0.025*** |
| | (0.005) | (0.005) | (0.005) | (0.007) | (0.004) | (0.005) |
| Family income | 0.043** | -0.038 | 0.058** | 0.026 | 0.017 | -0.022 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.020) | (0.027) | (0.026) | (0.032) | (0.014) | (0.027) |
| Rural | 0.035 | -0.049** | -0.031 | -0.016 | -0.012 | 0.023 |
| | (0.023) | (0.024) | (0.028) | (0.024) | (0.019) | (0.032) |
| Missing family information dummy | -0.180*** | 0.191*** | -0.147*** | -0.190*** | -0.084*** | -0.102** |
| | (0.034) | (0.034) | (0.047) | (0.038) | (0.026) | (0.040) |
| Constant | 0.971*** | -1.830*** | 5.342*** | 5.239*** | 0.477*** | 2.291*** |
| | (0.242) | (0.200) | (0.262) | (0.300) | (0.168) | (0.246) |
| Observations | 10489 | 10490 | 10457 | 10448 | 10458 | 10476 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A12. Relative deprivation and social relationships and friendship network***

| | (1) School attachment | (2) Relationship with students | (3) Relationship with teachers | (4) Friend nominations received | (5) Friend nominations sent | (6) Isolate | (7) Centrality |
|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.198*** | -0.100** | -0.052 | -1.149*** | -0.500** | 0.004 | -0.207*** |
| | (0.063) | (0.047) | (0.079) | (0.330) | (0.216) | (0.011) | (0.053) |
| Female | -0.031 | 0.096*** | 0.065*** | 0.337*** | 0.392*** | -0.022*** | 0.072*** |
| | (0.019) | (0.013) | (0.016) | (0.080) | (0.054) | (0.003) | (0.012) |
| Age | -0.055*** | -0.009 | -0.001 | -0.153** | -0.296*** | 0.004* | -0.061*** |
| | (0.013) | (0.007) | (0.013) | (0.060) | (0.039) | (0.002) | (0.008) |
| Black | -0.045 | 0.050* | -0.035 | -0.254** | -0.353*** | 0.000 | -0.133*** |
| | (0.037) | (0.025) | (0.030) | (0.115) | (0.097) | (0.005) | (0.024) |
| Hispanic | 0.020 | 0.042 | -0.040 | 0.126 | -0.072 | -0.013** | -0.018 |
| | (0.031) | (0.026) | (0.027) | (0.113) | (0.110) | (0.005) | (0.025) |
| Other race/ethnicity | -0.005 | -0.004 | 0.078** | -0.177 | -0.264* | 0.003 | -0.078*** |
| | (0.051) | (0.035) | (0.034) | (0.171) | (0.140) | (0.009) | (0.027) |
| Standardized PVT score | -0.011 | 0.011 | 0.004 | 0.093** | 0.174*** | -0.004 | 0.039*** |
| | (0.012) | (0.010) | (0.011) | (0.040) | (0.033) | (0.003) | (0.008) |
| First-born | 0.020 | -0.002 | 0.023 | -0.229*** | 0.024 | -0.001 | 0.000 |
| | (0.017) | (0.013) | (0.016) | (0.059) | (0.046) | (0.002) | (0.009) |
| Grade 8 | -0.012 | -0.008 | -0.100*** | 0.266** | 0.277** | 0.006 | 0.079** |
| | (0.031) | (0.020) | (0.036) | (0.131) | (0.115) | (0.006) | (0.031) |
| Grade 9 | -0.030 | -0.027 | -0.174*** | 0.734*** | 0.607*** | -0.007 | 0.122** |
| | (0.052) | (0.042) | (0.060) | (0.233) | (0.191) | (0.008) | (0.051) |
| Grade 10 | -0.020 | -0.047 | -0.122* | 0.665** | 0.734*** | -0.005 | 0.145** |
| | (0.055) | (0.042) | (0.065) | (0.287) | (0.224) | (0.010) | (0.057) |
| Grade 11 | -0.055 | -0.046 | -0.145* | 1.017*** | 0.793*** | -0.011 | 0.161*** |
| | (0.067) | (0.048) | (0.074) | (0.340) | (0.226) | (0.011) | (0.056) |
| Grade 12 | 0.068 | 0.035 | 0.019 | 0.953** | 1.102*** | -0.027* | 0.199*** |
| | (0.074) | (0.054) | (0.082) | (0.395) | (0.263) | (0.013) | (0.067) |
| Mother's education | 0.006 | 0.009*** | 0.007* | 0.074*** | 0.036** | -0.002* | 0.011*** |
| | (0.005) | (0.003) | (0.004) | (0.017) | (0.014) | (0.001) | (0.003) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Family income | 0.027 | 0.004 | 0.030 | 0.230** | 0.048 | -0.006*** | 0.007 |
| | (0.019) | (0.012) | (0.020) | (0.091) | (0.061) | (0.002) | (0.016) |
| Rural | -0.015 | -0.000 | -0.010 | -0.255** | 0.010 | -0.001 | -0.012 |
| | (0.022) | (0.012) | (0.023) | (0.108) | (0.070) | (0.003) | (0.015) |
| Missing family information dummy | -0.137*** | -0.057** | -0.136*** | -0.426*** | -0.179** | 0.006 | -0.053*** |
| | (0.030) | (0.024) | (0.031) | (0.109) | (0.083) | (0.006) | (0.018) |
| Missing network data dummy | | | | -0.067 | -0.106 | 0.001 | 0.001 |
| | | | | (0.135) | (0.141) | (0.005) | (0.012) |
| Constant | 0.862*** | -0.018 | -0.014 | 5.625*** | 8.092*** | 0.018 | 1.541*** |
| | (0.210) | (0.118) | (0.194) | (0.854) | (0.609) | (0.032) | (0.128) |
| Observations | 10490 | 10492 | 10492 | 10499 | 10499 | 10499 | 10499 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A13. Relative deprivation and self-medication***

| | (1) Cigarette smoking | (2) Binge drinking |
|---|---|---|
| Yitzhaki Index | 2.012** | 8.436 |
| | (0.840) | (5.230) |
| Female | 0.122 | -6.334*** |
| | (0.219) | (0.826) |
| Age | 0.361** | 3.226*** |
| | (0.164) | (0.758) |
| Black | -4.403*** | -6.227*** |
| | (0.375) | (1.343) |
| Hispanic | -1.352*** | -0.298 |
| | (0.362) | (1.466) |
| Other race/ethnicity | -2.027*** | -5.126*** |
| | (0.431) | (1.537) |
| Standardized PVT score | -0.400*** | -2.050*** |
| | (0.126) | (0.572) |
| First-born | -0.536** | -2.259*** |
| | (0.207) | (0.727) |
| Grade 8 | 0.576* | 1.808 |
| | (0.335) | (1.336) |
| Grade 9 | 2.998*** | 3.132 |
| | (0.562) | (1.970) |
| Grade 10 | 2.585*** | 1.806 |
| | (0.723) | (2.608) |
| Grade 11 | 4.167*** | 2.851 |
| | (0.837) | (3.013) |
| Grade 12 | 3.255*** | -0.202 |
| | (0.912) | (3.531) |
| Mother's education | -0.159*** | -0.262 |
| | (0.051) | (0.175) |
| Family income | -0.582*** | 2.615 |
| | (0.216) | (1.788) |
| Rural | -0.145 | 0.574 |
| | (0.215) | (1.096) |
| Missing family information dummy | 1.890*** | 5.694*** |
| | (0.346) | (1.820) |
| Constant | -0.295 | -34.244*** |
| | (2.372) | (11.360) |
| Observations | 10431 | 10479 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A14. Relative deprivation and social relationships*

| | (1) Feel close to people at school | (2) Feel like part of school | (3) Happy to be at school | (4) Difficulty getting along with other students | (5) Friends care about you | (6) Students are prejudiced | (7) Difficulty getting along with teachers | (8) Teachers care about you | (9) Teachers treat students fairly |
|---|---|---|---|---|---|---|---|---|---|
| Yitzhaki Index | -0.244$^{**}$ | -0.241$^{***}$ | -0.134 | 0.212$^{**}$ | -0.067 | -0.000 | 0.087 | -0.077 | -0.009 |
| | (0.096) | (0.075) | (0.100) | (0.081) | (0.068) | (0.103) | (0.085) | (0.102) | (0.116) |
| Female | -0.028 | -0.004 | -0.067$^{**}$ | -0.039$^{*}$ | 0.241$^{***}$ | 0.059$^{**}$ | -0.204$^{***}$ | 0.091$^{***}$ | -0.109$^{***}$ |
| | (0.021) | (0.021) | (0.028) | (0.020) | (0.016) | (0.024) | (0.021) | (0.021) | (0.023) |
| Age | -0.032$^{**}$ | -0.069$^{***}$ | -0.071$^{***}$ | 0.017 | -0.030$^{**}$ | -0.035$^{*}$ | 0.025 | 0.026 | -0.001 |
| | (0.016) | (0.015) | (0.021) | (0.016) | (0.012) | (0.018) | (0.017) | (0.018) | (0.018) |
| Black | -0.060 | 0.030 | -0.116$^{**}$ | -0.008 | -0.123$^{***}$ | -0.353$^{***}$ | 0.021 | 0.013 | -0.100$^{**}$ |
| | (0.041) | (0.046) | (0.049) | (0.044) | (0.029) | (0.049) | (0.035) | (0.044) | (0.040) |
| Hispanic | 0.052$^{*}$ | 0.013 | -0.004 | -0.107$^{**}$ | -0.065$^{**}$ | -0.121$^{**}$ | 0.046 | -0.074$^{*}$ | 0.000 |
| | (0.031) | (0.044) | (0.050) | (0.041) | (0.032) | (0.050) | (0.040) | (0.042) | (0.034) |
| Other race/ethnicity | 0.008 | -0.055 | 0.035 | -0.041 | -0.108$^{**}$ | -0.102 | -0.100$^{**}$ | 0.100$^{**}$ | 0.044 |
| | (0.057) | (0.062) | (0.066) | (0.041) | (0.052) | (0.070) | (0.046) | (0.040) | (0.050) |
| Standardized PVT score | -0.028$^{*}$ | 0.017 | -0.025$^{*}$ | -0.034$^{***}$ | 0.028$^{*}$ | 0.045$^{***}$ | -0.029$^{*}$ | -0.008 | -0.009 |
| | (0.016) | (0.014) | (0.014) | (0.013) | (0.014) | (0.015) | (0.015) | (0.014) | (0.013) |
| First-born | 0.003 | 0.020 | 0.042$^{*}$ | 0.008 | -0.029$^{**}$ | -0.044$^{*}$ | -0.010 | 0.013 | 0.049$^{**}$ |
| | (0.021) | (0.021) | (0.023) | (0.020) | (0.014) | (0.023) | (0.019) | (0.022) | (0.020) |
| Grade 8 | -0.002 | 0.019 | -0.060 | -0.051 | 0.046 | 0.156$^{***}$ | 0.043 | -0.164$^{***}$ | -0.097$^{*}$ |
| | (0.036) | (0.036) | (0.046) | (0.040) | (0.030) | (0.038) | (0.043) | (0.042) | (0.050) |
| Grade 9 | 0.012 | -0.015 | -0.097 | -0.064 | 0.055 | 0.259$^{***}$ | -0.018 | -0.341$^{***}$ | -0.224$^{***}$ |
| | (0.061) | (0.055) | (0.080) | (0.063) | (0.054) | (0.062) | (0.076) | (0.067) | (0.080) |
| Grade 10 | -0.006 | 0.027 | -0.088 | -0.146$^{**}$ | 0.075 | 0.459$^{***}$ | -0.151$^{*}$ | -0.323$^{***}$ | -0.224$^{**}$ |
| | (0.068) | (0.060) | (0.086) | (0.074) | (0.057) | (0.076) | (0.084) | (0.080) | (0.087) |
| Grade 11 | -0.099 | 0.004 | -0.080 | -0.168$^{**}$ | 0.120$^{*}$ | 0.554$^{***}$ | -0.173$^{*}$ | -0.325$^{***}$ | -0.325$^{***}$ |
| | (0.085) | (0.073) | (0.094) | (0.082) | (0.068) | (0.095) | (0.089) | (0.093) | (0.100) |
| Grade 12 | 0.012 | 0.161$^{*}$ | 0.038 | -0.267$^{***}$ | 0.241$^{***}$ | 0.560$^{***}$ | -0.350$^{***}$ | -0.158 | -0.172 |
| | (0.095) | (0.084) | (0.113) | (0.090) | (0.073) | (0.118) | (0.101) | (0.103) | (0.117) |
| Mother's | 0.004 | 0.012$^{**}$ | 0.001 | -0.010$^{*}$ | 0.013$^{***}$ | -0.001 | -0.011$^{**}$ | 0.009$^{*}$ | -0.000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| education | | | | | | | | | |
| | (0.006) | (0.006) | (0.006) | (0.005) | (0.004) | (0.006) | (0.005) | (0.005) | (0.006) |
| Family income | -0.001 | 0.031 | 0.056** | -0.023 | 0.007 | 0.024 | -0.031 | 0.012 | 0.047 |
| | (0.029) | (0.023) | (0.026) | (0.020) | (0.017) | (0.031) | (0.020) | (0.028) | (0.032) |
| Rural | -0.012 | -0.031 | -0.002 | 0.012 | 0.014 | 0.003 | 0.015 | -0.006 | -0.008 |
| | (0.027) | (0.026) | (0.031) | (0.023) | (0.019) | (0.024) | (0.021) | (0.028) | (0.041) |
| Missing family information dummy | -0.133*** | -0.160*** | -0.137*** | 0.095** | -0.076** | -0.026 | 0.147*** | -0.115*** | -0.154*** |
| | (0.039) | (0.034) | (0.042) | (0.039) | (0.030) | (0.042) | (0.043) | (0.039) | (0.038) |
| Constant | 4.245*** | 4.782*** | 4.901*** | 1.868*** | 4.422*** | 3.467*** | 1.842*** | 3.197*** | 3.729*** |
| | (0.254) | (0.239) | (0.315) | (0.246) | (0.203) | (0.280) | (0.249) | (0.258) | (0.264) |
| Observations | 10487 | 10489 | 10486 | 10491 | 10446 | 10467 | 10491 | 10435 | 10489 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

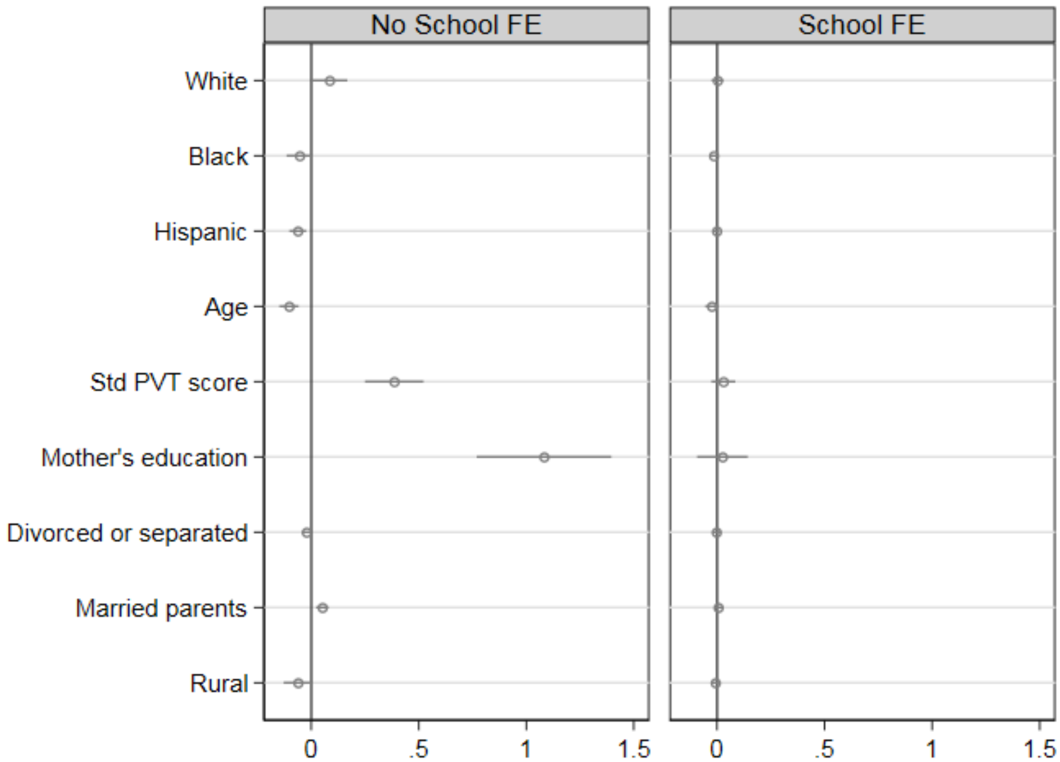
***Table A15. Relative deprivation and life chances expectations***

| | (1)<br>Expectations to live to 35 | (2)<br>Expectations killed by 20 | (3)<br>Expectations to get HIV/AIDS |
|---|---|---|---|
| Yitzhaki Index | -0.138 | 0.014 | 0.126 |
| | (0.083) | (0.075) | (0.084) |
| Female | 0.036** | 0.054*** | -0.016 |
| | (0.016) | (0.017) | (0.016) |
| Age | -0.054*** | -0.002 | 0.016 |
| | (0.013) | (0.011) | (0.013) |
| Black | -0.187*** | 0.051* | -0.020 |
| | (0.027) | (0.030) | (0.024) |
| Hispanic | -0.115*** | 0.036 | 0.018 |
| | (0.042) | (0.031) | (0.029) |
| Other race/ethnicity | -0.069 | 0.026 | -0.019 |
| | (0.051) | (0.043) | (0.029) |
| Standardized PVT score | 0.108*** | 0.010 | 0.013 |
| | (0.011) | (0.010) | (0.008) |
| First-born | 0.028* | -0.004 | 0.004 |
| | (0.014) | (0.015) | (0.014) |
| Grade 8 | 0.001 | 0.035 | 0.044* |
| | (0.034) | (0.032) | (0.024) |
| Grade 9 | -0.061 | 0.181*** | 0.145*** |
| | (0.043) | (0.043) | (0.046) |
| Grade 10 | -0.002 | 0.214*** | 0.113** |
| | (0.050) | (0.049) | (0.057) |
| Grade 11 | 0.008 | 0.242*** | 0.087 |
| | (0.061) | (0.057) | (0.066) |
| Grade 12 | 0.080 | 0.192*** | 0.021 |
| | (0.069) | (0.060) | (0.075) |
| Mother's education | 0.009** | -0.004 | -0.006 |
| | (0.004) | (0.004) | (0.004) |
| Family income | 0.019 | -0.015 | -0.009 |
| | (0.021) | (0.017) | (0.019) |
| Rural | -0.030 | 0.004 | -0.004 |
| | (0.022) | (0.024) | (0.018) |
| Missing family information dummy | -0.103*** | 0.079*** | 0.028 |
| | (0.030) | (0.027) | (0.029) |
| Constant | 5.178*** | 1.533*** | 1.246*** |
| | (0.192) | (0.169) | (0.194) |
| Observations | 10452 | 10443 | 10440 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

## 10. Appendix figures

***Figure A1. Balancing tests of grade-level standard deviation of parental income***




*Note*: Each dot is the coefficient from a separate regression that includes a set of grade dummies. Robust standard errors are clustered at the school level. The spikes present 90% confidence intervals.

# CHAPTER 3. Ability Rank and Adolescent Psychological Well-Being: Exploring Nonlinear Rank Effects

Jinho Kim

**ABSTRACT**

Although a large number of studies have documented the link between cognitive ability and adolescents' psychological health, relatively little is known about the underlying mechanisms behind the relationship. Social-psychological frameworks help us better understand how ability shapes psychological health among adolescents, by contextualizing the meaning of an individual's ability in reference to other students' ability in the school settings. Building on theories about status attainment and empirical evidence on relative-performance evaluation, I argue that the effects of ability rank on adolescent psychological health are largely driven by students at the top and bottom of the ability distribution due to differential rewards and penalties associated with status attainment/loss by relative position in the distribution. To evaluate this argument, I leverage a quasi-experimental research design and estimate the nonlinear effects of ability rank on adolescent depression. Using a large, nationally representative longitudinal survey of U.S. adolescents, this study shows that psychological consequences of ability rank are more pronounced among students at the top and bottom of the ability distribution while ability rank appears to have little impact in the middle of the distribution. In addition, this nonlinear nature of the relationship between ability rank and adolescent depression is found to be driven largely by male adolescents, reflecting gender differences in status attainment process and social integration patterns. Finally, this study provides evidence that social relationships (rather than psychological factors and future expectations) serve as the most likely and relevant mechanism of the rank effects on adolescent depression. My finding that ability rank is associated with self-perception on ability, but not self-esteem appears to support the proposition that it may not be students' self-assessment but peer prejudice and discrimination that connect ability rank to depressive symptoms.

Keywords: Ability; Ordinal Rank; Psychological Health; Depression; Social Relationship; Social Comparison; Social Stigma; Discrimination; Status Attainment; Gender; Adolescence

## 1. Introduction

Over the past two decades, a large number of studies, mostly in psychology and epidemiology, have documented the link between cognitive ability and psychological well-being (Beaujean, Parker, and Qiu 2013; Deary, Weiss, and Batty 2010; Emerson, Einfeld, and Stancliffe 2010; Gunnell et al. 2009; Zammit et al. 2004). These studies have shown that cognitive ability is negatively associated with various psychiatric disorders such as depressive symptoms and suicidality (both suicidal thoughts and suicide attempt). However, the underlying mechanisms behind this relationship remain relatively unclear. Although sociological theories appear to provide a clearer theoretical and conceptual framework for understanding how ability shape adolescent psychological well-being, this topic has been rarely discussed in sociological literature.

Ability (or academic success) has been viewed as one of the most desirable and visible attributes in adolescence since schools have a regulative purpose, differently rewarding students for ability and academic achievement (Sweeting et al. 2011). Known as a critical determinant of social status among adolescents (Coleman 1961; Levi Martin 2009; Rossman, Esparza, and Bonacich 2010), however, ability may matter more in relative rather than absolute terms since status attainment deals largely with one's relative position to the reference group (Easterlin 1974). Thus, an adolescent's psychological well-being may depend less on his or her absolute ability than it does on relative standing in terms of ability within the reference group (Fournier 2009; Link, Carpiano, and Weden 2013; Sapolsky 2004, 2005). In other words, to better understand how ability shapes adolescents' psychological well-being, it may be worth focusing on relative, rather than absolute, ability—i.e., contextualizing the meaning of cognitive ability (Fournier 2009).

Ability rank, representing relative position in local ability hierarchy, may affect adolescents' psychological health through various social and psychological channels. Drawing on social-psychological theories, ability rank may influence adolescent psychological health through a process of social comparison (Festinger 1954). These perspectives suggest that a peer group serves as a comparison point against which students assess themselves and perceiving themselves to be a lower ability rank (i.e., lower social status) among the group would be a stressor in itself. Students with a lower ability rank may thus have lower levels of adolescent psychological health due to a decrease in psychological resources such as self-esteem, self-efficacy, and confidence (e.g., Crosnoe 2007). In addition, the link between ability rank and adolescent mental health may also be driven by students' expectations about the future. Students with a lower position in social hierarchy may have lower expectations and pessimistic view about their future SES attainment (low college aspirations, unemployment, low income, etc.) and life chances (mortality and morbidity). The link between future expectations and adolescent health is well-established (McDade et al. 2011; Nguyen et al. 2012; Whitehead et al. 2015).

Lastly, the sociological tradition of social psychology explicitly articulating the process of social stigmatization as well as its consequences (Link and Phelan 2001; Major and O'Brien 2005) suggests that a lower rank may be stigmatized to create major disadvantages in social relationships (with both friends and teachers), thereby leading to social exclusion and school detachment. In contrast, a higher rank may place students on socially higher position, increasing their social attractiveness and popularity (Gould 2002). Students with higher relative position may thus enjoy psychological benefits through increased attention and encouragement from both teachers and peers (Fournier 2009; Newcomb, A.F., Bukowski, W.M., Pattee 1993). It is already well-known that social support and integration are crucial for adolescents' psychological well-being (Gariépy, Honkaniemi, and Quesnel-Vallée 2016).

Building on sociological theories, this study examines how ability rank influences depressive symptoms among adolescents. Using the National Longitudinal Study of Adolescent to Adult Health (Add Health) and leveraging a quasi-experimental research design, this study aims to identify causal effects of ability rank on adolescent depression. Specifically, this research design controls for school-fixed effects to leverage quasi-exogenous variation in school-cohort ability composition within the same school. Under the assumption that conditional on attending a given school, the cohort composition is as good as random, this strategy allows us to compare the outcomes of two students who have the same level of absolute ability but different ranks due to different ability distribution of their school cohorts. Because the validity of this research design strictly depends on the assumption, I provide empirical evidence of whether this assumption holds or not in the data.

In addition, drawing on theories about status attainment and empirical evidence on relative-performance evaluation, this study investigates potential nonlinear effects of ordinal ability rank on adolescent depression—i.e., whether the effects of rank on depression change throughout the rank distribution. In particular, a major goal of this analysis is to explore whether the effects of ability rank are more pronounced among students at the top and bottom of the ability distribution. Given gender differences in the way in which an adolescent conceptualizes and assesses social status and popularity, I stratify the results by gender to examine whether the rank effects on adolescent depression differ by gender. Finally, focusing on psychological factors (self-perception on ability, self-esteem, and future expectations) and social factors (social relationships with teachers and peers and school attachment), I explore a range of potential mechanisms linking ordinal rank to adolescent depression.

## 2. Background

### *2.1 Ability rank and adolescent depression*

A large number of studies in psychology and epidemiology have documented the positive association between cognitive ability and psychological health outcomes (Beaujean et al. 2013; Deary et al. 2010; Emerson et al. 2010; Gunnell et al. 2009; Zammit et al. 2004). Although the mechanisms behind this relationship are relatively unknown, those with a higher level of cognitive ability may experience fewer stressful life events or have more resources to mitigate the influence of such incidents (e.g., Koenen et al. 2009; Marmot 2004; Sapolsky 2005). Another potential explanation is that the observed association between cognitive ability and psychological health may be driven spuriously by confounding factors such as unobserved family background (e.g., genetic endowments, parenting style, child maltreatment) and environmental factors (e.g., neighborhood effects). In addition, the direction of the association may be reversed—i.e., depression lowers cognitive ability (Berndt et al. 2000; Hammar and Årdal 2009). Neurological evidence shows that people with varying degrees of known depressive disorders generally performed poorly on intelligence tests than mentally healthy individuals due to decreased functioning ability in the frontal lobe of their brains (e.g., Borkowska and Rybakowski 2001).

Sociological theories and literature provide an alternative approach to understand how ability shapes an individual's mental health. All social systems are characterized by social hierarchies, and rank is especially popular in bounded social institutions such as schools. In the school settings, cognitive ability (or academic success) is one of the most desirable and visible attributes since schools differentially reward students for ability and achievement. For example, based on ability and achievement, schools place students on a hierarchy, we have termed "scholastic." As cognitive ability is a critical basis of social hierarchy among adolescents (Coleman 1961; Levi Martin 2009; Rossman et al. 2010) and such hierarchy inevitably provides their relative social standings compared to others, a variety of social and psychological processes should emerge. Therefore, these sociological perspectives suggest that ability may matter more in relative terms for adolescent depression since it is relative, not absolute, ability that ascertain social status among adolescents (Easterlin 1974; Fournier 2009; Sapolsky 2004, 2005). Broadly, social-psychological theories suggest two most plausible mechanisms through which ability rank shape adolescent depression.

First, several social-psychological theories provide theoretical argument linking ability rank to adolescent psychological health. The social comparison theory and reflected self-appraisal (or looking-glass self) perspective have articulated the process by which individuals develop and maintain self-appraisal in social contexts (e.g., Crosnoe and Muller 2004; Crosnoe 2007). Social comparison theory posits that individuals construct a self-identity by comparing their beliefs, abilities, behaviors, and characteristics to those of others who belong to a reference group in their social environment (Festinger 1954; Suls and Wheeler 2000). Similarly, the reflected self-appraisal perspective indicates that individuals develop self-understanding by interpreting others' appraisals of one's beliefs, abilities, behaviors and characteristics (Cooley 1902).

These social-psychological theories thus imply that adolescents' ability rank within their reference peer group may be more important than their absolute ability—e.g., the Big-Fish–Little-Pond effect (Marsh 1987). In other words, two individuals with the same absolute ability may hold distinct self-confidence (or self-perception) about their own ability when surrounded by a set of peers with different ability composition: an adolescent who is surrounded by a group of smarter peers may perceive herself to be less smart than she actually is. According to the social-psychological theories, the link between ability rank and adolescent depression may be attributable to social comparisons. In general, ability *rank* is more discernable than exact absolute ability:

students can infer their rank in a peer group through daily socialization and occasional teacher feedback. Therefore, students with lower (higher) ability rank may have lower (higher) levels of self-esteem, self-efficacy, and confidence, thereby leading to higher (lower) levels of adolescent depression (Fournier 2009; Link et al. 2013; Sapolsky 2004, 2005).

Second, the link between rank position in ability hierarchy and depressive symptoms may be driven by students' future expectations about SES attainment (e.g., education and income) and life chances (e.g., mortality and morbidity). Students likely base their educational and life chances expectations on ability rank rather than absolute ability since it is more visible and intuitive, though it is likely to contain noisy information about their true ability (Ball, Crawford, and Kenardy 2004; Elsner and Isphording 2017a, 2017b; McDade et al. 2011; Nguyen et al. 2012). Therefore, students with a lower rank may have lower expectations of their future, which in turn, leads to a higher level of stress and depression (Fischhoff et al. 2000; Rief and Anna Glombiewski 2017; Whitehead et al. 2015).

Third, focusing explicitly on the process of social stigmatization as well as its consequences (Link and Phelan 2001; Major and O'Brien 2005; Schafer and Ferraro 2011), the sociological tradition of social psychology turns our attention to more active roles of a reference group than mere comparison points. These perspectives thus argue that a lower ability student may be depressed due to social rejection and exclusion by friends, possibly resulting from stigma processes. Although there is some variability in the definition of stigma (Link and Phelan 2001), most scholars agree with the following: "people who are stigmatized have (or are believed to have) an attribute that marks them as different and leads them to be devalued in the eyes of others" (Major and O'Brien 2005, p. 395). Therefore, different from the first two mechanisms focusing on self-evaluation to gauge group standing and their social worth, this mechanism rather suggests that students perceive status and popularity, as expressed by teachers and friends.

Under this mechanism, students are treated differently by friends and teachers based on ability rank, which shapes social integration and sense of belonging and consequently psychological health. For instance, low ability students may suffer a higher level of depressive symptoms due to an increase in the well-established vulnerability factors of attachment insecurity, low social support, and interpersonal rejection. Stigma-related stressors such as exclusion and discrimination by friends are known to increase psychological distress such as depression (Gariépy et al. 2016). Teacher discrimination against students of lower rank (e.g., showing lower expectations) may also affect their psychological health. On the other hand, students with higher ability, characterized by socially desirable traits and higher social status in peer hierarchy (Levi Martin 2009; Rossman et al. 2010), may enjoy psychological benefits through increased levels of social support from both teachers and peers and social integration (Fournier 2009; Newcomb, A.F., Bukowski, W.M., Pattee 1993).

***2.2 Nonlinear effects of ability rank on adolescent depression***

Are the rank effects on adolescent depression linear? A large body of existing evidence offers the possibility that the effects of ability rank may be nonlinear. One explanation for potential nonlinear effects is that psychological burden of being the lower ranks could be greater at the bottom than the middle of the ability distribution. By the same logic, students may reap psychological benefits the most from being at the top of the ability distribution. Some evidence supports this argument, indicating that there is a particular aversion to being in last place (i.e., Last-Place Aversion) and pride or a feeling of satisfaction from achieving high rank (i.e., First-Place Loving) (Gill et al. 2018; Kuziemko et al. 2014). The aversion to ranking at the bottom of a social group is also consistent with the large body of social-psychological literature on understanding of shame and embarrassment as social emotions (Goffman 1967; Leeming and Boyle 2004; Tangney et al. 1996): the effects of rank on shame and embarrassment may be highly concentrated at the bottom of the distribution, but above this threshold, rapidly decline.

Relatedly, ability rank at each end of the local rank distribution may be more discernable and less noisy to peers as well as teachers, whereas, in the middle of the distribution, students tend to move up and down more easily and more frequently than at each end of the distribution. For example, the phenomena of "Last-Place Aversion" and "First-Place Loving" may promote the persistence of rank positions (e.g., Tincani et al. 2015), particularly at each end of the ability distribution, providing students and teachers relatively precise information about who is ranked first or last in the distribution. Based on these arguments, I examine whether the effects of ordinal rank on adolescent depression are nonlinear—i.e., rank effects are driven by students at the top and bottom of the ability distribution. Finding evidence of nonlinear effects is crucial to improving our understanding of the structure and underlying mechanisms of local hierarchies in the school context. Moreover, the policy implications crucially depend on evidence of nonlinearity in the rank effects (e.g., Elsner and Isphording 2017; Epple and Romano 2011).

### *2.3 Gender perspectives*

Of the numerous risk factors associated with depression, the gender gap in depressive symptoms among adolescents is one of the most robust findings in mental health surveys across different countries and varying contexts (Landstedt, Asplund, and Gillander Gådin 2009; Schraedley M.A, Gotlib, and Hayward 1999). This gender gap in depression is known to emerge during adolescence with female adolescents almost twice as likely to have depressive symptoms as boys (Kessler 1993; Nolen-Hoeksema 2001). Prior studies provide mixed results about the moderating roles of gender in the relationship between social support and mental health problems. It has been proposed that the mental health problems of girls tend to be more related to the level of social support than for boys (Kaltiala-Heino et al. 2001; Schraedley M.A et al. 1999; Slavin and Rainer 1990) since girls have stronger needs for interpersonal closeness and intimacy than boys, and thus are more sensitive to lack of social support (Giordano 1995, 2003). Other studies have found no gender interaction in the relationship between social support deficits and depressive symptoms (McFarlane et al. 1994; Pelkonen, Marttunen, and Aro 2003).

Relatively less is known whether the effects of school-based hierarchies on adolescent depression differ by gender. The gender heterogeneity in styles and patterns of social interactions may hint at potential gender differences in the rank effect on adolescent depressive symptoms. Girls' friendships are often characterized as more intimate, intensive, and confidential (Maccoby 1990). As more investment in maintaining friendship is often required among females, the influence of peers (i.e., social support from and integration into the friendship group) may also be greater. In other words, girls may be more willing to conform to group norms because they fear losing friends as well as social worth. However, sources of peer influences may also differ by gender since friendships range from close friends to classmates, and to schoolmates. While girls maintain more intense friendships with a few close friends, boys interact less intimately with a wider group of peers (Crosnoe 2000; Lindenlaub and Prummer 2013; Maccoby 1990). With smaller and more exclusive friendship networks, girls' friendships tend to be based on closeness and disclosure, whereas boys' friendships tend to be organized more broadly around shared activities and status (Benenson 1990; Crosnoe 2000).

More important, existing evidence suggests that the rank effects on adolescent depression may vary by gender due to gender differences in the way in which adolescents conceptualize and assess social status and popularity (Crosnoe 2011; Maccoby 1998; Sedikides and Skowronski 1995). In short, boys learn to attain their status and popularity through competition and dominance in status hierarchies within the larger group while girls tend to gain social worth through increased closeness and intimacy with close friendship groups (e.g., Foels and Tomcho 2009; Guimond et al. 2006; Latrofa, Vaes, and Cadinu 2012). These gender differences in status attainment process can be explained by different early socialization experiences from parents and teachers and in segregated same-sex peer groups: in childhood boys are encouraged to be instrumental and independent through competitiveness and physical activity while girls learn to be cooperative, reciprocal, and caring (Francis 2002). In this sense, ability rank—i.e., relative position in status hierarchy in the school settings—may be a more critical source of status and popularity (and thus social support and integration) among boys since it conveys clear and direct feedback about social dominance (e.g., Legewie and DiPrete 2012). Therefore, it could be hypothesized that a higher ability rank that can be translated into a more powerful position within the peer group may be more important for depression among boys than girls.

### *2.4 The present study*

The study uses the National Longitudinal Study of Adolescent to Adult Health (Add Health) to examine whether ability rank influences adolescent depression. In particular, this study employs a novel approach where I estimate the rank effects net of student's absolute ability (i.e., controlling for a quartic in absolute ability). The relevance of this approach is couched in the idea that, regardless of an individual's absolute level of ability, those who have higher ability relative to their peers would have higher levels of depressive symptoms. In order to identify a causal effect of ability rank, I rely on idiosyncratic variation in the cohort composition within the same school over time. The core assumption of this approach to generate quasi-experimental variation in ability rank (holding absolute ability) is that parents and children only sort across schools based on the characteristics of the school, but not those of the child's cohort. I present evidence consistent with this key assumption to show that cohort composition is quasi-exogenous to a host of student and family characteristics, conditional on attending a given school. Based on this evidence, I argue that students' ability ranks in their school cohort are quasi-randomly assigned.

In this study, I investigate potential nonlinearities in the effects of ordinal rank on adolescent depression—i.e., are the rank effects driven by students being top or bottom of the class? These analyses enhance our understanding of whether the effects of rank on depression differ across the rank distribution, particularly at each end of the distribution. To implement this, I allow for nonlinear effects of rank by replacing a linear ability rank (percentile rank) with quartic polynomials in ability rank. In addition, this study examines whether the rank effects on adolescent depression differ by gender. Finally, I explore a range of potential pathways through which ordinal rank influences adolescent depression. In particular, I investigate several mechanisms including psychological and social factors.

## 3. Data and methods

### *3.1 Data*

The data used in this study come from the restricted version of Add Health. Add Health is a school-based, longitudinal study of the health-related behaviors of adolescents and their outcomes in young adulthood. Beginning with an in-school questionnaire administered to a nationally representative sample of students in grades 7 through 12 in 1994-1995, the study follows up with participants via a series of in-home interviews approximately one year (Wave 2), six years (Wave 3), and thirteen years later (Wave 4). Other sources of data include questionnaires for parents, siblings, fellow students, and school administrators. By design, the Add Health survey included a sample stratified by region, urbanicity, school type, ethnic mix, and size.

An unusual feature of Add Health is that the survey covers multiple cohorts within the same school. This feature is essential for the identification strategy of this study because it allows for comparing students in different cohorts within the same school and using school fixed effects to account for selection into schools. Of the 20,745 individuals who completed the Wave 1 survey, 14,736 respondents were followed up in Wave 2. Because the explanatory variable of interest, ability rank, is computed based on classmates' ability in the same school, I dropped 653 respondents who had missing values on school identification code and grade level. Furthermore, I dropped 205 respondents from the grades where the number of sampled individuals was fewer than 5, leaving 13,878 students. Nonresponse to one or more control variables and PVT score information (615 students) leaves an analytic sample of 13,263. The final analytic sample sizes slightly differ across models due to different levels of missingness on each dependent variable. In order to maximize the available sample, I imputed Wave 1 family income and mother's education level for about 2,500 respondents[7].

### *3.2 Measures*

#### <u>3.2.1 Dependent and mechanism variables</u>

The main dependent variable of this study is a measure of depressive symptoms measured in Wave 2, which was based on a 19-item self-report measure of the Center for Epidemiological Studies Depression Scale (CES-D)[8] (Meier 2007). The CES-D assesses respondents' feelings, thoughts, and physical conditions during the past week. Each question had four response categories: 0 = never or rarely; 1 = sometimes; 2 = a lot of the time; and 3 = most of the time or all of the time. The standardized average of the responses to these 19 items serves as the final scale (Cronbach's

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[7] I employed single imputation techniques and included in our estimation models a dummy variable identifying the cases with imputed values. I used the following variables in the imputation process: age, gender, race/ethnicity, test score, rural status, and parental socioeconomic status (if available).

[8] 19 items include: (1) You were bothered by things that usually don't bother you; (2) You didn't feel like eating, your appetite was poor; (3) You felt that you could not shake off the blues, even with help from your family and your friends; (4) You felt that you were just as good as other people (reverse-coded); (5) You had trouble keeping your mind on what you were doing; (6) You felt depressed; (7) You felt that you were too tired to do things; (8) You felt hopeful about the future (reverse-coded); (9) You thought your life had been a failure; (10) You felt fearful; (11) You were happy (reverse-coded); (12) You talked less than usual; (13) You felt lonely; (14) People were unfriendly to you; (15) You enjoyed life (reverse-coded); (16) You felt sad; (17) You felt that people disliked you; (18) It was hard to get started doing things; and (19) You felt life was not worth living.

alpha = 0.87 for Wave 2). Several mechanism variables are used in the analysis. A detailed description about mechanism variables is presented in Table A1 in the Appendix.

**3.2.2 Ordinal ability rank**

The key explanatory variable of this study is a student's ordinal rank based on a student's rank position in the ability distribution of his/her school cohort. In order to compute ordinal rankings in terms of cognitive ability, I use the scores of a standardized Peabody Picture Vocabulary Test (PVT). This test measures verbal intelligence and scholastic aptitude, and it has been shown to strongly correlate with widely used ability and intelligence tests, such as the Wechsler Adult Intelligence Scale or the Armed Forces Qualification Test (AFQT). Since the absolute rank measure does not account for different sizes of the cohort, the percentile rank is standardized to cohort size:

$$Percentile\ rank = \frac{absolute\ rank - 1}{number\ of\ students\ in\ grade} \cdots (1)$$

Since the analysis is interested in comparing students with the same level of absolute ability in the same school who differ in their ordinal rank because they are "exogenously" situated in different cohorts, students' absolute level of ability is controlled for in quartic polynomials.

(Figure 1 about here)

Figure 1 describes to what extent ability rank varies for a given decile in absolute ability, showing that there are quite large differences between absolute and relative ability. I compute VIF (Variance inflation factor) to test multicollinearity between ability and ability rank. As a rule of thumb, a variable whose VIF values are greater than 10 may be problematic. I find that VIFs for all variables were below the rule-of-thumb cutoff of 10 (4.24 for ability vs. 3.50 for ability rank) with a mean VIF of 2.80, suggesting that multicollinearity is not of primary concern (results not shown).

### *3.3 Analytic strategy*

The aim of the study is to estimate a causal effect of students' ordinal rank on their depressive symptoms. To identify a causal effect, I exploit idiosyncratic variation in cohort composition within the same school across grades. In other words, exploiting within-school across-cohort variation, I compare the outcomes of students in cohorts within the same school. This strategy is based on the assumption that conditional on attending a given school, the cohort composition is quasi-exogenous. This assumption holds if parents and children sort across schools based on the characteristics of the school, but not those of the child's cohort. In other words, dissatisfaction with school cohort quality may be one of the reasons for school choice, but students with dissatisfaction hardly change grades within the same school. Therefore, being in one cohort or another is determined almost exclusively by a student's birth date and the cut-off date for school entry.

(Figure 2 about here)

In this set-up, students with the same level of absolute ability can have different ranks if they are situated in cohorts with distinct ability distributions (at the school-cohort level). Figure 2 illustrates where the variations of this research design can come from—i.e., how those with the same ability can have different ranks. The variation in cohort composition can be driven by differences in mean ability across cohorts[9]. In Figure 2, each grade has different mean ability—i.e. Grade 9 has the lowest mean ability and Grade 10 has the highest. Due to this difference in mean ability, a student with ability at X would have different rank, depending on the timing of school entry. Although, in Grade 9, the student belongs to the highest ranked group, the student could have been ranked in the middle group if the student entered the school a year earlier. Therefore,

[9] Figure A1 in the Appendix illustrates how differences in standard deviation of ability across cohorts could also lead to different ability ranks among those with the same absolute ability.

this study uses the variation which comes from the fluctuations in the ability distribution across cohorts within the same school. Because the validity of this research design strictly depends on the assumption that these fluctuations are quasi-exogenous, I conduct an empirical test to determine whether this assumption holds or not in the data.

The primary empirical specification of this study is as follows:

$$Y_{igs} = X_{igs}B + \beta oridnal\ rank_{igs} + \delta ability_{igs} + W_s\theta + U_g\gamma + \varepsilon_{igs}\ \cdots (2)$$

where $Y_{igs}$ is a measure of depressive symptoms of individual $i$ in grade $g$ in school $s$, individual and family characteristics are contained in a vector *X*. $W_s$ is a set of school dummies that controls for unobserved school-level characteristics or confounding factors shared by all individuals within the same school while $U_g$ is a set of grade dummies that removes the mean differences in all variables between the grade levels in the sample. By separately controlling for sets of school and grade fixed effects, this model relies on the variation across grades within school.

In this analysis, I control for students' absolute level of ability. Since a person's ordinal rank is a function of his or her own ability, without controlling for own ability, the ordinal rank is a mere proxy for ability. Therefore, to ensure that $\beta$, coefficients of interest, exclusively captures the impact of ordinal rank, I include a quartic in own ability as controls, which takes into account a global mechanism through which ability influences depression. Lastly, $\varepsilon_{igs}$ is the error term that captures all unobservable factors that affect depressive symptoms. The robust standard errors are allowed to be clustered at the school level.

The specifications thus far assumed the effect of rank is linear. However, the theoretical and empirical literature suggest that the rank effects may be driven by students in the top and bottom of the ability distribution. In order to examine potential nonlinear effects of rank, I replace the rank parameter with higher polynomials of the rank measure (i.e., quadratic, cubic, and quartic polynomials in the ability rank). In addition, as a robustness check, I allow for nonlinear effects of rank by replacing the rank parameter with the deciles of ability rank while adding 114 dummies for each discrete level of own ability. Using this specification, the empirical results remain qualitatively unchanged.

**4. Results**

Summary statistics are presented in Table 1. Slightly more than half of the respondents were female, and the average age in the analytic sample ranged from 12 to 21, with a mean of 15.80. Approximately 54 percent of the respondents were non-Hispanic White, while 22 percent were Black, 16 percent were Hispanic, and 8 percent were identified as other racial/ethnic groups.

(Table 1 about here)

Before examining the effects of ability rank on adolescent depression, I start by showing evidence of whether conditional on attending a given school the cohort composition with regard to ability is quasi-exogenous. I conduct a simple, intuitive empirical test that mimics analyses often conducted in the randomized control trials. Specifically, I first examine whether the cohort mean ability is correlated with predetermined student characteristics by running regression of several important student characteristics on cohort mean ability. Then, I examine whether controlling for school fixed effects removes statistically significant correlations. The disappearance of the associations is interpreted as evidence that within-school cohort-to-cohort variation in ability distribution is plausibly exogenous, and so is student's ranking.

(Figure 3 about here)

Figure 3 plots correlations between school-cohort mean ability and individual-level characteristics[10] (Table A2 in the Appendix shows the full results). Each dot is the coefficient from

[10] Figure A2 in the Appendix presents results of balancing tests for grade-level standard deviation of ability.

a separate regression, and is labeled with the name of dependent variable. School fixed effects are controlled for only in the right panel of Figure 3. As shown in the left panel of Figure 3, cohort mean ability is significantly correlated with all individual characteristics except rural status. Results show that being White and having parents with high SES and married parents *increase* the likelihood of attending schools with higher cohort mean ability, whereas being Black or Hispanic, being older, and having divorced or separated parents *decrease* the likelihood of attending schools with higher cohort mean ability. However, when controlling for school fixed effects (the right panel of Figure 3), all these correlations disappear, indicating that there is strong systematic school selection, but conditional on attending a given school, cohort-to-cohort variation in ability distribution is plausibly exogenous (or quasi-random).

***4.1 Ability rank and adolescent depression***

Table 2 presents OLS estimates of the relationship between the ability rank and depressive symptoms measured in Wave 2. All models include individual demographic controls, family-level controls, student's own ability, and grade as well as school fixed effects. Model 1 shows that controlling for absolute ability students with a higher rank are more likely to have lower scores on depressive symptoms in Wave 2. Models 2-4 provide evidence that the effects of ability rank on depressive symptoms are robust to different methods of controlling for student's own ability—i.e., quadratic (Model 2), cubic (Model 3), and quartic (Model 4) polynomials in absolute ability. Throughout the analyses, a quartic in ability is used to control for students' absolute ability. In sum, these findings suggest that a student's ordinal rank significantly affects depressive symptoms.

(Table 2 about here)

Finding evidence on whether the rank effects on adolescent depression are nonlinear is fundamental to our understanding of the structure and underlying mechanisms of the rank effects. In order to assess potential nonlinearities in the effects of ability rank on adolescent depression, I introduce a cubic term for the ability rank. Empirical evidence in support of the nonlinear rank effects is found if the polynomials are statistically significant. This parametric approach is aimed at examining whether the rank effects are more pronounced at the top and bottom of the ability distribution. In addition, in order to test whether the rank effects differ by gender, I perform analyses separately for male and female adolescents.

(Table 3 about here)

Table 3 presents OLS estimates of nonlinear relationship between the ability rank and depressive symptoms, for the full sample (Models 1-2), and separately for male (Models 3-4) and female samples (Models 5-6). While in Model 1 a linear ability rank is used, Model 2 includes cubic terms of ability rank. Model 2 demonstrates that all coefficients for polynomials are statistically significant, suggesting that the rank effects on adolescent depression are nonlinear. Results in Models 3 and 4 suggest that ability rank, whether linear or nonlinear, has no impact on depressive symptoms among female adolescents. On the other hand, Models 5 and 6 provide evidence that ability rank significantly influences male adolescents' depression, regardless of functional forms of ability rank. However, the goodness-of-fit statistics (including AIC and BIC) indicate that the model using a nonlinear ability rank is preferable.

(Figure 4 about here)

In order to ease the interpretation of the nonlinear patterns of the relationship between ability rank and depressive symptoms, I present figures of predicted probabilities of depressive symptoms by ability rank. The predicted probabilities for female (Model 4) and female (Model 6) adolescents are plotted in Figure 4. As shown in Figure 4, the effect of rank for male adolescents is nonlinear, with notable flicks at the top and bottom distribution. Although the effect of rank for female adolescents appears to be almost linear throughout the rank distribution, this linear relationship is found to be statistically insignificant (Model 3). These results conclude that the rank effect on adolescent depression is pronounced among male adolescents, especially at the top and bottom of the hierarchy. As a robustness check, I replace polynomials with deciles of ability rank while controlling for dummies for each level of ability scores (Table A3 in the Appendix). Results are qualitatively similar to the ones shown in Table 3. Among male adolescents (and the full sample), only the coefficients for the first and the tenth decile of ability rank are statistically different from the reference group of the median-ranked students (i.e., 6th decile). This indicates that the effect of rank does not exist throughout the distribution, but is most pronounced at the top and bottom of the distribution.

### *4.2 Mechanisms*

In order to shed light on potential mechanisms through which ability rank affects depressive symptoms among male adolescents, I estimate several auxiliary regression models. I begin with showing the relationship between ability rank and a large set of mechanism variables (measured in Wave 1). In Table 4, I present results of nonlinear relationship between ability rank and mechanism variables while controlling for absolute ability[11]. The mechanism variables, list in the first column, are used as an outcome and coefficients in each row (i.e., coefficients for cubic terms) come from the same regression model.

(Table 4 about here)

Panel A of Table 4 presents results for psychological factors as a pathway. Results demonstrate that controlling for absolute ability, ability rank strongly predicts the likelihood of reporting that they are more intelligent than other people at their age. This finding suggests that

[11] While I focus on male adolescents in this analysis, results for the full sample are presented in Tables A4-A9 in the Appendix. Results using composite measures for future expectations and social relationships are presented in Tables A10-A11 in the Appendix. In addition, results for the linear relationship between ability rank and mechanism variables are presented in Table A12 in the Appendix.

the relative position in local ability distribution is an important source of adolescents' self-perception on ability, though ability rank is nonlinearly related to this self-perception of ability. This finding also appears to indicate that school cohort is a plausible reference group for social comparison among adolescents. Surprisingly, however, ability rank is not associated with student's self-esteem. Panel B of Table 4 presents results for the relationship between ability rank and future expectations. Results suggest that ability rank has no impact on educational and life chances expectations as well as feelings of hopefulness in the future.

In Panel C of Table 4, I examine whether ability rank is associated with social relationships in the school settings. Results show strong evidence of the relationship between ability rank and relationship with friends and teachers. Specifically, those with a lower ability rank are more likely to experience difficulty in getting along with other students and teachers and feel that students in their school are prejudiced. It should be noted that ability rank is nonlinearly related to social relationship: the link is greater at the top and bottom of the rank distribution. It may also be interesting to examine whether ability rank affects students' close friendship network. In supplementary analysis (not shown), I explore the association between ability rank and several measures of friendship network (including friend nominations received/sent, isolate, and centrality). However, no evidence is found in support of this relationship.

Finally, I examine whether the effect of rank is explained by mechanism variables proposed by this study. These analyses are presented as a sequence of nested models. Specifically, I investigate whether the coefficient of the rank effect on adolescent depression disappears when sets of variables that may mediate the relationship between ability rank and depressive symptoms is added in the baseline model (i.e., Model 6 of Table 3). The key interest of this analysis is to examine to what extent the inclusion of these variables reduces the estimated coefficient for the rank effect[12].

(Table 5 about here)

In Table 5, while Model 1 presents baseline results, Model 2 shows that both self-perception on own ability and self-esteem are strongly associated with depressive symptoms among male adolescents in Wave 2. However, the inclusion of these psychological factors does not eliminate the effects of ability rank. Similarly, according to Models 3-5, although educational and mortality expectations and feeling of hopefulness in the future are associated with depressive symptoms, the inclusion of these variables does not affect the coefficients of the nonlinear effects of rank. In Models 6-9, sets of social relationship measures are shown to be associated with depressive symptoms. Importantly, as shown in Model 7, when measures of relationship with friends are added, the nonlinear effects of ability rank substantially diminish, thereby leading to statistically insignificance. When all measures of social relationships are included simultaneously (Model 9), the nonlinear effects of ability rank further decline. These findings suggest that the nonlinear effects of ability rank on depressive symptoms among male adolescents are attributable to major disadvantages in social relationships (particularly with other students) in the school settings.

(Figure 5 about here)

Figure 5 illustrates the mediation results by presenting changes in the predicted probabilities of depressive symptoms among male adolescents when each set of mechanism

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[12] Results for the full sample are presented in Table A13 in the Appendix. As a robustness check, I replace polynomials with deciles of ability rank while controlling for dummies for each level of ability scores (Tables A14-A16 in the Appendix). Figures A3 and A4 in the Appendix plot mediation results—i.e., changes in the predicted probabilities of depressive symptoms among the full and male samples, respectively. In addition, I conduct the same mediation analysis using the linear ability rank (Table A17 in the Appendix).

variables is added[13]. Panels A and B of Figure 5 demonstrate that the inclusion of measures of psychological factors and future expectations has no statistically significant impact on the nonlinear relationship between ability rank and adolescent depression. Panel C of Figure 5, however, shows that the inclusion of measures of social relationships explains a large portion of the nonlinear effects of ability rank on adolescent depressive symptoms—i.e., the nonlinear relationship flattens out with the inclusion of these variables.

### *4.3 Robustness checks*

In this section, I discuss results for a series of robustness checks to confirm the validity of the findings of this study. First, I further address the possibility of contextual-level confounders. In the baseline model, I include separate fixed effects for schools and cohorts, allowing for comparisons of students with the same absolute ability who belong to different cohorts in the same school. The school fixed effects control for observed and unobserved factors that affect selection into schools. However, school-cohort specific confounding factors (e.g., teacher quality and classroom environment) cannot be captured by these separate school and cohort fixed effects.

An alternative specification might be to include school by grade fixed effects rather than school fixed effects and grade fixed effects. A disadvantage of using this specification is that relative and absolute ability would be confounded more explicitly, whereby in order for a student to have a higher relative ability than another student in the same school-grade, he or she must have a higher ability. Thus, the effects of ability rank would be uncovered in part based on the functional form assumptions we make about the effects of absolute ability. Despite this limitation, I show that the results of this study are robust to controls for several important grade-level characteristics as well as school-by-grade fixed effects (Table A18 in the Appendix).

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[13] Figure A5 in the Appendix presents results for the full sample.

In Table A19 in the Appendix, I show results of sensitivity checks with respect to the definition of ability hierarchies. In order to test whether the results of this study are robust to alternative operationalization of ability hierarchies. Borrowing from the relative deprivation literature, I use several relative deprivation measures (so-called "upward-looking" measure) that are designed to capture average distance between an individual's characteristic (affluence) and aggregate-level characteristic for those above the individual, within a social reference group (Adjaye-Gbewonyo and Kawachi 2012; Runciman 1966; Stewart 2006). Results do not show any evidence on the relationship between these alternative measures of ability hierarchy and adolescent depression. One possible explanation is that students may not be sophisticated enough or lack more detailed information to assess or measure the "quantity" of relative advantage or disadvantage in terms of cognitive ability while they have a relatively good understanding of where one stands in relation to the reference group (Tversky and Kahneman 1974). This also appears to provide further support for the nonlinear nature of the rank effects on adolescent depression since it is much easier and reliable to figure out who is at the top or bottom of the ability distribution than to correctly rank students at the middle of the distribution.

In addition, considering that social position is multidimensional in nature and adolescents may belong to multiple social hierarchies (Sweeting et al. 2011), I examine whether the rank effects found in this study are robust to controlling for rank measures of other salient characteristics for young people. In this supplementary analysis, I control for two additional rank measures created based on body mass index (BMI) and parental income. As shown in Table A20 in the Appendix, even after controlling for these rank measures, the coefficients for the nonlinear effects of ability rank remain almost identical and statistically significant. However, it is worth noting that these two rank measures appear to have an impact on adolescent depression independently from the effects of ability rank. This presents a promising direction for future research to examine the potential effects of "status inconsistency," which is defined as having inconsistent hierarchical positions in different stratification systems (House and Harkins 1975; Stryker and Macke 1978). For example, students with higher relative position in terms of parental SES in a peer group, but a lower ability rank in the same peer group may have worse psychological health.

Finally, in order to provide more stringent test of the causal effects of ability rank, this study exploits exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school. Although a sibling comparison model is better at addressing several important possible threats to internal validity of this study (e.g., eliminating potential confounding such as family background characteristics and school selection), it could produce biased estimates in case of violation of the central assumption that there are no spillovers between siblings (Fletcher and Wolfe 2008). In Table A21 in the Appendix, family-fixed effects models produce qualitatively similar results: after controlling for shared unobserved heterogeneity at the family level, ability rank still has an impact on adolescent depression. However, these fixed effects estimates should be interpreted cautiously due to potential sibling spillover effects.

**5. Discussion and conclusion**

Although a large number of studies have documented the link between cognitive ability and adolescents' psychological health, relatively little is known about the underlying mechanisms behind the relationship. Building on social-psychological theories, this study rather argues that to better understand how ability shapes adolescents' psychological health, it is critical to contextualize the meaning of an individual's ability in reference to other students' ability in the school settings. Using a large, nationally representative longitudinal survey of U.S. adolescents, this study examines the relationship between ordinal rank and adolescent depressive symptoms.

Specifically, this study investigates whether psychological health outcomes differ among students who have the same level of absolute ability but different ability ranks depending on their cohort-level ability distribution, which I found quasi-randomly assigned within the school.

The results of this study show that controlling for own ability, students with a lower ability rank are more likely to have higher levels of depressive symptoms. By allowing for nonlinear effects, this study also provides empirical evidence on the nonlinear relationship between ability rank and adolescent depression. Results suggest that the rank effects are more pronounced among students at the top and bottom of the ability distribution while ability rank appears to have little impact in the middle of the distribution. These findings are in line with more recent studies showing that individuals tend to be "last-place averse" and "first-place loving" (Gill et al. 2018; Kuziemko et al. 2014): psychological consequences of status attainment/loss are greater at the ends of the distribution due to nonlinearities in preferences with respect to relative positions. The nonlinear nature of the relationship between ability rank and adolescent depression is found to be relevant only for male adolescents, reflecting gender differences in the way in which an adolescent gains status: boys attain status and popularity through competition and dominance in status hierarchies within the larger group while girls gain them through increased closeness and intimacy with close friendship groups.

How does ability rank influence adolescent depression? This study provides evidence showing the sense in which social relationships (rather than psychological factors and future expectations) serve as the most relevant mechanism of the rank effects on depressive symptoms. Specifically, my findings suggest that among other aspects of social relationships in the school settings, especially relationship with other students appear to be an important channel—i.e., the inclusion of the measure of relationship with other students eliminates the nonlinear effects of ability rank on male adolescents' depression. It is, however, worth pointing out that ability does not affect depressive symptoms through changes in psychological resources such as self-esteem. Moreover, interestingly, for both male and female adolescents, ability rank is associated with self-perception on ability, but not self-esteem. This finding appears to support the notion that it may not be students' self-assessment but peer prejudice and discrimination that connect ability rank to depressive symptoms—i.e., the rank effects may be socially, rather than psychologically, driven.

This study builds on existing literature on social status and adolescent psychological health by conceptualizing ability rank as one of the important dimensions of status attainment among adolescents. In particular, to the author's knowledge, the present study is the first to consider the nonlinear patterns of the effects of status attainment/loss on adolescent psychological health. Drawing on the theoretical and empirical research concerning gender differences in status attainment process and social integration patterns, this study also develops and tests the gender-specific social-psychological mechanisms through which relative standing in the ability hierarchy influences adolescents' depressive symptoms. Lastly, in a series of robustness checks, this study carefully addresses several threats to internal validity and interpretation of the findings of this study. In short, results from a series of robustness check provide additional confidence in the findings of this study that ability rank has a significant impact on adolescent depression and these effects are highly nonlinear.

While not conclusive, the findings of this study could be policy-relevant. Since adolescent depression is a major public health concern and limits the possibilities of individuals throughout their life course (e.g., socioeconomic attainment), identifying potential risk and protective factors could be of much benefit in helping adolescents reduce depressive symptoms. Among a broad range of individual and socioenvironmental determinants of adolescent depression, this study highlights the importance of social factors, particularly peer relationships. Deficits in social support from friends (or social isolation and exclusion from friends) have long been considered as a risk factor for adolescent depression. For instance, lack of support from friends may generate a feeling or perception that one is rejected or not valued in interpersonal relationships (Nangle et al. 2003; Respress et al. 2013). This study adds to this line of research by providing strong evidence that ability rank is a critical source of peer hierarchies and social integration among adolescents.

Moreover, the policy implications may crucially depend on evidence of this study that the rank effects are nonlinear and driven largely by male adolescents. It is therefore important that schools understand how male students respond to ability rank of their own and others, in order to be able to design effective policies for adolescents' psychological health that take into account the implicit penalties generated by school-based local hierarchies. Finally, the results of this study provides broader implications of parental choices about residence and school. Documenting the potential trade-off between school quality and rank position—i.e., a student in a better-quality school should be ranked lower, this study provides support for the claim that the rank of a child is another (often neglected) factor to consider when choosing a school for their children. However, more research is required to assess how much of the rank effects is offset by differential school inputs (e.g., teacher quality, average peer quality, and school resources).

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## 7. Tables

***Table 1. Summary statistics, National Longitudinal Study of Adolescent to Adult Health (N = 13,263)***

| | Mean | SD | Min | Max |
|---|---|---|---|---|
| ***Ability measures*** | | | | |
| Ability rank | 0.492 | 0.296 | 0.0 | 1.0 |
| PVT score | 100.135 | 14.769 | 13.0 | 139.0 |
| ***Dependent variables*** | | | | |
| Depressive symptoms (W2) | -0.009 | 0.998 | -1.5 | 5.9 |
| ***Mechanism variables*** | | | | |
| *Psychological factors* | | | | |
| More intelligent than the average | 0.547 | 0.498 | 0.0 | 1.0 |
| Self-esteem | 0.011 | 0.995 | -5.6 | 1.7 |
| *Future expectations* | | | | |
| I want to go to college | 4.454 | 1.010 | 1.0 | 5.0 |
| I will likely go to college | 4.146 | 1.137 | 1.0 | 5.0 |
| Expectations to live to 35 | 4.361 | 0.865 | 1.0 | 5.0 |
| Expectations killed by 21 | 1.649 | 0.808 | 1.0 | 5.0 |
| Hopeful about future | 1.792 | 0.988 | 0.0 | 3.0 |
| *Social factors* | | | | |
| Feel part of school | 3.832 | 1.015 | 1.0 | 5.0 |
| Happy to be at school | 3.710 | 1.108 | 1.0 | 5.0 |
| Feel close to people at school | 3.711 | 0.993 | 1.0 | 5.0 |
| Difficulty getting along with other students | 1.878 | 0.984 | 1.0 | 5.0 |
| Friends care about me | 4.230 | 0.799 | 1.0 | 5.0 |
| Students are prejudiced | 3.106 | 1.212 | 1.0 | 5.0 |
| Difficulty getting along with teachers | 1.887 | 0.979 | 1.0 | 5.0 |
| Teachers care about me | 3.515 | 0.997 | 1.0 | 5.0 |
| Teachers treat students fairly | 3.495 | 1.069 | 1.0 | 5.0 |
| ***Control variables*** | | | | |
| Female | 0.513 | 0.500 | 0.0 | 1.0 |
| Age | 15.795 | 1.579 | 12.0 | 21.0 |
| White | 0.542 | 0.498 | 0.0 | 1.0 |
| Black | 0.223 | 0.416 | 0.0 | 1.0 |
| Hispanic | 0.160 | 0.367 | 0.0 | 1.0 |
| Other race/ethnicity | 0.075 | 0.263 | 0.0 | 1.0 |
| First-born | 0.499 | 0.500 | 0.0 | 1.0 |
| Grade 7 | 0.153 | 0.360 | 0.0 | 1.0 |
| Grade 8 | 0.156 | 0.363 | 0.0 | 1.0 |
| Grade 9 | 0.201 | 0.400 | 0.0 | 1.0 |
| Grade 10 | 0.228 | 0.420 | 0.0 | 1.0 |
| Grade 11 | 0.219 | 0.414 | 0.0 | 1.0 |
| Grade 12 | 0.043 | 0.203 | 0.0 | 1.0 |
| Mother's education | 13.164 | 2.347 | 0.0 | 17.0 |
| Family income | 0.458 | 0.476 | 0.0 | 10.0 |

| | | | | |
|---|---|---|---|---|
| Rural | 0.257 | 0.437 | 0.0 | 1.0 |
| Missing family information dummy | 0.294 | 0.456 | 0.0 | 1.0 |
| Observations | 13263 | | | |

*Note.* Family income and maternal education contain imputed values and parent missing data dummy reflects this missingness.

***Table 2. Ability rank and Wave 2 depressive symptoms***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) |
|---|---|---|---|---|
| Ability rank | -0.263*** | -0.281*** | -0.156* | -0.191** |
| | (0.083) | (0.087) | (0.090) | (0.094) |
| PVT score | -0.004** | -0.006 | 0.053*** | 0.100*** |
| | (0.002) | (0.006) | (0.012) | (0.038) |
| PVT score square | | 0.000 | -0.001*** | -0.002** |
| | | (0.000) | (0.000) | (0.001) |
| PVT score cubic | | | 0.000*** | 0.000 |
| | | | (0.000) | (0.000) |
| PVT score quartic | | | | -0.000 |
| | | | | (0.000) |
| Female | 0.240*** | 0.240*** | 0.239*** | 0.239*** |
| | (0.022) | (0.022) | (0.022) | (0.022) |
| Age | 0.095*** | 0.095*** | 0.093*** | 0.093*** |
| | (0.013) | (0.013) | (0.013) | (0.013) |
| Black | 0.097** | 0.097** | 0.091** | 0.092** |
| | (0.038) | (0.038) | (0.037) | (0.037) |
| Hispanic | 0.064** | 0.064** | 0.057** | 0.056** |
| | (0.027) | (0.027) | (0.027) | (0.027) |
| Other race/ethnicity | 0.215*** | 0.214*** | 0.203*** | 0.201*** |
| | (0.045) | (0.046) | (0.047) | (0.047) |
| First-born | -0.015 | -0.015 | -0.017 | -0.017 |
| | (0.015) | (0.015) | (0.015) | (0.015) |
| Grade 8 | 0.046 | 0.046 | 0.051 | 0.050 |
| | (0.035) | (0.034) | (0.034) | (0.034) |
| Grade 9 | -0.021 | -0.021 | -0.008 | -0.011 |
| | (0.055) | (0.055) | (0.055) | (0.055) |
| Grade 10 | -0.086 | -0.087 | -0.069 | -0.074 |
| | (0.061) | (0.061) | (0.062) | (0.061) |
| Grade 11 | -0.202*** | -0.203*** | -0.179** | -0.185*** |
| | (0.070) | (0.070) | (0.070) | (0.070) |
| Grade 12 | -0.343*** | -0.344*** | -0.317*** | -0.325*** |
| | (0.085) | (0.085) | (0.085) | (0.085) |
| Mother's education | -0.023*** | -0.023*** | -0.022*** | -0.022*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | -0.054*** | -0.054*** | -0.054*** | -0.055*** |
| | (0.020) | (0.020) | (0.020) | (0.020) |
| Rural | -0.009 | -0.009 | -0.008 | -0.008 |
| | (0.027) | (0.027) | (0.027) | (0.027) |
| Missing family information dummy | 0.066*** | 0.066*** | 0.064*** | 0.064*** |
| | (0.021) | (0.021) | (0.021) | (0.021) |

| | | | | |
|---|---|---|---|---|
| Constant | -0.760*** | -0.682** | -2.003*** | -2.649*** |
| | (0.236) | (0.341) | (0.386) | (0.529) |
| Observations | 13263 | 13263 | 13263 | 13263 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 3. Nonlinear relationship between ability rank and Wave 2 depressive symptoms, by gender***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|
| Sample | All | All | Female | Female | Male | Male |
| Ability rank | -0.191** | -0.764** | -0.179 | -0.487 | -0.210* | -0.970** |
| | (0.094) | (0.346) | (0.138) | (0.532) | (0.122) | (0.399) |
| Ability rank square | | 1.369* | | 0.690 | | 1.861** |
| | | (0.708) | | (1.059) | | (0.856) |
| Ability rank cubic | | -0.924** | | -0.442 | | -1.280** |
| | | (0.460) | | (0.680) | | (0.578) |
| PVT score | 0.100*** | 0.082** | 0.122*** | 0.111** | 0.085* | 0.061 |
| | (0.038) | (0.041) | (0.047) | (0.050) | (0.048) | (0.049) |
| PVT score square | -0.002** | -0.001 | -0.002* | -0.002 | -0.002 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.239*** | 0.240*** | | | | |
| | (0.022) | (0.022) | | | | |
| Age | 0.093*** | 0.093*** | 0.109*** | 0.109*** | 0.088*** | 0.088*** |
| | (0.013) | (0.013) | (0.020) | (0.020) | (0.017) | (0.017) |
| Black | 0.092** | 0.093** | 0.097** | 0.097** | 0.097* | 0.100** |
| | (0.037) | (0.037) | (0.048) | (0.048) | (0.049) | (0.049) |
| Hispanic | 0.056** | 0.056** | 0.043 | 0.042 | 0.065* | 0.066* |
| | (0.027) | (0.027) | (0.043) | (0.044) | (0.039) | (0.039) |
| Other race/ethnicity | 0.201*** | 0.201*** | 0.169** | 0.168** | 0.226*** | 0.229*** |
| | (0.047) | (0.047) | (0.073) | (0.073) | (0.051) | (0.050) |
| First-born | -0.017 | -0.017 | -0.008 | -0.008 | -0.017 | -0.018 |
| | (0.015) | (0.015) | (0.023) | (0.023) | (0.021) | (0.021) |
| Grade 8 | 0.050 | 0.050 | 0.076 | 0.075 | 0.020 | 0.020 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.034) | (0.035) | (0.052) | (0.052) | (0.040) | (0.040) |
| Grade 9 | -0.011 | -0.011 | -0.048 | -0.047 | 0.017 | 0.015 |
| | (0.055) | (0.055) | (0.081) | (0.081) | (0.067) | (0.068) |
| Grade 10 | -0.074 | -0.074 | -0.149 | -0.148 | -0.014 | -0.016 |
| | (0.061) | (0.061) | (0.090) | (0.090) | (0.070) | (0.071) |
| Grade 11 | -0.185*** | -0.186*** | -0.288*** | -0.288*** | -0.111 | -0.113 |
| | (0.070) | (0.070) | (0.105) | (0.105) | (0.082) | (0.083) |
| Grade 12 | -0.325*** | -0.327*** | -0.531*** | -0.532*** | -0.134 | -0.138 |
| | (0.085) | (0.085) | (0.136) | (0.136) | (0.105) | (0.106) |
| Mother's education | -0.022*** | -0.022*** | -0.024*** | -0.024*** | -0.020*** | -0.020*** |
| | (0.005) | (0.005) | (0.007) | (0.007) | (0.006) | (0.006) |
| Family income | -0.055*** | -0.055*** | -0.072** | -0.072** | -0.039* | -0.039* |
| | (0.020) | (0.020) | (0.032) | (0.032) | (0.021) | (0.021) |
| Rural | -0.008 | -0.008 | 0.015 | 0.015 | -0.035 | -0.035 |
| | (0.027) | (0.027) | (0.036) | (0.036) | (0.034) | (0.034) |
| Missing family information dummy | 0.064*** | 0.064*** | 0.064** | 0.064** | 0.055** | 0.055** |
| | (0.021) | (0.021) | (0.028) | (0.028) | (0.024) | (0.024) |
| Constant | -2.649*** | -2.438*** | -3.183*** | -3.047*** | -2.135*** | -1.888*** |
| | (0.529) | (0.543) | (0.642) | (0.677) | (0.652) | (0.668) |
| Observations | 13263 | 13263 | 6804 | 6804 | 6459 | 6459 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table 4. Ability rank and Wave 1 mechanism variables, Male (N~9,100)***

| | (1)<br>Ability rank | (2)<br>Ability rank square | (3)<br>Ability rank cubic |
|---|---|---|---|
| **Panel A. Psychological factors** | | | |
| More intelligent than the average | -0.455** | 1.330*** | -0.797** |
| | (0.223) | (0.492) | (0.330) |
| Self-esteem | 0.215 | -0.076 | -0.069 |
| | (0.312) | (0.683) | (0.442) |
| **Panel B. Future expectations** | | | |
| *Educational expectations* | | | |
| I want to go to college | -0.082 | 0.618 | -0.420 |
| | (0.568) | (1.154) | (0.718) |
| I will likely go to college | 0.123 | 0.710 | -0.577 |
| | (0.554) | (1.124) | (0.704) |
| *Life chances expectations and hopefulness about future* | | | |
| Expectations to live to 35 | -0.166 | 0.534 | -0.397 |
| | (0.406) | (0.830) | (0.532) |
| Expectations killed by 21 | 0.326 | -0.787 | 0.612 |
| | (0.345) | (0.692) | (0.441) |
| Hopeful about future | 0.064 | 0.060 | 0.084 |
| | (0.457) | (1.035) | (0.685) |
| **Panel C. Social relationships** | | | |
| *School attachment* | | | |
| Feel part of school | 0.193 | -0.243 | 0.120 |
| | (0.457) | (0.961) | (0.629) |
| Happy to be at school | 0.812 | -1.287 | 0.736 |
| | (0.500) | (1.152) | (0.761) |
| Feel close to people at school | -0.038 | 0.516 | -0.513 |
| | (0.429) | (0.995) | (0.691) |
| *Relationship with friends* | | | |
| Difficulty getting along with other students | -0.983** | 1.949** | -1.221** |
| | (0.454) | (0.917) | (0.588) |
| Friends care about you | 0.240 | -0.832 | 0.642 |
| | (0.326) | (0.723) | (0.487) |
| Students are prejudiced | -1.173** | 2.788*** | -1.745*** |
| | (0.473) | (0.980) | (0.635) |
| *Relationship with teachers* | | | |
| Difficulty getting along with teachers | -1.105*** | 2.068*** | -1.265** |
| | (0.368) | (0.779) | (0.522) |
| Teachers care about you | 0.167 | 0.006 | -0.034 |
| | (0.419) | (0.844) | (0.554) |
| Teachers treat students fairly | 0.721* | -1.561* | 1.013 |
| | (0.402) | (0.939) | (0.641) |

*Note.* Each row is obtained from a separate regression. In all models, robust standard errors are clustered at the

school level. All models include school fixed effects. All models include the following control variables: gender, age, race/ethnicity, standardized PVT score, first-born child, grade level, mother's education, family income, rural status, and missing family information dummy.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table 5. Mediation for the relationship between ability rank and Wave 2 depressive symptoms variables, Male*

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanism variables | Baseline | Psychological factors | Educational expectations (A) | Mortality expectations and hopefulness (B) | Future expectations (A)+(B) | School attachment (C) | Relationship with friends (D) | Relationship with teachers (E) | Social relationship (C)+(D)+(E) | All (A)+(B)+(C)+(D)+(E) |
| Ability rank | -0.970$^{**}$ | -0.894$^{**}$ | -0.889$^{**}$ | -1.054$^{***}$ | -1.045$^{***}$ | -0.755$^{*}$ | -0.582 | -0.670$^{*}$ | -0.421 | -0.617 |
| | (0.399) | (0.381) | (0.399) | (0.387) | (0.388) | (0.403) | (0.386) | (0.395) | (0.391) | (0.378) |
| Ability rank square | 1.861$^{**}$ | 1.633$^{*}$ | 1.819$^{**}$ | 2.128$^{**}$ | 2.181$^{***}$ | 1.507$^{*}$ | 0.951 | 1.348 | 0.747 | 1.115 |
| | (0.856) | (0.841) | (0.850) | (0.834) | (0.834) | (0.843) | (0.834) | (0.857) | (0.832) | (0.825) |
| Ability rank cubic | -1.280$^{**}$ | -1.127$^{**}$ | -1.261$^{**}$ | -1.446$^{**}$ | -1.486$^{***}$ | -1.083$^{*}$ | -0.677 | -0.977$^{*}$ | -0.578 | -0.784 |
| | (0.578) | (0.560) | (0.571) | (0.561) | (0.561) | (0.561) | (0.558) | (0.571) | (0.549) | (0.543) |
| PVT score | 0.061 | 0.042 | 0.075 | 0.060 | 0.069 | 0.080$^{*}$ | 0.077 | 0.109$^{**}$ | 0.106$^{**}$ | 0.078 |
| | (0.049) | (0.047) | (0.051) | (0.052) | (0.052) | (0.047) | (0.048) | (0.049) | (0.048) | (0.048) |
| PVT score square | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.002 | -0.001 | -0.002$^{*}$ | -0.002$^{*}$ | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| More intelligent than the average | | -0.056$^{**}$ | | | | | | | | -0.021 |
| | | (0.023) | | | | | | | | (0.023) |
| Self-esteem | | -0.371$^{***}$ | | | | | | | | -0.269$^{***}$ |
| | | (0.014) | | | | | | | | (0.015) |
| I want to go to college | | | -0.021 | | -0.007 | | | | | 0.012 |
| | | | (0.015) | | (0.014) | | | | | (0.014) |
| I will likely go to college | | | -0.110$^{***}$ | | -0.079$^{***}$ | | | | | -0.035$^{**}$ |
| | | | (0.017) | | (0.016) | | | | | (0.014) |

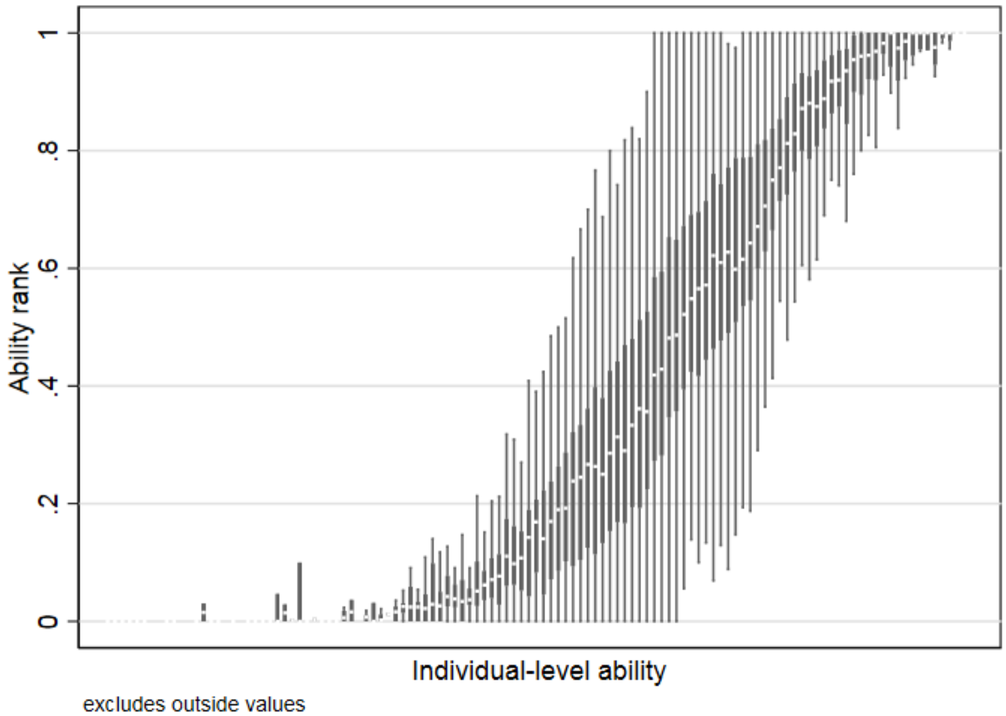
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Expectations to live to 35 | | | | -0.134*** | -0.120*** | | | | | -0.058*** |
| | | | | (0.014) | (0.013) | | | | | (0.013) |
| Expectations killed by 21 | | | | 0.103*** | 0.096*** | | | | | 0.051*** |
| | | | | (0.016) | (0.017) | | | | | (0.017) |
| Hopeful about future | | | | -0.149*** | -0.138*** | | | | | -0.058*** |
| | | | | (0.014) | (0.014) | | | | | (0.011) |
| Feel part of school | | | | | | -0.086*** | | | -0.052*** | -0.008 |
| | | | | | | (0.014) | | | (0.014) | (0.014) |
| Happy to be at school | | | | | | -0.107*** | | | -0.062*** | -0.034*** |
| | | | | | | (0.012) | | | (0.012) | (0.011) |
| Feel close to people at school | | | | | | -0.045*** | | | -0.012 | -0.004 |
| | | | | | | (0.015) | | | (0.014) | (0.013) |
| Difficulty getting along with other students | | | | | | | 0.142*** | | 0.090*** | 0.069*** |
| | | | | | | | (0.013) | | (0.012) | (0.012) |
| Friends care about you | | | | | | | -0.139*** | | -0.099*** | -0.046*** |
| | | | | | | | (0.014) | | (0.015) | (0.014) |
| Students are prejudiced | | | | | | | 0.062*** | | 0.037*** | 0.038*** |
| | | | | | | | (0.010) | | (0.010) | (0.010) |
| Difficulty getting along with teachers | | | | | | | | 0.119*** | 0.088*** | 0.075*** |
| | | | | | | | | (0.014) | (0.013) | (0.013) |
| Teachers care about you | | | | | | | | -0.100*** | -0.043*** | -0.009 |
| | | | | | | | | (0.014) | (0.015) | (0.014) |
| Teachers treat students fairly | | | | | | | | -0.051*** | -0.017 | -0.007 |
| | | | | | | | | (0.013) | (0.013) | (0.013) |
| Age | 0.088*** | 0.059*** | 0.057*** | 0.070*** | 0.052*** | 0.071*** | 0.087*** | 0.084*** | 0.076*** | 0.049*** |
| | (0.017) | (0.016) | (0.017) | (0.016) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.016) |
| Black | 0.100** | 0.165*** | 0.124** | 0.091* | 0.106** | 0.111** | 0.127*** | 0.111** | 0.124*** | 0.166*** |
| | (0.049) | (0.042) | (0.049) | (0.046) | (0.046) | (0.045) | (0.045) | (0.046) | (0.042) | (0.038) |
| Hispanic | 0.066* | 0.061* | 0.074* | 0.030 | 0.036 | 0.077** | 0.099** | 0.078** | 0.095** | 0.068* |
| | (0.039) | (0.036) | (0.041) | (0.037) | (0.038) | (0.038) | (0.038) | (0.039) | (0.038) | (0.035) |
| Other race/ethnicity | 0.229*** | 0.153*** | 0.275*** | 0.199*** | 0.228*** | 0.240*** | 0.230*** | 0.275*** | 0.253*** | 0.178*** |
| | (0.050) | (0.046) | (0.052) | (0.049) | (0.050) | (0.057) | (0.054) | (0.050) | (0.056) | (0.051) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| First-born | -0.018 | -0.006 | -0.015 | -0.004 | -0.003 | -0.014 | -0.020 | -0.011 | -0.015 | 0.002 |
| | (0.021) | (0.020) | (0.020) | (0.021) | (0.020) | (0.020) | (0.021) | (0.021) | (0.020) | (0.020) |
| Grade 8 | 0.020 | 0.043 | 0.052 | 0.030 | 0.047 | 0.010 | 0.017 | 0.010 | 0.009 | 0.039 |
| | (0.040) | (0.036) | (0.040) | (0.040) | (0.040) | (0.038) | (0.039) | (0.038) | (0.037) | (0.034) |
| Grade 9 | 0.015 | 0.006 | 0.060 | 0.001 | 0.029 | 0.033 | 0.013 | 0.002 | 0.022 | 0.014 |
| | (0.068) | (0.050) | (0.068) | (0.064) | (0.064) | (0.071) | (0.061) | (0.065) | (0.064) | (0.051) |
| Grade 10 | -0.016 | -0.002 | 0.065 | -0.008 | 0.042 | 0.009 | -0.030 | -0.018 | -0.007 | 0.010 |
| | (0.071) | (0.058) | (0.072) | (0.067) | (0.067) | (0.073) | (0.066) | (0.071) | (0.069) | (0.056) |
| Grade 11 | -0.113 | -0.079 | 0.000 | -0.101 | -0.030 | -0.079 | -0.127 | -0.106 | -0.093 | -0.061 |
| | (0.083) | (0.069) | (0.085) | (0.077) | (0.079) | (0.083) | (0.077) | (0.083) | (0.078) | (0.068) |
| Grade 12 | -0.138 | -0.052 | 0.031 | -0.081 | 0.024 | -0.083 | -0.117 | -0.085 | -0.055 | 0.021 |
| | (0.106) | (0.091) | (0.108) | (0.100) | (0.101) | (0.106) | (0.102) | (0.103) | (0.102) | (0.089) |
| Mother's education | -0.020$^{***}$ | -0.012$^{**}$ | -0.011$^{*}$ | -0.013$^{**}$ | -0.008 | -0.019$^{***}$ | -0.017$^{***}$ | -0.017$^{***}$ | -0.016$^{***}$ | -0.008 |
| | (0.006) | (0.005) | (0.006) | (0.005) | (0.005) | (0.005) | (0.006) | (0.006) | (0.005) | (0.005) |
| Family income | -0.039$^{*}$ | -0.009 | -0.024 | -0.034$^{*}$ | -0.025 | -0.027 | -0.031 | -0.033 | -0.025 | -0.010 |
| | (0.021) | (0.019) | (0.019) | (0.020) | (0.018) | (0.021) | (0.019) | (0.022) | (0.021) | (0.019) |
| Rural | -0.035 | -0.028 | -0.038 | -0.045 | -0.045 | -0.025 | -0.026 | -0.033 | -0.022 | -0.029 |
| | (0.034) | (0.029) | (0.034) | (0.031) | (0.030) | (0.032) | (0.033) | (0.032) | (0.031) | (0.027) |
| Missing family information dummy | 0.055$^{**}$ | 0.022 | 0.038 | 0.028 | 0.020 | 0.037 | 0.037 | 0.031 | 0.021 | -0.003 |
| | (0.024) | (0.023) | (0.024) | (0.024) | (0.024) | (0.023) | (0.023) | (0.023) | (0.022) | (0.023) |
| Constant | -1.888$^{***}$ | -1.349$^{**}$ | -1.233$^{*}$ | -1.031 | -0.689 | -0.864 | -2.005$^{***}$ | -2.207$^{***}$ | -1.682$^{***}$ | -1.413$^{**}$ |
| | (0.668) | (0.631) | (0.709) | (0.743) | (0.756) | (0.609) | (0.612) | (0.666) | (0.636) | (0.631) |
| Observations | 6459 | 6443 | 6428 | 6405 | 6398 | 6451 | 6410 | 6413 | 6387 | 6341 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

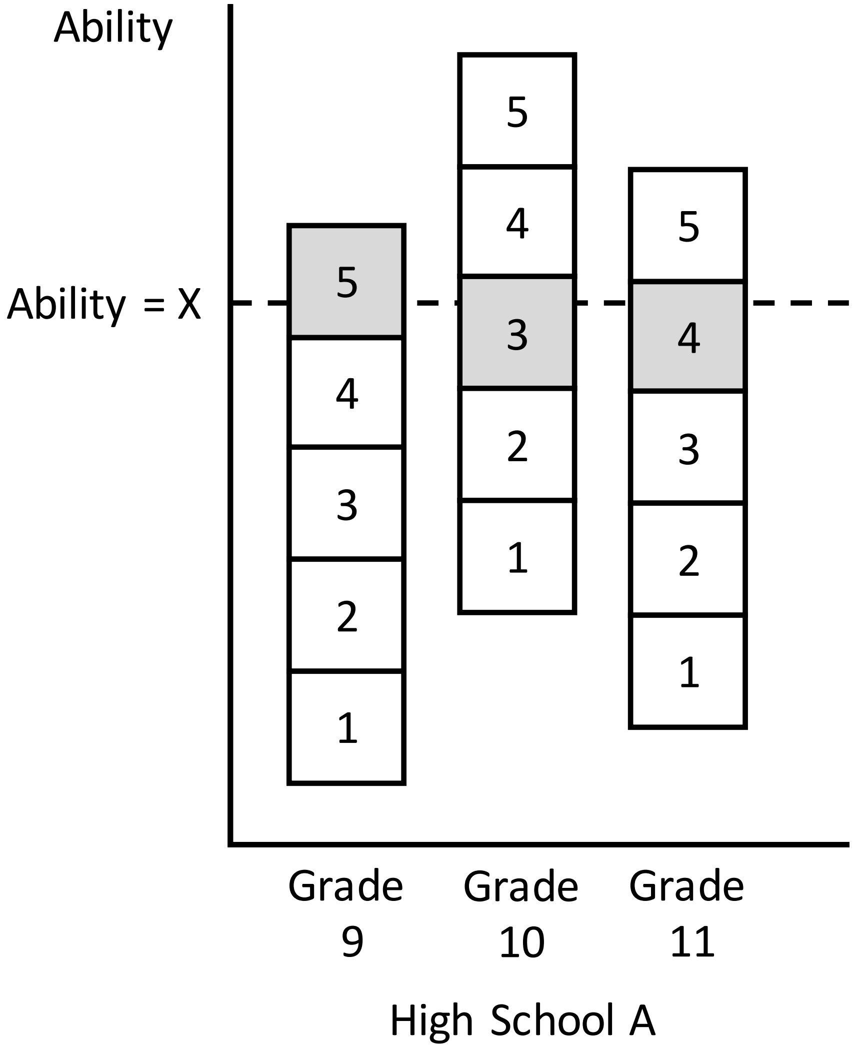
## 8. Figures

***Figure 1. Absolute versus relative ability***



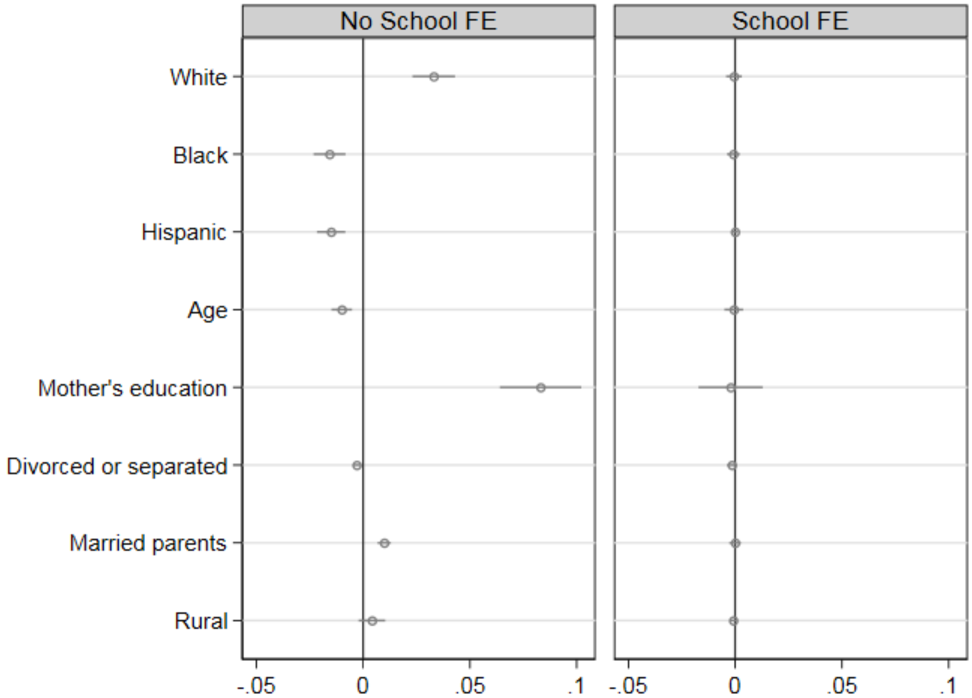

*Note*: The figure presents the variation in the local rank for each discrete level of PVT scores (i.e., global rank). The boxes (dark grey) represent the interquartile range with the median indicated by white line, and the whiskers (light grey) extend to the most extreme data point within 1.5 times the interquartile range from the edge of the box.

***Figure 2. Rank dependent on distribution of ability (mean)***



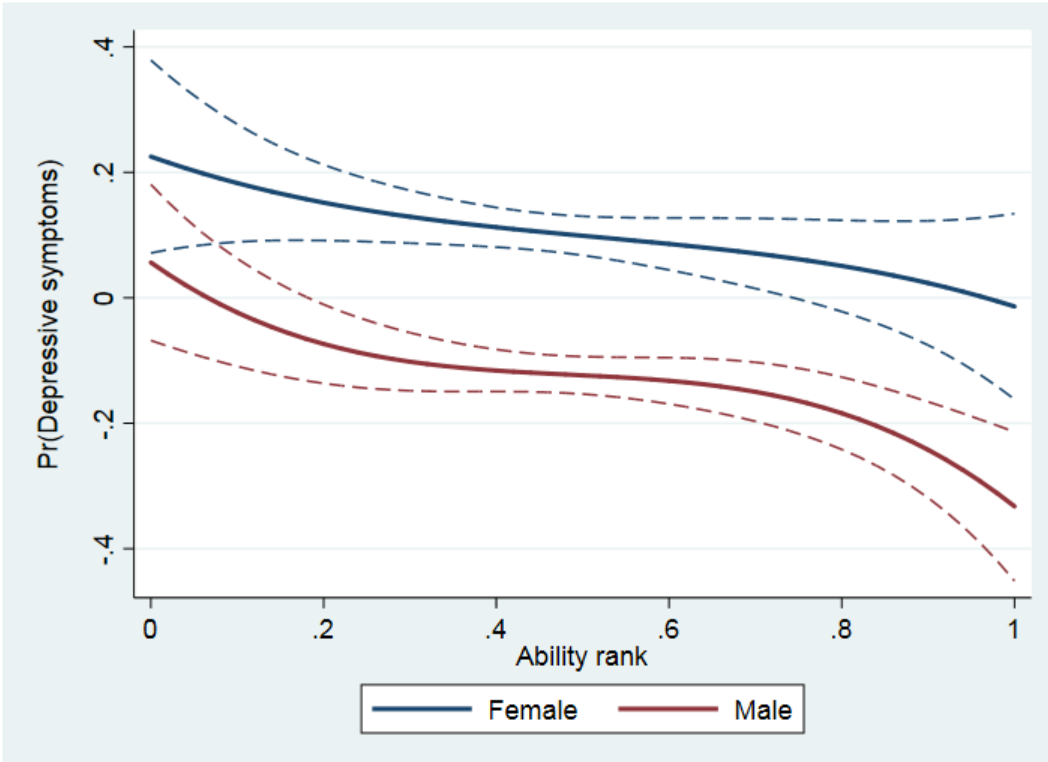

*Note*: This figure illustrates that students with the same ability can have different ranks depending on different school-cohort distributions of ability (mean). This is based on the illustration from Elsner and Isphording (2017).

***Figure 3. Balancing tests of grade-level mean ability***




*Note*: Each dot is the coefficient from a separate regression that includes a set of grade dummies. Robust standard errors are clustered at the school level. The spikes present 90% confidence intervals.

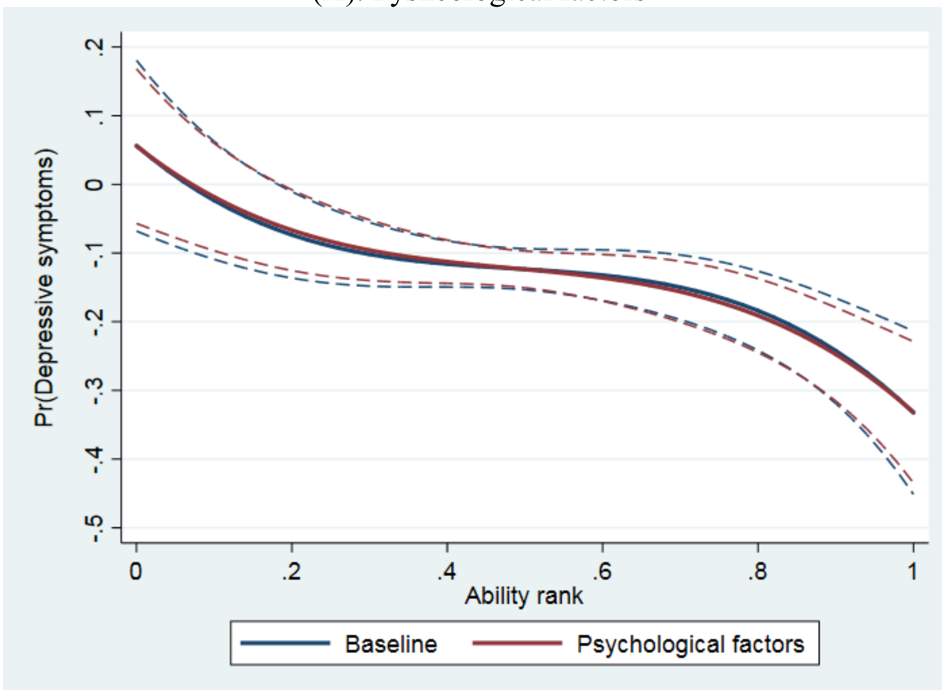
***Figure 4. Predicted probabilities of Wave 2 depressive symptoms, by gender***



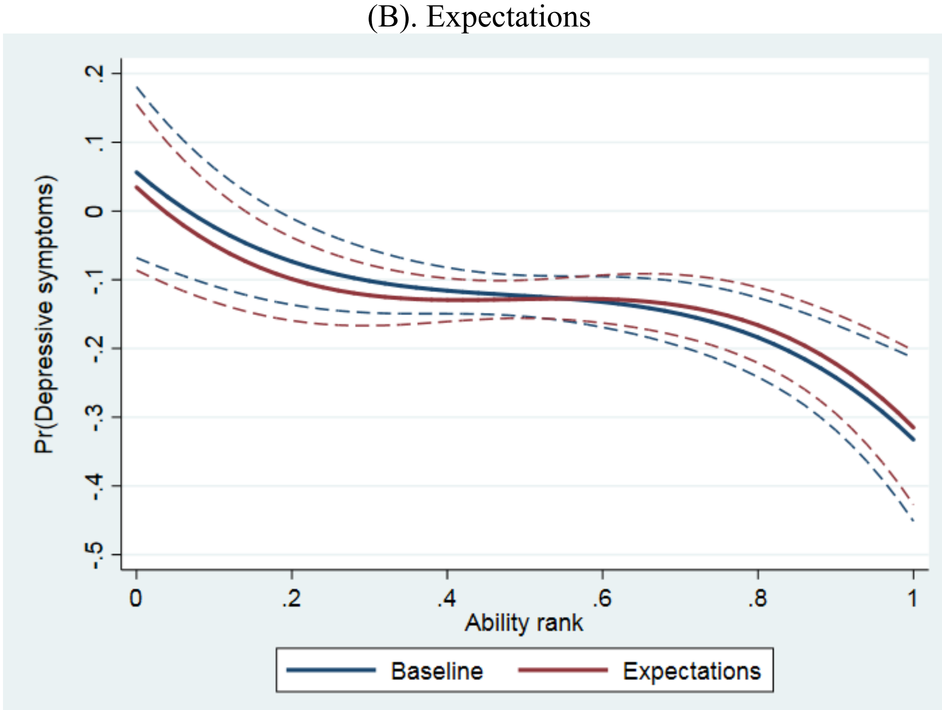

*Note*: Predicted probabilities are computed based on the results shown in Model 4 (Female) and Model 6 (Male) from Table 3.

***Figure 5. Mediation for the relationship between ability rank and Wave 2 depressive symptoms variables, Male***

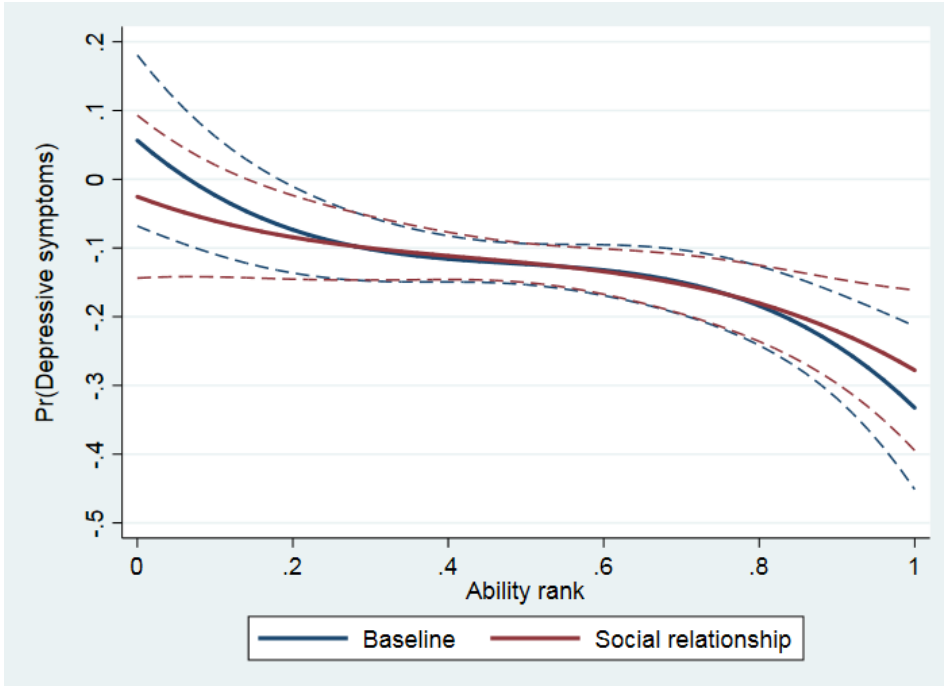
(A). Pyshcological factors




(B). Expectations




(C). Social relationship


Pr(Depressive symptoms)
.2
.1
0
-.1
-.2
-.3
-.4
-.5
0
.2
.4
.6
.8
1
Ability rank
Baseline
Social relationship

## 9. Appendix tables

***Table A1. Description of potential mechanism variables***

| Variable | Description | Range |
|---|---|---|
| ***1. Psychological factors*** | | |
| More intelligent than the average | "Compared with other people your age, how intelligent are you?" | 0 = moderately below average/slightly below average/about average; 1 = slightly above average/moderately above average/extremely above average |
| Self-esteem | Average of six items: (1) I have a lot of good qualities; (2) I have a lot to be proud of; (3) I like myself just the way I am; (4) I feel like I am doing everything just about right; (5) I feel socially accepted; and (6) I feel loved and wanted. | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| ***2. Future expectations*** | | |
| *2-1. Educational expectations* | | |
| I want to go to college | "On a scale of 1 to 5, where 1 is low and 5 is high, how much do you want to go to college?" | 1 – 5 |
| I will likely go to college | "On a scale of 1 to 5, where 1 is low and 5 is high, how likely is it that you will go to college?" | 1 – 5 |
| *2-2. Life chances expectations* | | |
| Expectations to live to 35 | "What do you think are the chances that you will live to age 35?" | 1 = almost no chance; 2 = some chance, but probably not; 3 = a 50-50 chance; 4 = a good chance; 5 = almost certain |
| Expectations killed by 21 | "What do you think are the chances that you will be killed by age 21?" | 1 = almost no chance; 2 = some chance, but probably not; 3 = a 50-50 chance; 4 = a good chance; 5 = almost certain |
| *2-3. Hopefulness about future* | | |

| | | |
|---|---|---|
| Hopeful about future | "How often was the following true during the last week? You felt hopeful about the future." | 0 = never or rarely; 1 = sometimes; 2 = a lot of the time; 3 = most of the time or all of the time |
| ***3. Social relationships*** | | |
| *3-1. School attachment* | | |
| Feel like part of school | "Do you feel like being part of school?" | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| Happy to be at school | "Are you happy to be at school?" | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| Feel close to people at school | "Do you feel close to people at school?" | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| *3-2. Relationship with friends* | | |
| Difficulty getting along with other students | "How often the respondent had trouble getting along with other students?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| Friends care about you | "How much the respondent agrees that friends care about her?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| Students are prejudiced | "How much the respondent feels that students at school are prejudiced?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| *3-3. Relationship with teachers* | | |
| Difficulty getting along with teachers | "How often the respondent had trouble getting along with teachers?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |
| Teachers care about you | "How much the respondent agrees that teachers care about them?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |

| | | |
|---|---|---|
| Teachers treat students fairly | "How much the respondent feels that teachers at school treat students fairly?" | 1 = never; 2 = just a few times; 3 = about once a week; 4 = almost every day; 5 = every day |

***Table A2. Balancing tests of grade-level ability distribution***

| | (1) Grade-level mean ability | (2) Grade-level mean ability | (3) Grade-level standard deviation ability | (4) Grade-level standard deviation ability |
|---|---|---|---|---|
| School fixed effects | No | Yes | No | Yes |
| White | 0.033*** | -0.001 | -0.051*** | 0.002* |
| | (0.006) | (0.002) | (0.008) | (0.001) |
| Black | -0.016*** | -0.001 | 0.006 | 0.000 |
| | (0.005) | (0.002) | (0.006) | (0.001) |
| Hispanic | -0.015*** | -0.000 | 0.038*** | -0.002** |
| | (0.004) | (0.001) | (0.009) | (0.001) |
| Age | -0.010*** | -0.001 | 0.004 | -0.001 |
| | (0.003) | (0.003) | (0.005) | (0.004) |
| Mother's education | 0.083*** | -0.002 | -0.101*** | -0.000 |
| | (0.012) | (0.009) | (0.025) | (0.007) |
| Divorced or separated | -0.003*** | -0.002 | 0.002 | -0.000 |
| | (0.001) | (0.001) | (0.002) | (0.002) |
| Married parents | 0.010*** | -0.000 | -0.008*** | 0.000 |
| | (0.002) | (0.002) | (0.003) | (0.002) |
| Rural | 0.004 | -0.001 | -0.025*** | 0.000 |
| | (0.004) | (0.001) | (0.004) | (0.001) |

*Note.* Each cell contains coefficients from separate regressions that include a set of grade dummies.
Robust standard errors are clustered at the school level.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

***Table A3. Nonlinear relationship between ability rank and Wave 2 depressive symptoms (decile), by gender***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) |
|---|---|---|---|
| Sample | All | Female | Male |
| Decile 1 | 0.146** | 0.147 | 0.134* |
| | (0.065) | (0.095) | (0.080) |
| Decile 2 | 0.065 | 0.091 | 0.032 |
| | (0.054) | (0.078) | (0.070) |
| Decile 3 | 0.054 | 0.086 | 0.020 |
| | (0.044) | (0.065) | (0.057) |
| Decile 4 | 0.049 | 0.035 | 0.061 |
| | (0.044) | (0.065) | (0.056) |
| Decile 5 | 0.055 | 0.075 | 0.021 |
| | (0.038) | (0.057) | (0.044) |
| Decile 6 (Ref.) | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) |
| Decile 7 | -0.003 | -0.015 | 0.003 |
| | (0.038) | (0.063) | (0.044) |
| Decile 8 | -0.016 | 0.020 | -0.058 |
| | (0.041) | (0.065) | (0.050) |
| Decile 9 | -0.044 | -0.024 | -0.058 |
| | (0.049) | (0.077) | (0.059) |
| Decile 10 | -0.130** | -0.083 | -0.165*** |
| | (0.051) | (0.084) | (0.062) |
| Female | 0.239*** | | |
| | (0.021) | | |
| Age | 0.096*** | 0.112*** | 0.094*** |
| | (0.013) | (0.020) | (0.017) |
| Black | 0.090** | 0.091* | 0.092* |
| | (0.038) | (0.047) | (0.050) |
| Hispanic | 0.057** | 0.039 | 0.071* |
| | (0.028) | (0.046) | (0.040) |
| Other race/ethnicity | 0.211*** | 0.174** | 0.226*** |
| | (0.045) | (0.071) | (0.050) |
| First-born | -0.019 | -0.009 | -0.024 |
| | (0.016) | (0.023) | (0.021) |
| Grade 8 | 0.049 | 0.071 | 0.019 |
| | (0.035) | (0.053) | (0.041) |
| Grade 9 | -0.021 | -0.059 | -0.010 |
| | (0.054) | (0.080) | (0.067) |
| Grade 10 | -0.083 | -0.164* | -0.041 |
| | (0.060) | (0.089) | (0.071) |
| Grade 11 | -0.196*** | -0.313*** | -0.135 |
| | (0.069) | (0.102) | (0.082) |
| Grade 12 | -0.338*** | -0.547*** | -0.171 |
| | (0.083) | (0.134) | (0.106) |
| Mother's education | -0.022*** | -0.023*** | -0.020*** |

| | | | |
|---|---|---|---|
| | (0.005) | (0.008) | (0.006) |
| Family income | -0.057*** | -0.077** | -0.037* |
| | (0.020) | (0.030) | (0.021) |
| Rural | -0.006 | 0.014 | -0.037 |
| | (0.027) | (0.037) | (0.033) |
| Missing family information dummy | 0.067*** | 0.064** | 0.061** |
| | (0.021) | (0.029) | (0.024) |
| Constant | -1.391*** | -1.376*** | -1.399*** |
| | (0.205) | (0.314) | (0.273) |
| Observations | 13263 | 6804 | 6459 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects. To control for absolute ability, 114 dummies reflecting each discrete level of ability scores are added.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A4. Ability rank and Wave 1 mechanism variables: Psychological factors, by gender*

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | More intelligent than the average | Self-esteem | More intelligent than the average | Self-esteem | More intelligent than the average | Self-esteem |
| Sample | All | All | Female | Female | Male | Male |
| Ability rank | -0.246* | 0.215 | -0.136 | -0.078 | -0.455** | 0.502 |
| | (0.145) | (0.312) | (0.171) | (0.448) | (0.223) | (0.451) |
| Ability rank square | 0.989*** | -0.076 | 0.827** | 0.779 | 1.330*** | -1.068 |
| | (0.315) | (0.683) | (0.360) | (0.957) | (0.492) | (0.975) |
| Ability rank cubic | -0.649*** | -0.069 | -0.592** | -0.653 | -0.797** | 0.657 |
| | (0.214) | (0.442) | (0.241) | (0.612) | (0.330) | (0.630) |
| PVT score | 0.021 | -0.045 | 0.030 | -0.035 | 0.014 | -0.071 |
| | (0.021) | (0.036) | (0.028) | (0.066) | (0.024) | (0.046) |
| PVT score square | -0.001 | 0.001 | -0.001 | 0.001 | -0.000 | 0.002 |
| | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | -0.000 | 0.000 | -0.000 | 0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | 0.000 | -0.000 | 0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | -0.001 | -0.318*** | | | | |
| | (0.009) | (0.020) | | | | |
| Age | -0.044*** | -0.066*** | -0.042*** | -0.073*** | -0.047*** | -0.065*** |
| | (0.006) | (0.011) | (0.008) | (0.017) | (0.009) | (0.015) |
| Black | 0.089*** | 0.176*** | 0.102*** | 0.187*** | 0.077*** | 0.158*** |
| | (0.014) | (0.038) | (0.016) | (0.054) | (0.022) | (0.033) |
| Hispanic | -0.021 | -0.064** | -0.032 | -0.109** | -0.010 | -0.023 |
| | (0.014) | (0.031) | (0.023) | (0.047) | (0.021) | (0.032) |
| Other race/ethnicity | 0.027 | -0.171*** | 0.021 | -0.112** | 0.034 | -0.229*** |
| | (0.020) | (0.037) | (0.024) | (0.053) | (0.027) | (0.042) |
| First-born | 0.016** | -0.008 | 0.017* | -0.041* | 0.015 | 0.026 |
| | (0.007) | (0.015) | (0.010) | (0.023) | (0.009) | (0.018) |
| Grade 8 | 0.064*** | -0.006 | 0.063*** | -0.031 | 0.067*** | 0.016 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.014) | (0.031) | (0.020) | (0.049) | (0.019) | (0.039) |
| Grade 9 | 0.101*** | -0.095* | 0.082** | -0.118* | 0.125*** | -0.081 |
| | (0.025) | (0.051) | (0.034) | (0.067) | (0.036) | (0.071) |
| Grade 10 | 0.185*** | -0.033 | 0.163*** | -0.053 | 0.211*** | -0.014 |
| | (0.028) | (0.055) | (0.040) | (0.076) | (0.041) | (0.076) |
| Grade 11 | 0.237*** | 0.081 | 0.211*** | 0.115 | 0.268*** | 0.045 |
| | (0.034) | (0.064) | (0.043) | (0.084) | (0.048) | (0.087) |
| Grade 12 | 0.305*** | 0.205*** | 0.263*** | 0.259*** | 0.354*** | 0.152 |
| | (0.039) | (0.071) | (0.049) | (0.099) | (0.057) | (0.100) |
| Mother's education | 0.018*** | 0.027*** | 0.020*** | 0.028*** | 0.017*** | 0.025*** |
| | (0.002) | (0.004) | (0.003) | (0.006) | (0.003) | (0.005) |
| Family income | 0.042*** | 0.041*** | 0.037*** | 0.030 | 0.049*** | 0.053*** |
| | (0.010) | (0.015) | (0.010) | (0.022) | (0.013) | (0.019) |
| Rural | -0.012 | 0.010 | -0.012 | 0.023 | -0.013 | 0.006 |
| | (0.012) | (0.019) | (0.016) | (0.039) | (0.016) | (0.026) |
| Missing family information dummy | -0.022*** | -0.065*** | -0.007 | -0.063*** | -0.037** | -0.066*** |
| | (0.008) | (0.017) | (0.010) | (0.023) | (0.014) | (0.023) |
| Constant | 0.532 | 1.212* | 0.296 | 1.131 | 0.721* | 1.275 |
| | (0.340) | (0.666) | (0.403) | (1.086) | (0.421) | (0.801) |
| Observations | 18607 | 18645 | 9430 | 9449 | 9177 | 9196 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A5. Ability rank and Wave 1 mechanism variables: Educational expectations, by gender***

| | (1) I want to go to college | (2) I will likely go to college | (3) I want to go to college | (4) I will likely go to college | (5) I want to go to college | (6) I will likely go to college |
|---|---|---|---|---|---|---|
| Sample | All | All | Female | Female | Male | Male |
| Ability rank | 0.148 | 0.344 | 0.539 | 0.625 | -0.082 | 0.123 |
| | (0.321) | (0.328) | (0.373) | (0.396) | (0.568) | (0.554) |
| Ability rank square | 0.091 | -0.100 | -0.621 | -0.878 | 0.618 | 0.710 |
| | (0.671) | (0.700) | (0.725) | (0.816) | (1.154) | (1.124) |
| Ability rank cubic | -0.084 | -0.039 | 0.356 | 0.467 | -0.420 | -0.577 |
| | (0.435) | (0.458) | (0.460) | (0.529) | (0.718) | (0.704) |
| PVT score | 0.051 | 0.077 | 0.028 | 0.058 | 0.076 | 0.097 |
| | (0.040) | (0.050) | (0.057) | (0.063) | (0.057) | (0.069) |
| PVT score square | -0.001$^{*}$ | -0.002$^{*}$ | -0.001 | -0.002 | -0.002$^{*}$ | -0.002 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000$^{**}$ | 0.000$^{**}$ | 0.000 | 0.000 | 0.000$^{**}$ | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000$^{**}$ | -0.000$^{**}$ | -0.000 | -0.000 | -0.000$^{**}$ | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.200$^{***}$ | 0.288$^{***}$ | | | | |
| | (0.018) | (0.020) | | | | |
| Age | -0.119$^{***}$ | -0.168$^{***}$ | -0.088$^{***}$ | -0.131$^{***}$ | -0.146$^{***}$ | -0.197$^{***}$ |
| | (0.014) | (0.018) | (0.019) | (0.023) | (0.019) | (0.023) |
| Black | 0.208$^{***}$ | 0.137$^{***}$ | 0.144$^{***}$ | 0.113$^{***}$ | 0.281$^{***}$ | 0.172$^{***}$ |
| | (0.029) | (0.031) | (0.035) | (0.036) | (0.041) | (0.046) |
| Hispanic | 0.079$^{**}$ | 0.019 | 0.059 | -0.009 | 0.101$^{**}$ | 0.043 |
| | (0.037) | (0.042) | (0.049) | (0.054) | (0.048) | (0.052) |
| Other race/ethnicity | 0.317$^{***}$ | 0.333$^{***}$ | 0.299$^{***}$ | 0.310$^{***}$ | 0.337$^{***}$ | 0.357$^{***}$ |
| | (0.044) | (0.039) | (0.052) | (0.052) | (0.048) | (0.046) |
| First-born | -0.007 | 0.003 | -0.026 | -0.026 | 0.013 | 0.035 |
| | (0.014) | (0.014) | (0.020) | (0.018) | (0.023) | (0.022) |
| Grade 8 | 0.085$^{***}$ | 0.142$^{***}$ | 0.063$^{*}$ | 0.128$^{***}$ | 0.109$^{**}$ | 0.160$^{***}$ |
| | (0.028) | (0.031) | (0.037) | (0.047) | (0.047) | (0.046) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Grade 9 | 0.127*** | 0.197*** | 0.107* | 0.199*** | 0.153** | 0.199*** |
| | (0.046) | (0.051) | (0.059) | (0.069) | (0.070) | (0.071) |
| Grade 10 | 0.226*** | 0.382*** | 0.166** | 0.320*** | 0.283*** | 0.437*** |
| | (0.057) | (0.066) | (0.071) | (0.088) | (0.077) | (0.084) |
| Grade 11 | 0.369*** | 0.600*** | 0.321*** | 0.528*** | 0.412*** | 0.657*** |
| | (0.069) | (0.084) | (0.088) | (0.101) | (0.093) | (0.106) |
| Grade 12 | 0.462*** | 0.954*** | 0.396*** | 0.821*** | 0.517*** | 1.075*** |
| | (0.082) | (0.097) | (0.103) | (0.125) | (0.113) | (0.125) |
| Mother's education | 0.044*** | 0.071*** | 0.040*** | 0.066*** | 0.048*** | 0.076*** |
| | (0.004) | (0.006) | (0.006) | (0.006) | (0.008) | (0.010) |
| Family income | 0.076*** | 0.106*** | 0.056*** | 0.096*** | 0.099*** | 0.121** |
| | (0.022) | (0.032) | (0.020) | (0.031) | (0.034) | (0.047) |
| Rural | -0.042* | -0.027 | -0.061** | -0.017 | -0.030 | -0.047 |
| | (0.025) | (0.022) | (0.028) | (0.027) | (0.032) | (0.033) |
| Missing family information dummy | -0.042*** | -0.055*** | -0.029 | -0.045* | -0.062** | -0.077*** |
| | (0.015) | (0.015) | (0.022) | (0.023) | (0.025) | (0.027) |
| Constant | 4.872*** | 4.140*** | 4.854*** | 4.189*** | 5.003*** | 4.343*** |
| | (0.701) | (0.879) | (0.991) | (1.135) | (0.945) | (1.078) |
| Observations | 18586 | 18570 | 9422 | 9415 | 9164 | 9155 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A6. Ability rank and Wave 1 mechanism variables: Life chances expectations and hopefulness about future, by gender*

| | (1) Expectations to live to 35 | (2) Expectations killed by 21 | (3) Hopeful about future | (4) Expectations to live to 35 | (5) Expectations killed by 21 | (6) Hopeful about future | (7) Expectations to live to 35 | (8) Expectations killed by 21 | (9) Hopeful about future |
|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | Female | Female | Female | Male | Male | Male |
| Ability rank | 0.160 | -0.034 | -0.022 | 0.451 | -0.397 | -0.095 | -0.166 | 0.326 | 0.064 |
| | (0.248) | (0.248) | (0.282) | (0.340) | (0.331) | (0.347) | (0.406) | (0.345) | (0.457) |
| Ability rank square | -0.214 | -0.097 | 0.736 | -0.860 | 0.596 | 1.299* | 0.534 | -0.787 | 0.060 |
| | (0.519) | (0.520) | (0.638) | (0.708) | (0.706) | (0.749) | (0.830) | (0.692) | (1.035) |
| Ability rank cubic | 0.076 | 0.135 | -0.485 | 0.478 | -0.371 | -0.968* | -0.397 | 0.612 | 0.084 |
| | (0.342) | (0.338) | (0.444) | (0.460) | (0.467) | (0.524) | (0.532) | (0.441) | (0.685) |
| PVT score | -0.117*** | -0.029 | -0.057** | -0.171*** | 0.060 | -0.051 | -0.080 | -0.078 | -0.058 |
| | (0.031) | (0.037) | (0.028) | (0.052) | (0.041) | (0.045) | (0.053) | (0.050) | (0.040) |
| PVT score square | 0.002*** | 0.001 | 0.001* | 0.003*** | -0.001 | 0.001 | 0.002 | 0.001 | 0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | -0.000*** | -0.000 | -0.000 | -0.000*** | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | 0.000** | 0.000 | 0.000 | 0.000** | -0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.065*** | 0.017 | 0.004 | | | | | | |
| | (0.013) | (0.013) | (0.019) | | | | | | |
| Age | -0.058*** | -0.002 | -0.032** | -0.054*** | -0.004 | -0.019 | -0.060*** | 0.000 | -0.045** |
| | (0.010) | (0.010) | (0.013) | (0.014) | (0.015) | (0.018) | (0.017) | (0.013) | (0.019) |
| Black | -0.167*** | 0.069*** | 0.085*** | -0.181*** | 0.057* | 0.118*** | -0.143*** | 0.081*** | 0.047 |
| | (0.020) | (0.022) | (0.027) | (0.027) | (0.033) | (0.035) | (0.028) | (0.029) | (0.039) |
| Hispanic | -0.136*** | 0.047** | -0.070** | -0.159*** | 0.053 | -0.051 | -0.105*** | 0.038 | -0.092** |
| | (0.030) | (0.022) | (0.031) | (0.043) | (0.033) | (0.042) | (0.035) | (0.030) | (0.040) |
| Other race/ethnicity | -0.059** | 0.046 | -0.040 | -0.057* | 0.078* | 0.021 | -0.056 | 0.014 | -0.094** |
| | (0.025) | (0.034) | (0.034) | (0.034) | (0.040) | (0.045) | (0.043) | (0.046) | (0.044) |
| First-born | 0.018 | -0.008 | 0.036*** | 0.007 | -0.002 | 0.007 | 0.033* | -0.014 | 0.070*** |
| | (0.012) | (0.011) | (0.013) | (0.016) | (0.015) | (0.022) | (0.018) | (0.017) | (0.021) |
| Grade 8 | 0.029 | 0.062** | 0.066** | 0.052 | 0.064 | 0.023 | -0.004 | 0.066* | 0.104** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (0.028) | (0.027) | (0.031) | (0.037) | (0.040) | (0.040) | (0.040) | (0.035) | (0.046) |
| Grade 9 | -0.008 | 0.149$^{***}$ | 0.069 | 0.030 | 0.169$^{***}$ | 0.160$^{**}$ | -0.057 | 0.146$^{***}$ | -0.033 |
| | (0.033) | (0.037) | (0.050) | (0.049) | (0.057) | (0.074) | (0.055) | (0.055) | (0.064) |
| Grade 10 | 0.021 | 0.181$^{***}$ | 0.135$^{**}$ | 0.058 | 0.194$^{***}$ | 0.171$^{**}$ | -0.021 | 0.175$^{***}$ | 0.088 |
| | (0.041) | (0.043) | (0.056) | (0.057) | (0.069) | (0.078) | (0.064) | (0.064) | (0.077) |
| Grade 11 | 0.079$^{*}$ | 0.199$^{***}$ | 0.220$^{***}$ | 0.158$^{**}$ | 0.169$^{**}$ | 0.300$^{***}$ | -0.008 | 0.236$^{***}$ | 0.125 |
| | (0.046) | (0.048) | (0.066) | (0.070) | (0.076) | (0.088) | (0.072) | (0.070) | (0.099) |
| Grade 12 | 0.151$^{***}$ | 0.176$^{***}$ | 0.350$^{***}$ | 0.203$^{**}$ | 0.156$^{*}$ | 0.391$^{***}$ | 0.089 | 0.204$^{**}$ | 0.293$^{***}$ |
| | (0.052) | (0.054) | (0.075) | (0.081) | (0.085) | (0.100) | (0.085) | (0.080) | (0.109) |
| Mother's education | 0.017$^{***}$ | -0.007$^{**}$ | 0.023$^{***}$ | 0.012$^{***}$ | -0.005 | 0.029$^{***}$ | 0.022$^{***}$ | -0.008$^{**}$ | 0.016$^{***}$ |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.004) | (0.006) | (0.004) | (0.004) | (0.005) |
| Family income | 0.033$^{**}$ | -0.012 | 0.016 | 0.047$^{***}$ | -0.001 | 0.007 | 0.019 | -0.027 | 0.020 |
| | (0.015) | (0.013) | (0.017) | (0.018) | (0.022) | (0.021) | (0.022) | (0.017) | (0.030) |
| Rural | -0.054$^{***}$ | 0.022 | 0.012 | -0.066$^{***}$ | 0.024 | 0.032 | -0.038 | 0.024 | -0.005 |
| | (0.019) | (0.020) | (0.025) | (0.023) | (0.026) | (0.032) | (0.028) | (0.027) | (0.035) |
| Missing family information dummy | -0.050$^{***}$ | 0.014 | -0.020 | -0.011 | -0.007 | -0.008 | -0.092$^{***}$ | 0.042$^{**}$ | -0.032 |
| | (0.012) | (0.012) | (0.015) | (0.017) | (0.020) | (0.019) | (0.019) | (0.018) | (0.023) |
| Constant | 6.328$^{***}$ | 1.923$^{***}$ | 2.280$^{***}$ | 7.289$^{***}$ | 0.333 | 1.758$^{**}$ | 5.779$^{***}$ | 2.836$^{***}$ | 2.715$^{***}$ |
| | (0.501) | (0.675) | (0.491) | (0.875) | (0.605) | (0.713) | (0.860) | (0.851) | (0.694) |
| Observations | 18571 | 18535 | 18614 | 9412 | 9393 | 9431 | 9159 | 9142 | 9183 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A7. Ability rank and Wave 1 mechanism variables: School attachment, by gender***

| | (1) Feel part of school | (2) Happy to be at school | (3) Feel close to people at school | (4) Feel part of school | (5) Happy to be at school | (6) Feel close to people at school | (7) Feel part of school | (8) Happy to be at school | (9) Feel close to people at school |
|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | Female | Female | Female | Male | Male | Male |
| Ability rank | -0.051 | 0.448 | -0.251 | -0.270 | 0.086 | -0.487 | 0.193 | 0.812 | -0.038 |
| | (0.323) | (0.360) | (0.273) | (0.399) | (0.434) | (0.371) | (0.457) | (0.500) | (0.429) |
| Ability rank square | 0.164 | -0.370 | 0.658 | 0.409 | 0.497 | 0.735 | -0.243 | -1.287 | 0.516 |
| | (0.685) | (0.814) | (0.616) | (0.866) | (0.928) | (0.821) | (0.961) | (1.152) | (0.995) |
| Ability rank cubic | -0.070 | 0.159 | -0.494 | -0.107 | -0.381 | -0.402 | 0.120 | 0.736 | -0.513 |
| | (0.460) | (0.554) | (0.436) | (0.585) | (0.637) | (0.564) | (0.629) | (0.761) | (0.691) |
| PVT score | 0.059 | 0.095** | 0.084** | 0.114* | 0.091 | 0.107** | 0.033 | 0.098* | 0.070 |
| | (0.043) | (0.037) | (0.038) | (0.061) | (0.060) | (0.050) | (0.047) | (0.056) | (0.054) |
| PVT score square | -0.001 | -0.002** | -0.002** | -0.002* | -0.002 | -0.002** | -0.001 | -0.002 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000** | 0.000** | 0.000* | 0.000 | 0.000** | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000* | -0.000** | -0.000* | -0.000 | -0.000** | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.008 | -0.079*** | -0.050*** | | | | | | |
| | (0.017) | (0.022) | (0.017) | | | | | | |
| Age | -0.080*** | -0.075*** | -0.034*** | -0.087*** | -0.092*** | -0.042** | -0.078*** | -0.068*** | -0.033** |
| | (0.011) | (0.013) | (0.012) | (0.017) | (0.019) | (0.017) | (0.015) | (0.017) | (0.016) |
| Black | -0.002 | -0.108*** | -0.099*** | -0.119*** | -0.195*** | -0.275*** | 0.125*** | -0.006 | 0.097** |
| | (0.032) | (0.036) | (0.029) | (0.042) | (0.046) | (0.038) | (0.043) | (0.049) | (0.042) |
| Hispanic | 0.002 | 0.038 | 0.039 | -0.027 | 0.022 | 0.006 | 0.032 | 0.059 | 0.074* |
| | (0.031) | (0.035) | (0.029) | (0.040) | (0.041) | (0.038) | (0.044) | (0.045) | (0.041) |
| Other race/ethnicity | 0.034 | 0.079* | 0.139** | 0.036 | 0.092 | 0.093 | 0.038 | 0.084 | 0.201** |
| | (0.062) | (0.047) | (0.065) | (0.074) | (0.057) | (0.063) | (0.064) | (0.060) | (0.080) |
| First-born | 0.007 | 0.011 | -0.014 | -0.005 | -0.007 | -0.007 | 0.022 | 0.031 | -0.015 |
| | (0.015) | (0.017) | (0.013) | (0.019) | (0.020) | (0.020) | (0.023) | (0.025) | (0.020) |
| Grade 8 | -0.012 | -0.078** | -0.004 | 0.010 | -0.059 | -0.005 | -0.028 | -0.086* | 0.012 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (0.030) | (0.036) | (0.028) | (0.042) | (0.053) | (0.043) | (0.043) | (0.049) | (0.039) |
| Grade 9 | 0.029 | -0.067 | 0.022 | 0.028 | -0.115 | -0.018 | 0.037 | 0.003 | 0.068 |
| | (0.051) | (0.060) | (0.051) | (0.074) | (0.079) | (0.074) | (0.053) | (0.068) | (0.059) |
| Grade 10 | 0.066 | -0.059 | 0.013 | 0.036 | -0.099 | -0.098 | 0.099 | 0.005 | 0.129* |
| | (0.060) | (0.065) | (0.061) | (0.084) | (0.087) | (0.087) | (0.067) | (0.078) | (0.072) |
| Grade 11 | 0.098 | -0.005 | -0.021 | 0.077 | -0.024 | -0.128 | 0.126* | 0.049 | 0.104 |
| | (0.065) | (0.072) | (0.071) | (0.093) | (0.103) | (0.103) | (0.076) | (0.086) | (0.081) |
| Grade 12 | 0.198** | 0.084 | 0.052 | 0.173 | 0.087 | -0.056 | 0.232** | 0.124 | 0.183* |
| | (0.076) | (0.083) | (0.080) | (0.107) | (0.114) | (0.115) | (0.090) | (0.101) | (0.096) |
| Mother's education | 0.015*** | 0.002 | 0.007 | 0.018*** | 0.001 | 0.009* | 0.011* | 0.001 | 0.002 |
| | (0.004) | (0.004) | (0.004) | (0.005) | (0.006) | (0.005) | (0.006) | (0.006) | (0.006) |
| Family income | 0.056*** | 0.043** | 0.041*** | 0.045* | 0.027 | 0.026 | 0.066** | 0.052* | 0.058*** |
| | (0.020) | (0.020) | (0.016) | (0.024) | (0.024) | (0.025) | (0.028) | (0.027) | (0.020) |
| Rural | -0.021 | -0.007 | -0.003 | -0.038 | -0.015 | -0.013 | 0.007 | 0.013 | 0.009 |
| | (0.020) | (0.026) | (0.022) | (0.034) | (0.036) | (0.029) | (0.028) | (0.033) | (0.031) |
| Missing family information dummy | -0.067*** | -0.057*** | -0.054*** | -0.048* | -0.073*** | -0.055** | -0.087*** | -0.034 | -0.051** |
| | (0.017) | (0.019) | (0.017) | (0.027) | (0.028) | (0.025) | (0.024) | (0.028) | (0.024) |
| Constant | 4.182*** | 3.945*** | 3.159*** | 3.256*** | 4.360*** | 3.032*** | 4.665*** | 3.607*** | 3.164*** |
| | (0.686) | (0.619) | (0.646) | (1.054) | (1.034) | (0.767) | (0.648) | (0.848) | (0.937) |
| Observations | 18644 | 18648 | 18644 | 9451 | 9451 | 9453 | 9193 | 9197 | 9191 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A8. Ability rank and Wave 1 mechanism variables: Relationship with friends, by gender***

| | (1) Difficulty getting along with other students | (2) Friends care about you | (3) Students are prejudiced | (4) Difficulty getting along with other students | (5) Friends care about you | (6) Students are prejudiced | (7) Difficulty getting along with other students | (8) Friends care about you | (9) Students are prejudiced |
|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | Female | Female | Female | Male | Male | Male |
| Ability rank | -0.359 | -0.049 | -0.544 | 0.276 | -0.346 | 0.003 | -0.983** | 0.240 | -1.173** |
| | (0.310) | (0.218) | (0.329) | (0.426) | (0.307) | (0.418) | (0.454) | (0.326) | (0.473) |
| Ability rank square | 0.584 | -0.110 | 1.141* | -0.778 | 0.642 | -0.244 | 1.949** | -0.832 | 2.788*** |
| | (0.624) | (0.475) | (0.689) | (0.917) | (0.668) | (0.904) | (0.917) | (0.723) | (0.980) |
| Ability rank cubic | -0.364 | 0.139 | -0.712 | 0.494 | -0.385 | 0.172 | -1.221** | 0.642 | -1.745*** |
| | (0.395) | (0.324) | (0.456) | (0.579) | (0.463) | (0.610) | (0.588) | (0.487) | (0.635) |
| PVT score | 0.012 | 0.042 | 0.029 | 0.080 | 0.031 | 0.022 | -0.036 | 0.047 | 0.015 |
| | (0.038) | (0.046) | (0.050) | (0.062) | (0.048) | (0.071) | (0.041) | (0.061) | (0.056) |
| PVT score square | 0.000 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | 0.001 | -0.001 | -0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | -0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | 0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | 0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | -0.062*** | 0.239*** | 0.032 | | | | | | |
| | (0.018) | (0.013) | (0.024) | | | | | | |
| Age | 0.032*** | -0.031*** | -0.025* | 0.052*** | -0.042*** | -0.005 | 0.020 | -0.022* | -0.037* |
| | (0.012) | (0.009) | (0.014) | (0.017) | (0.015) | (0.020) | (0.017) | (0.013) | (0.020) |
| Black | 0.024 | -0.152*** | -0.427*** | 0.154*** | -0.229*** | -0.407*** | -0.126*** | -0.067** | -0.441*** |
| | (0.032) | (0.023) | (0.038) | (0.042) | (0.034) | (0.047) | (0.041) | (0.027) | (0.048) |
| Hispanic | -0.110*** | -0.055*** | -0.136*** | -0.065 | -0.086*** | -0.113** | -0.161*** | -0.022 | -0.155** |
| | (0.030) | (0.019) | (0.041) | (0.045) | (0.028) | (0.045) | (0.037) | (0.028) | (0.061) |
| Other race/ethnicity | -0.063* | -0.073* | -0.239*** | -0.041 | -0.088* | -0.257*** | -0.090** | -0.052 | -0.213** |
| | (0.037) | (0.038) | (0.070) | (0.053) | (0.051) | (0.069) | (0.040) | (0.038) | (0.086) |
| First-born | 0.025* | -0.027*** | -0.032* | 0.038* | -0.034** | 0.003 | 0.012 | -0.018 | -0.070*** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (0.015) | (0.010) | (0.016) | (0.020) | (0.015) | (0.023) | (0.022) | (0.014) | (0.026) |
| Grade 8 | -0.039 | 0.029 | 0.163*** | -0.040 | 0.026 | 0.111* | -0.046 | 0.032 | 0.211*** |
| | (0.033) | (0.025) | (0.039) | (0.046) | (0.033) | (0.060) | (0.048) | (0.038) | (0.051) |
| Grade 9 | -0.108** | 0.093** | 0.264*** | -0.092 | 0.130** | 0.216*** | -0.136** | 0.054 | 0.304*** |
| | (0.052) | (0.040) | (0.057) | (0.067) | (0.052) | (0.079) | (0.061) | (0.055) | (0.072) |
| Grade 10 | -0.196*** | 0.134*** | 0.480*** | -0.204** | 0.186*** | 0.394*** | -0.205*** | 0.082 | 0.550*** |
| | (0.058) | (0.042) | (0.070) | (0.080) | (0.061) | (0.092) | (0.070) | (0.058) | (0.084) |
| Grade 11 | -0.244*** | 0.183*** | 0.529*** | -0.301*** | 0.229*** | 0.414*** | -0.220** | 0.139* | 0.619*** |
| | (0.065) | (0.049) | (0.081) | (0.089) | (0.070) | (0.107) | (0.084) | (0.071) | (0.101) |
| Grade 12 | -0.344*** | 0.259*** | 0.584*** | -0.400*** | 0.257*** | 0.434*** | -0.324*** | 0.270*** | 0.709*** |
| | (0.071) | (0.053) | (0.090) | (0.102) | (0.086) | (0.119) | (0.092) | (0.076) | (0.115) |
| Mother's education | -0.008 | 0.016*** | -0.001 | -0.012* | 0.016*** | -0.003 | -0.002 | 0.016*** | 0.001 |
| | (0.005) | (0.003) | (0.005) | (0.006) | (0.004) | (0.007) | (0.005) | (0.004) | (0.006) |
| Family income | -0.025 | 0.032*** | 0.007 | -0.027 | 0.010 | -0.008 | -0.016 | 0.055*** | 0.028 |
| | (0.018) | (0.012) | (0.019) | (0.019) | (0.018) | (0.030) | (0.026) | (0.014) | (0.037) |
| Rural | 0.011 | 0.006 | 0.033 | 0.042 | -0.010 | 0.055* | -0.022 | 0.013 | 0.020 |
| | (0.020) | (0.018) | (0.020) | (0.027) | (0.025) | (0.029) | (0.032) | (0.024) | (0.032) |
| Missing family information dummy | 0.023 | -0.028** | 0.009 | 0.012 | -0.026 | -0.027 | 0.034 | -0.029 | 0.044* |
| | (0.017) | (0.012) | (0.021) | (0.019) | (0.018) | (0.025) | (0.024) | (0.018) | (0.026) |
| Constant | 1.352** | 3.234*** | 3.043*** | -0.117 | 3.897*** | 3.070*** | 2.275*** | 2.985*** | 3.244*** |
| | (0.616) | (0.742) | (0.866) | (1.010) | (0.806) | (1.149) | (0.735) | (1.078) | (0.967) |
| Observations | 18651 | 18545 | 18603 | 9454 | 9394 | 9428 | 9197 | 9151 | 9175 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A9. Ability rank and Wave 1 mechanism variables: Relationship with teachers, by gender***

| | (1) Difficulty getting along with teachers | (2) Teachers care about you | (3) Teachers treat students fairly | (4) Difficulty getting along with teachers | (5) Teachers care about you | (6) Teachers treat students fairly | (7) Difficulty getting along with teachers | (8) Teachers care about you | (9) Teachers treat students fairly |
|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | Female | Female | Female | Male | Male | Male |
| Ability rank | -0.588** | 0.021 | 0.146 | -0.033 | -0.179 | -0.429 | -1.105*** | 0.167 | 0.721* |
| | (0.277) | (0.275) | (0.292) | (0.400) | (0.363) | (0.400) | (0.368) | (0.419) | (0.402) |
| Ability rank square | 1.366** | 0.065 | -0.157 | 0.494 | 0.242 | 1.254 | 2.068*** | 0.006 | -1.561* |
| | (0.555) | (0.601) | (0.657) | (0.843) | (0.798) | (0.828) | (0.779) | (0.844) | (0.939) |
| Ability rank cubic | -0.938** | 0.085 | 0.165 | -0.447 | 0.111 | -0.708 | -1.265** | -0.034 | 1.013 |
| | (0.362) | (0.409) | (0.452) | (0.556) | (0.546) | (0.557) | (0.522) | (0.554) | (0.641) |
| PVT score | -0.090** | 0.126** | 0.126*** | -0.040 | 0.081 | 0.077 | -0.136** | 0.164** | 0.164*** |
| | (0.037) | (0.052) | (0.039) | (0.045) | (0.057) | (0.056) | (0.053) | (0.075) | (0.058) |
| PVT score square | 0.002*** | -0.003** | -0.002*** | 0.001 | -0.002 | -0.001 | 0.003*** | -0.003** | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | -0.000*** | 0.000** | 0.000** | -0.000 | 0.000 | 0.000 | -0.000*** | 0.000** | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | 0.000*** | -0.000** | -0.000* | 0.000* | -0.000 | -0.000 | 0.000** | -0.000** | -0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | -0.213*** | 0.072*** | -0.081*** | | | | | | |
| | (0.013) | (0.015) | (0.019) | | | | | | |
| Age | 0.015 | 0.013 | -0.012 | 0.017 | 0.016 | -0.013 | 0.015 | 0.009 | -0.013 |
| | (0.012) | (0.012) | (0.012) | (0.017) | (0.016) | (0.019) | (0.017) | (0.020) | (0.017) |
| Black | 0.063** | 0.017 | -0.108*** | 0.167*** | -0.045 | -0.135*** | -0.055 | 0.094** | -0.079** |
| | (0.026) | (0.029) | (0.026) | (0.032) | (0.038) | (0.039) | (0.039) | (0.038) | (0.038) |
| Hispanic | -0.012 | -0.019 | 0.024 | 0.032 | -0.041 | 0.000 | -0.063 | 0.011 | 0.060 |
| | (0.033) | (0.032) | (0.028) | (0.042) | (0.041) | (0.046) | (0.041) | (0.044) | (0.039) |
| Other race/ethnicity | -0.146*** | 0.107*** | 0.130*** | -0.116** | 0.097 | 0.089 | -0.184*** | 0.124*** | 0.173*** |
| | (0.033) | (0.040) | (0.040) | (0.048) | (0.059) | (0.059) | (0.038) | (0.040) | (0.046) |
| First-born | -0.013 | 0.003 | 0.025 | -0.014 | -0.008 | 0.038* | -0.013 | 0.019 | 0.014 |
| | (0.015) | (0.015) | (0.017) | (0.020) | (0.019) | (0.022) | (0.022) | (0.021) | (0.020) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Grade 8 | 0.024 | -0.146*** | -0.102** | 0.036 | -0.177*** | -0.134** | -0.001 | -0.108** | -0.063 |
| | (0.040) | (0.036) | (0.042) | (0.049) | (0.048) | (0.058) | (0.052) | (0.048) | (0.052) |
| Grade 9 | -0.038 | -0.253*** | -0.202*** | 0.028 | -0.250*** | -0.214** | -0.109 | -0.255*** | -0.176** |
| | (0.056) | (0.050) | (0.070) | (0.074) | (0.064) | (0.104) | (0.072) | (0.075) | (0.076) |
| Grade 10 | -0.142** | -0.237*** | -0.230*** | -0.105 | -0.249*** | -0.231** | -0.184** | -0.222*** | -0.215*** |
| | (0.061) | (0.057) | (0.074) | (0.080) | (0.079) | (0.112) | (0.079) | (0.084) | (0.079) |
| Grade 11 | -0.219*** | -0.175*** | -0.226*** | -0.190** | -0.168* | -0.197 | -0.258*** | -0.176* | -0.241*** |
| | (0.064) | (0.066) | (0.081) | (0.086) | (0.087) | (0.125) | (0.082) | (0.103) | (0.090) |
| Grade 12 | -0.350*** | -0.050 | -0.168* | -0.290*** | -0.082 | -0.161 | -0.421*** | -0.009 | -0.161 |
| | (0.075) | (0.084) | (0.090) | (0.098) | (0.103) | (0.138) | (0.101) | (0.123) | (0.098) |
| Mother's education | -0.008** | 0.012*** | -0.002 | -0.005 | 0.010* | -0.003 | -0.011* | 0.013*** | -0.000 |
| | (0.004) | (0.003) | (0.004) | (0.005) | (0.005) | (0.006) | (0.006) | (0.004) | (0.005) |
| Family income | -0.024 | 0.024 | 0.031* | -0.043** | 0.041* | 0.022 | -0.001 | 0.012 | 0.037 |
| | (0.023) | (0.016) | (0.016) | (0.020) | (0.021) | (0.021) | (0.030) | (0.022) | (0.024) |
| Rural | 0.008 | -0.005 | -0.029 | 0.020 | -0.015 | -0.034 | -0.001 | 0.004 | -0.020 |
| | (0.021) | (0.021) | (0.033) | (0.030) | (0.026) | (0.043) | (0.034) | (0.031) | (0.038) |
| Missing family information dummy | 0.035** | -0.029 | -0.076*** | 0.010 | 0.003 | -0.054** | 0.054** | -0.063** | -0.095*** |
| | (0.014) | (0.019) | (0.017) | (0.021) | (0.027) | (0.025) | (0.021) | (0.024) | (0.024) |
| Constant | 3.083*** | 1.645* | 2.082*** | 1.854** | 2.577** | 2.682*** | 3.934*** | 0.958 | 1.613 |
| | (0.711) | (0.928) | (0.662) | (0.773) | (1.051) | (0.920) | (0.969) | (1.344) | (0.984) |
| Observations | 18653 | 18521 | 18648 | 9455 | 9374 | 9453 | 9198 | 9147 | 9195 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A10. Ability rank and Wave 1 mechanism variables: Expectations (composite measures), by gender***

| | (1) Mortality expectations | (2) Future expectations | (3) Mortality expectations | (4) Future expectations | (5) Mortality expectations | (6) Future expectations |
|---|---|---|---|---|---|---|
| Sample | All | All | Female | Female | Male | Male |
| Ability rank | 0.101 | 0.145 | 0.466 | 0.387$^{*}$ | -0.286 | -0.056 |
| | (0.252) | (0.187) | (0.321) | (0.218) | (0.383) | (0.330) |
| Ability rank square | -0.048 | 0.084 | -0.809 | -0.348 | 0.780 | 0.478 |
| | (0.531) | (0.407) | (0.677) | (0.448) | (0.784) | (0.698) |
| Ability rank cubic | -0.046 | -0.107 | 0.477 | 0.152 | -0.599 | -0.338 |
| | (0.346) | (0.271) | (0.443) | (0.297) | (0.503) | (0.447) |
| PVT score | -0.056$^{*}$ | -0.007 | -0.148$^{***}$ | -0.046 | -0.000 | 0.021 |
| | (0.030) | (0.021) | (0.045) | (0.030) | (0.041) | (0.029) |
| PVT score square | 0.001$^{*}$ | 0.000 | 0.003$^{***}$ | 0.001 | 0.000 | -0.001 |
| | (0.001) | (0.000) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | -0.000$^{*}$ | 0.000 | -0.000$^{***}$ | -0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | 0.000 | -0.000 | 0.000$^{**}$ | 0.000 | 0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.026$^{**}$ | 0.099$^{***}$ | | | | |
| | (0.013) | (0.011) | | | | |
| Age | -0.032$^{***}$ | -0.071$^{***}$ | -0.028$^{**}$ | -0.054$^{***}$ | -0.035$^{**}$ | -0.085$^{***}$ |
| | (0.010) | (0.009) | (0.014) | (0.011) | (0.014) | (0.012) |
| Black | -0.139$^{***}$ | 0.026 | -0.139$^{***}$ | 0.015 | -0.134$^{***}$ | 0.041$^{*}$ |
| | (0.019) | (0.016) | (0.029) | (0.021) | (0.027) | (0.024) |
| Hispanic | -0.105$^{***}$ | -0.038$^{*}$ | -0.122$^{***}$ | -0.051$^{*}$ | -0.082$^{**}$ | -0.023 |
| | (0.024) | (0.021) | (0.034) | (0.029) | (0.033) | (0.025) |
| Other race/ethnicity | -0.061$^{*}$ | 0.087$^{***}$ | -0.080$^{**}$ | 0.081$^{***}$ | -0.038 | 0.096$^{***}$ |
| | (0.031) | (0.018) | (0.036) | (0.023) | (0.047) | (0.027) |
| First-born | 0.015 | 0.013 | 0.004 | -0.006 | 0.028 | 0.035$^{***}$ |
| | (0.011) | (0.008) | (0.014) | (0.012) | (0.017) | (0.013) |
| Grade 8 | -0.022 | 0.045$^{***}$ | -0.010 | 0.033 | -0.043 | 0.053$^{**}$ |
| | (0.026) | (0.017) | (0.038) | (0.024) | (0.036) | (0.024) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Grade 9 | -0.096*** | 0.032 | -0.087 | 0.051 | -0.123** | 0.007 |
| | (0.034) | (0.026) | (0.053) | (0.036) | (0.055) | (0.037) |
| Grade 10 | -0.098** | 0.095*** | -0.086 | 0.084* | -0.117* | 0.100** |
| | (0.039) | (0.033) | (0.062) | (0.044) | (0.062) | (0.043) |
| Grade 11 | -0.077* | 0.187*** | -0.016 | 0.204*** | -0.146** | 0.161*** |
| | (0.046) | (0.041) | (0.073) | (0.050) | (0.071) | (0.055) |
| Grade 12 | -0.020 | 0.315*** | 0.019 | 0.303*** | -0.070 | 0.317*** |
| | (0.051) | (0.046) | (0.082) | (0.061) | (0.082) | (0.063) |
| Mother's education | 0.014*** | 0.031*** | 0.010*** | 0.029*** | 0.018*** | 0.033*** |
| | (0.003) | (0.003) | (0.004) | (0.003) | (0.004) | (0.004) |
| Family income | 0.026* | 0.047*** | 0.028 | 0.040*** | 0.028 | 0.056*** |
| | (0.015) | (0.013) | (0.021) | (0.015) | (0.020) | (0.019) |
| Rural | -0.044** | -0.026** | -0.053** | -0.026* | -0.035 | -0.030 |
| | (0.017) | (0.012) | (0.023) | (0.015) | (0.025) | (0.018) |
| Missing family information dummy | -0.038*** | -0.037*** | -0.002 | -0.016 | -0.078*** | -0.064*** |
| | (0.013) | (0.008) | (0.019) | (0.011) | (0.019) | (0.014) |
| Constant | 1.066** | 0.517 | 2.650*** | 0.944* | 0.134 | 0.367 |
| | (0.494) | (0.357) | (0.723) | (0.541) | (0.657) | (0.469) |
| Observations | 18580 | 18645 | 9418 | 9449 | 9162 | 9196 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A11. Ability rank and Wave 1 mechanism variables: Social relationships (composite measures), by gender***

| | (1) School attachment | (2) Relation-ship with friends | (3) Relation-ship with teachers | (4) School attachment | (5) Relation-ship with friends | (6) Relation-ship with teachers | (7) School attachment | (8) Relation-ship with friends | (9) Relation-ship with teachers |
|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | Female | Female | Female | Male | Male | Male |
| Ability rank | 0.034 | 0.268 | 0.258 | -0.225 | -0.225 | -0.176 | 0.289 | 0.787*** | 0.663** |
| | (0.256) | (0.175) | (0.200) | (0.318) | (0.243) | (0.291) | (0.360) | (0.249) | (0.269) |
| Ability rank square | 0.161 | -0.586 | -0.515 | 0.526 | 0.582 | 0.278 | -0.284 | -1.831*** | -1.209** |
| | (0.579) | (0.377) | (0.435) | (0.682) | (0.547) | (0.608) | (0.837) | (0.507) | (0.609) |
| Ability rank cubic | -0.138 | 0.394 | 0.416 | -0.282 | -0.370 | -0.013 | 0.084 | 1.199*** | 0.751* |
| | (0.400) | (0.256) | (0.301) | (0.465) | (0.372) | (0.410) | (0.567) | (0.332) | (0.422) |
| PVT score | 0.075** | 0.003 | 0.111*** | 0.095** | -0.017 | 0.063 | 0.063 | 0.021 | 0.152*** |
| | (0.031) | (0.027) | (0.030) | (0.041) | (0.035) | (0.039) | (0.043) | (0.033) | (0.042) |
| PVT score square | -0.002** | -0.000 | -0.002*** | -0.002** | 0.000 | -0.001* | -0.001 | -0.001 | -0.003*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000** | 0.000 | 0.000*** | 0.000** | -0.000 | 0.000* | 0.000 | 0.000 | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000** | -0.000 | -0.000*** | -0.000** | 0.000 | -0.000 | -0.000 | -0.000 | -0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | -0.038** | 0.110*** | 0.071*** | | | | | | |
| | (0.015) | (0.013) | (0.012) | | | | | | |
| Age | -0.060*** | -0.018** | -0.005 | -0.069*** | -0.035*** | -0.004 | -0.057*** | -0.006 | -0.007 |
| | (0.009) | (0.007) | (0.009) | (0.014) | (0.011) | (0.014) | (0.012) | (0.010) | (0.013) |
| Black | -0.066** | 0.046** | -0.050** | -0.188*** | -0.035 | -0.115*** | 0.071* | 0.134*** | 0.025 |
| | (0.027) | (0.020) | (0.020) | (0.034) | (0.026) | (0.027) | (0.037) | (0.027) | (0.030) |
| Hispanic | 0.025 | 0.051** | 0.006 | 0.000 | 0.017 | -0.023 | 0.053 | 0.086*** | 0.044 |
| | (0.024) | (0.020) | (0.024) | (0.030) | (0.024) | (0.032) | (0.033) | (0.027) | (0.031) |
| Other race/ethnicity | 0.080 | 0.058** | 0.126*** | 0.070 | 0.050* | 0.101*** | 0.103* | 0.069** | 0.156*** |
| | (0.052) | (0.026) | (0.024) | (0.057) | (0.030) | (0.037) | (0.060) | (0.034) | (0.027) |
| First-born | 0.001 | -0.010 | 0.014 | -0.006 | -0.026** | 0.014 | 0.011 | 0.009 | 0.016 |
| | (0.011) | (0.009) | (0.012) | (0.015) | (0.012) | (0.015) | (0.018) | (0.014) | (0.015) |
| Grade 8 | -0.029 | -0.019 | -0.089*** | -0.016 | -0.005 | -0.114*** | -0.031 | -0.029 | -0.054 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (0.025) | (0.020) | (0.031) | (0.037) | (0.028) | (0.040) | (0.033) | (0.027) | (0.039) |
| Grade 9 | -0.003 | 0.003 | -0.133*** | -0.031 | 0.025 | -0.162** | 0.035 | -0.013 | -0.099* |
| | (0.044) | (0.038) | (0.047) | (0.063) | (0.049) | (0.064) | (0.044) | (0.043) | (0.059) |
| Grade 10 | 0.008 | -0.008 | -0.100** | -0.050 | 0.040 | -0.120* | 0.076 | -0.045 | -0.073 |
| | (0.051) | (0.039) | (0.050) | (0.071) | (0.052) | (0.070) | (0.055) | (0.044) | (0.061) |
| Grade 11 | 0.024 | 0.016 | -0.053 | -0.024 | 0.086 | -0.055 | 0.090 | -0.033 | -0.040 |
| | (0.057) | (0.045) | (0.055) | (0.083) | (0.059) | (0.077) | (0.062) | (0.053) | (0.068) |
| Grade 12 | 0.107 | 0.066 | 0.052 | 0.065 | 0.127* | 0.019 | 0.173** | 0.030 | 0.096 |
| | (0.066) | (0.048) | (0.066) | (0.092) | (0.065) | (0.089) | (0.075) | (0.058) | (0.082) |
| Mother's education | 0.007** | 0.009*** | 0.006** | 0.009** | 0.011*** | 0.004 | 0.005 | 0.007** | 0.008** |
| | (0.003) | (0.002) | (0.003) | (0.004) | (0.003) | (0.004) | (0.004) | (0.003) | (0.004) |
| Family income | 0.045*** | 0.019** | 0.026* | 0.031* | 0.016 | 0.035** | 0.056*** | 0.020* | 0.015 |
| | (0.015) | (0.009) | (0.015) | (0.019) | (0.014) | (0.016) | (0.021) | (0.010) | (0.018) |
| Rural | -0.010 | -0.011 | -0.014 | -0.021 | -0.034** | -0.023 | 0.009 | 0.006 | -0.005 |
| | (0.018) | (0.012) | (0.019) | (0.026) | (0.017) | (0.023) | (0.025) | (0.019) | (0.026) |
| Missing family information dummy | -0.057*** | -0.021* | -0.045*** | -0.055** | -0.007 | -0.020 | -0.055*** | -0.035** | -0.068*** |
| | (0.014) | (0.011) | (0.013) | (0.022) | (0.015) | (0.019) | (0.019) | (0.014) | (0.017) |
| Constant | 0.036 | -0.124 | -1.441** | -0.103 | 0.559 | -0.497 | 0.058 | -0.523 | -2.116*** |
| | (0.497) | (0.439) | (0.572) | (0.650) | (0.616) | (0.703) | (0.667) | (0.581) | (0.763) |
| Observations | 18652 | 18653 | 18654 | 9455 | 9456 | 9456 | 9197 | 9197 | 9198 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A12. Ability rank and Wave 1 mechanism variables (linear), Male (N~9,100)***

| | (1)<br>Ability rank |
|---|---|
| **Panel A. Psychological factors** | |
| More intelligent than the average | 0.180*** |
| | (0.062) |
| Self-esteem | 0.006 |
| | (0.103) |
| **Panel B. Future expectations** | |
| *Educational expectations* | |
| I want to go to college | 0.173 |
| | (0.111) |
| I will likely go to college | 0.341** |
| | (0.137) |
| *Life chances expectations and hopefulness about future* | |
| Expectations to live to 35 | 0.027 |
| | (0.102) |
| Expectations killed by 21 | 0.063 |
| | (0.093) |
| Hopeful about future | 0.188* |
| | (0.104) |
| **Panel C. Social relationships** | |
| *School attachment* | |
| Feel part of school | 0.056 |
| | (0.126) |
| Happy to be at school | 0.170 |
| | (0.122) |
| Feel close to people at school | 0.045 |
| | (0.121) |
| *Relationship with friends* | |
| Difficulty getting along with other students | -0.095 |
| | (0.119) |
| Friends care about you | -0.042 |
| | (0.089) |
| Students are prejudiced | 0.098 |
| | (0.124) |
| *Relationship with teachers* | |
| Difficulty getting along with teachers | -0.139 |
| | (0.116) |
| Teachers care about you | 0.145 |
| | (0.123) |
| Teachers treat students fairly | 0.039 |
| | (0.125) |

*Note.* Each row is obtained from a separate regression. In all models, robust standard errors are clustered at the school level. All models include school fixed effects. All models include the following control variables: gender, age, race/ethnicity, standardized PVT score, first-born child, grade level, mother's education, family income, rural status, and missing family information dummy.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A13. Mediation for the relationship between ability rank and Wave 2 depressive symptoms variables, All***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanism variables | Baseline | Psychological factors | Educational expectations (A) | Mortality expectations and hopefulness (B) | Future expectations (A)+(B) | School attachment (C) | Relationship with friends (D) | Relationship with teachers (E) | Social relationship (C)+(D)+(E) | All (A)+(B)+(C)+(D)+(E) |
| Ability rank | -0.764$^{**}$ | -0.771$^{**}$ | -0.678$^{*}$ | -0.773$^{**}$ | -0.747$^{**}$ | -0.698$^{**}$ | -0.644$^{*}$ | -0.589$^{*}$ | -0.557$^{*}$ | -0.643$^{**}$ |
| | (0.346) | (0.316) | (0.343) | (0.333) | (0.331) | (0.348) | (0.330) | (0.341) | (0.334) | (0.306) |
| Ability rank square | 1.369$^{*}$ | 1.454$^{**}$ | 1.272$^{*}$ | 1.518$^{**}$ | 1.510$^{**}$ | 1.293$^{*}$ | 1.078 | 0.983 | 0.929 | 1.200$^{*}$ |
| | (0.708) | (0.672) | (0.703) | (0.702) | (0.699) | (0.696) | (0.657) | (0.696) | (0.660) | (0.640) |
| Ability rank cubic | -0.924$^{**}$ | -0.991$^{**}$ | -0.870$^{*}$ | -1.029$^{**}$ | -1.026$^{**}$ | -0.866$^{*}$ | -0.727$^{*}$ | -0.637 | -0.599 | -0.793$^{*}$ |
| | (0.460) | (0.439) | (0.458) | (0.463) | (0.462) | (0.445) | (0.419) | (0.453) | (0.421) | (0.418) |
| PVT score | 0.082$^{**}$ | 0.050 | 0.097$^{**}$ | 0.065 | 0.078$^{*}$ | 0.098$^{**}$ | 0.084$^{**}$ | 0.131$^{***}$ | 0.121$^{***}$ | 0.075$^{*}$ |
| | (0.041) | (0.037) | (0.044) | (0.043) | (0.045) | (0.039) | (0.041) | (0.044) | (0.043) | (0.040) |
| PVT score square | -0.001 | -0.001 | -0.002$^{*}$ | -0.001 | -0.001 | -0.002$^{*}$ | -0.002 | -0.002$^{**}$ | -0.002$^{**}$ | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000$^{**}$ | 0.000$^{*}$ | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| More intelligent than the average | | -0.027 | | | | | | | | 0.018 |
| | | (0.017) | | | | | | | | (0.017) |
| Self-esteem | | -0.387$^{***}$ | | | | | | | | -0.283$^{***}$ |
| | | (0.010) | | | | | | | | (0.009) |
| I want to go to college | | | -0.029$^{**}$ | | -0.012 | | | | | 0.010 |
| | | | (0.013) | | (0.012) | | | | | (0.011) |
| I will likely go to college | | | -0.122$^{***}$ | | -0.086$^{***}$ | | | | | -0.035$^{***}$ |
| | | | (0.011) | | (0.010) | | | | | (0.010) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Expectations to live to 35 | | | | -0.144*** | -0.130*** | | | | | -0.062*** |
| | | | | (0.010) | (0.010) | | | | | (0.011) |
| Expectations killed by 21 | | | | 0.112*** | 0.106*** | | | | | 0.056*** |
| | | | | (0.013) | (0.013) | | | | | (0.012) |
| Hopeful about future | | | | -0.183*** | -0.169*** | | | | | -0.066*** |
| | | | | (0.012) | (0.012) | | | | | (0.009) |
| Feel part of school | | | | | | -0.111*** | | | -0.075*** | -0.020* |
| | | | | | | (0.012) | | | (0.012) | (0.011) |
| Happy to be at school | | | | | | -0.105*** | | | -0.051*** | -0.022** |
| | | | | | | (0.010) | | | (0.010) | (0.010) |
| Feel close to people at school | | | | | | -0.038*** | | | -0.009 | -0.008 |
| | | | | | | (0.011) | | | (0.011) | (0.010) |
| Difficulty getting along with other students | | | | | | | 0.159*** | | 0.094*** | 0.072*** |
| | | | | | | | (0.009) | | (0.009) | (0.009) |
| Friends care about you | | | | | | | -0.148*** | | -0.098*** | -0.039*** |
| | | | | | | | (0.013) | | (0.013) | (0.011) |
| Students are prejudiced | | | | | | | 0.067*** | | 0.038*** | 0.035*** |
| | | | | | | | (0.009) | | (0.009) | (0.008) |
| Difficulty getting along with teachers | | | | | | | | 0.134*** | 0.100*** | 0.084*** |
| | | | | | | | | (0.010) | (0.010) | (0.009) |
| Teachers care about you | | | | | | | | -0.121*** | -0.064*** | -0.027*** |
| | | | | | | | | (0.009) | (0.010) | (0.010) |
| Teachers treat students fairly | | | | | | | | -0.064*** | -0.027*** | -0.009 |
| | | | | | | | | (0.009) | (0.010) | (0.009) |
| Female | 0.240*** | 0.112*** | 0.281*** | 0.244*** | 0.270*** | 0.231*** | 0.287*** | 0.276*** | 0.293*** | 0.189*** |
| | (0.022) | (0.017) | (0.022) | (0.020) | (0.020) | (0.020) | (0.021) | (0.021) | (0.020) | (0.017) |
| Age | 0.093*** | 0.067*** | 0.066*** | 0.079*** | 0.063*** | 0.072*** | 0.088*** | 0.090*** | 0.077*** | 0.057*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Black | 0.093** | 0.162*** | 0.114*** | 0.078** | 0.094*** | 0.075** | 0.090*** | 0.080** | 0.074** | 0.132*** |
| | (0.037) | (0.029) | (0.037) | (0.035) | (0.035) | (0.033) | (0.035) | (0.035) | (0.032) | (0.028) |
| Hispanic | 0.056** | 0.030 | 0.061** | 0.016 | 0.021 | 0.064** | 0.075*** | 0.061** | 0.073*** | 0.037 |
| | (0.027) | (0.024) | (0.026) | (0.026) | (0.026) | (0.026) | (0.028) | (0.026) | (0.026) | (0.024) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Other race/ethnicity | 0.201*** | 0.151*** | 0.251*** | 0.185*** | 0.217*** | 0.218*** | 0.208*** | 0.247*** | 0.237*** | 0.187*** |
| | (0.047) | (0.044) | (0.049) | (0.044) | (0.046) | (0.054) | (0.051) | (0.047) | (0.053) | (0.048) |
| First-born | -0.017 | -0.015 | -0.019 | -0.006 | -0.008 | -0.016 | -0.023 | -0.012 | -0.018 | -0.011 |
| | (0.015) | (0.015) | (0.015) | (0.014) | (0.014) | (0.015) | (0.015) | (0.015) | (0.015) | (0.014) |
| Grade 8 | 0.050 | 0.051 | 0.075** | 0.056 | 0.071** | 0.044 | 0.048 | 0.023 | 0.032 | 0.048 |
| | (0.035) | (0.031) | (0.034) | (0.034) | (0.033) | (0.032) | (0.032) | (0.032) | (0.030) | (0.030) |
| Grade 9 | -0.011 | -0.048 | 0.019 | -0.017 | 0.005 | -0.008 | -0.007 | -0.046 | -0.023 | -0.044 |
| | (0.055) | (0.046) | (0.056) | (0.052) | (0.052) | (0.055) | (0.050) | (0.055) | (0.053) | (0.046) |
| Grade 10 | -0.074 | -0.092* | -0.010 | -0.069 | -0.028 | -0.064 | -0.072 | -0.090 | -0.072 | -0.079 |
| | (0.061) | (0.051) | (0.063) | (0.059) | (0.060) | (0.059) | (0.057) | (0.061) | (0.059) | (0.052) |
| Grade 11 | -0.186*** | -0.159*** | -0.093 | -0.159** | -0.100 | -0.164** | -0.179*** | -0.190*** | -0.166** | -0.134** |
| | (0.070) | (0.060) | (0.072) | (0.065) | (0.066) | (0.067) | (0.066) | (0.070) | (0.066) | (0.059) |
| Grade 12 | -0.327*** | -0.248*** | -0.189** | -0.270*** | -0.182** | -0.272*** | -0.292*** | -0.279*** | -0.243*** | -0.177** |
| | (0.085) | (0.071) | (0.087) | (0.078) | (0.079) | (0.084) | (0.080) | (0.082) | (0.081) | (0.071) |
| Mother's education | -0.022*** | -0.013** | -0.012*** | -0.015*** | -0.009** | -0.020*** | -0.018*** | -0.020*** | -0.016*** | -0.008* |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.004) | (0.005) | (0.005) | (0.005) | (0.004) | (0.004) |
| Family income | -0.055*** | -0.036** | -0.040** | -0.048** | -0.038** | -0.045** | -0.051*** | -0.045** | -0.039** | -0.030* |
| | (0.020) | (0.017) | (0.017) | (0.019) | (0.018) | (0.018) | (0.019) | (0.018) | (0.017) | (0.016) |
| Rural | -0.008 | -0.012 | -0.014 | -0.025 | -0.026 | -0.015 | -0.008 | -0.015 | -0.015 | -0.024 |
| | (0.027) | (0.026) | (0.028) | (0.025) | (0.025) | (0.025) | (0.027) | (0.025) | (0.025) | (0.024) |
| Missing family information dummy | 0.064*** | 0.034* | 0.054*** | 0.048** | 0.043** | 0.046** | 0.051** | 0.050** | 0.039* | 0.020 |
| | (0.021) | (0.019) | (0.020) | (0.020) | (0.020) | (0.020) | (0.021) | (0.020) | (0.020) | (0.019) |
| Constant | -2.438*** | -1.537*** | -1.671*** | -1.270** | -0.973 | -1.248** | -2.255*** | -2.533*** | -1.911*** | -1.435*** |
| | (0.543) | (0.501) | (0.593) | (0.591) | (0.610) | (0.511) | (0.527) | (0.588) | (0.589) | (0.544) |
| Observations | 13263 | 13226 | 13202 | 13156 | 13143 | 13245 | 13158 | 13164 | 13107 | 13024 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A14. Mediation for the relationship between ability rank (decile) and Wave 2 depressive symptoms variables, All*

| | (1)<br>Depressive symptoms (W2) | (2)<br>Depressive symptoms (W2) | (3)<br>Depressive symptoms (W2) | (4)<br>Depressive symptoms (W2) | (5)<br>Depressive symptoms (W2) | (6)<br>Depressive symptoms (W2) | (7)<br>Depressive symptoms (W2) | (8)<br>Depressive symptoms (W2) | (9)<br>Depressive symptoms (W2) | (10)<br>Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanism variables | Baseline | Psychological factors | Educational expectations (A) | Mortality expectations and hopefulness (B) | Future expectations (A)+(B) | School attachment (C) | Relationship with friends (D) | Relationship with teachers (E) | Social relationship (C)+(D)+(E) | All (A)+(B)+(C)+(D)+(E) |
| Decile 1 | 0.146** | 0.125** | 0.122* | 0.125** | 0.111* | 0.120* | 0.124* | 0.131** | 0.110* | 0.097* |
| | (0.065) | (0.059) | (0.062) | (0.062) | (0.061) | (0.062) | (0.063) | (0.063) | (0.061) | (0.057) |
| Decile 2 | 0.065 | 0.047 | 0.053 | 0.038 | 0.031 | 0.040 | 0.051 | 0.054 | 0.036 | 0.031 |
| | (0.054) | (0.050) | (0.053) | (0.051) | (0.051) | (0.051) | (0.053) | (0.052) | (0.051) | (0.048) |
| Decile 3 | 0.054 | 0.035 | 0.039 | 0.034 | 0.025 | 0.033 | 0.025 | 0.050 | 0.020 | 0.010 |
| | (0.044) | (0.043) | (0.044) | (0.042) | (0.043) | (0.042) | (0.043) | (0.044) | (0.043) | (0.042) |
| Decile 4 | 0.049 | 0.035 | 0.038 | 0.022 | 0.015 | 0.033 | 0.034 | 0.051 | 0.031 | 0.017 |
| | (0.044) | (0.041) | (0.044) | (0.042) | (0.042) | (0.042) | (0.043) | (0.041) | (0.040) | (0.038) |
| Decile 5 | 0.055 | 0.037 | 0.040 | 0.036 | 0.027 | 0.038 | 0.035 | 0.039 | 0.022 | 0.016 |
| | (0.038) | (0.035) | (0.039) | (0.035) | (0.036) | (0.036) | (0.037) | (0.037) | (0.036) | (0.034) |
| Decile 6 (Ref.) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 7 | -0.003 | -0.008 | -0.005 | -0.007 | -0.007 | -0.010 | -0.026 | -0.010 | -0.022 | -0.017 |
| | (0.038) | (0.034) | (0.038) | (0.037) | (0.036) | (0.036) | (0.038) | (0.036) | (0.036) | (0.034) |
| Decile 8 | -0.016 | -0.001 | -0.016 | -0.012 | -0.013 | -0.023 | -0.038 | -0.013 | -0.031 | -0.013 |
| | (0.041) | (0.039) | (0.041) | (0.040) | (0.040) | (0.040) | (0.041) | (0.040) | (0.041) | (0.040) |
| Decile 9 | -0.044 | -0.045 | -0.047 | -0.039 | -0.040 | -0.051 | -0.067 | -0.044 | -0.062 | -0.052 |
| | (0.049) | (0.049) | (0.050) | (0.048) | (0.049) | (0.050) | (0.050) | (0.048) | (0.050) | (0.049) |
| Decile 10 | -0.130** | -0.130** | -0.127** | -0.131** | -0.128** | -0.117** | -0.132** | -0.099** | -0.105** | -0.109** |
| | (0.051) | (0.051) | (0.051) | (0.052) | (0.052) | (0.052) | (0.052) | (0.050) | (0.052) | (0.052) |
| More intelligent than the average | | -0.028 | | | | | | | | 0.016 |
| | | (0.017) | | | | | | | | (0.017) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Self-esteem | | $-0.386^{***}$ | | | | | | | | $-0.282^{***}$ |
| | | (0.010) | | | | | | | | (0.009) |
| I want to go to college | | | $-0.029^{**}$ | | -0.010 | | | | | 0.011 |
| | | | (0.013) | | (0.012) | | | | | (0.011) |
| I will likely go to college | | | $-0.122^{***}$ | | $-0.085^{***}$ | | | | | $-0.035^{***}$ |
| | | | (0.011) | | (0.010) | | | | | (0.009) |
| Expectations to live to 35 | | | | $-0.142^{***}$ | $-0.128^{***}$ | | | | | $-0.061^{***}$ |
| | | | | (0.011) | (0.011) | | | | | (0.011) |
| Expectations killed by 20 | | | | $0.116^{***}$ | $0.110^{***}$ | | | | | $0.059^{***}$ |
| | | | | (0.014) | (0.013) | | | | | (0.012) |
| Hopeful about future | | | | $-0.185^{***}$ | $-0.171^{***}$ | | | | | $-0.067^{***}$ |
| | | | | (0.012) | (0.013) | | | | | (0.009) |
| Feel part of school | | | | | | $-0.110^{***}$ | | | $-0.075^{***}$ | $-0.019^{*}$ |
| | | | | | | (0.012) | | | (0.012) | (0.011) |
| Happy to be at school | | | | | | $-0.105^{***}$ | | | $-0.050^{***}$ | $-0.022^{**}$ |
| | | | | | | (0.010) | | | (0.010) | (0.010) |
| Feel close to people at school | | | | | | $-0.040^{***}$ | | | -0.010 | -0.008 |
| | | | | | | (0.011) | | | (0.011) | (0.010) |
| Difficulty getting along with other students | | | | | | | $0.160^{***}$ | | $0.094^{***}$ | $0.072^{***}$ |
| | | | | | | | (0.009) | | (0.009) | (0.009) |
| Friends care about you | | | | | | | $-0.149^{***}$ | | $-0.098^{***}$ | $-0.039^{***}$ |
| | | | | | | | (0.013) | | (0.013) | (0.011) |
| Students are prejudiced | | | | | | | $0.067^{***}$ | | $0.038^{***}$ | $0.036^{***}$ |
| | | | | | | | (0.009) | | (0.009) | (0.008) |
| Difficulty getting along with teachers | | | | | | | | $0.136^{***}$ | $0.102^{***}$ | $0.086^{***}$ |
| | | | | | | | | (0.010) | (0.010) | (0.009) |
| Teachers care about you | | | | | | | | $-0.123^{***}$ | $-0.066^{***}$ | $-0.029^{***}$ |
| | | | | | | | | (0.009) | (0.010) | (0.010) |
| Teachers treat students fairly | | | | | | | | $-0.063^{***}$ | $-0.025^{**}$ | -0.008 |
| | | | | | | | | (0.010) | (0.010) | (0.009) |
| Female | $0.239^{***}$ | $0.111^{***}$ | $0.279^{***}$ | $0.243^{***}$ | $0.269^{***}$ | $0.230^{***}$ | $0.286^{***}$ | $0.274^{***}$ | $0.291^{***}$ | $0.187^{***}$ |
| | (0.021) | (0.017) | (0.021) | (0.020) | (0.020) | (0.019) | (0.020) | (0.021) | (0.020) | (0.017) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Age | 0.096*** | 0.070*** | 0.069*** | 0.082*** | 0.066*** | 0.075*** | 0.091*** | 0.093*** | 0.080*** | 0.060*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Black | 0.090** | 0.158*** | 0.111*** | 0.074** | 0.089** | 0.074** | 0.086** | 0.077** | 0.071** | 0.127*** |
| | (0.038) | (0.030) | (0.037) | (0.035) | (0.035) | (0.033) | (0.035) | (0.036) | (0.032) | (0.029) |
| Hispanic | 0.057** | 0.032 | 0.061** | 0.018 | 0.022 | 0.066** | 0.078*** | 0.064** | 0.075*** | 0.038 |
| | (0.028) | (0.025) | (0.027) | (0.027) | (0.027) | (0.027) | (0.028) | (0.027) | (0.027) | (0.025) |
| Other race/ethnicity | 0.211*** | 0.159*** | 0.256*** | 0.191*** | 0.221*** | 0.227*** | 0.215*** | 0.254*** | 0.245*** | 0.194*** |
| | (0.045) | (0.042) | (0.048) | (0.042) | (0.045) | (0.052) | (0.049) | (0.045) | (0.051) | (0.047) |
| First-born | -0.019 | -0.017 | -0.020 | -0.009 | -0.010 | -0.017 | -0.025* | -0.013 | -0.020 | -0.013 |
| | (0.016) | (0.015) | (0.015) | (0.014) | (0.014) | (0.015) | (0.015) | (0.015) | (0.015) | (0.014) |
| Grade 8 | 0.049 | 0.050 | 0.073** | 0.053 | 0.068** | 0.044 | 0.048 | 0.023 | 0.032 | 0.047 |
| | (0.035) | (0.032) | (0.034) | (0.035) | (0.034) | (0.032) | (0.032) | (0.032) | (0.030) | (0.030) |
| Grade 9 | -0.021 | -0.056 | 0.007 | -0.028 | -0.007 | -0.019 | -0.016 | -0.058 | -0.032 | -0.052 |
| | (0.054) | (0.046) | (0.056) | (0.052) | (0.053) | (0.055) | (0.050) | (0.055) | (0.053) | (0.047) |
| Grade 10 | -0.083 | -0.098* | -0.023 | -0.079 | -0.039 | -0.074 | -0.081 | -0.103* | -0.082 | -0.087 |
| | (0.060) | (0.051) | (0.063) | (0.060) | (0.061) | (0.059) | (0.057) | (0.061) | (0.059) | (0.053) |
| Grade 11 | -0.196*** | -0.167*** | -0.107 | -0.171*** | -0.113* | -0.176*** | -0.191*** | -0.206*** | -0.179*** | -0.146** |
| | (0.069) | (0.059) | (0.071) | (0.065) | (0.066) | (0.065) | (0.065) | (0.069) | (0.066) | (0.059) |
| Grade 12 | -0.338*** | -0.256*** | -0.204** | -0.282*** | -0.196** | -0.283*** | -0.303*** | -0.294*** | -0.254*** | -0.187** |
| | (0.083) | (0.072) | (0.087) | (0.078) | (0.079) | (0.082) | (0.080) | (0.082) | (0.081) | (0.072) |
| Mother's education | -0.022*** | -0.013*** | -0.013*** | -0.015*** | -0.009** | -0.020*** | -0.018*** | -0.020*** | -0.016*** | -0.009** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.004) | (0.004) |
| Family income | -0.057*** | -0.037** | -0.042** | -0.050*** | -0.041** | -0.046** | -0.052*** | -0.046** | -0.041** | -0.031* |
| | (0.020) | (0.017) | (0.017) | (0.019) | (0.018) | (0.018) | (0.019) | (0.018) | (0.017) | (0.016) |
| Rural | -0.006 | -0.009 | -0.012 | -0.023 | -0.024 | -0.013 | -0.005 | -0.012 | -0.013 | -0.021 |
| | (0.027) | (0.026) | (0.028) | (0.025) | (0.025) | (0.025) | (0.027) | (0.026) | (0.025) | (0.024) |
| Missing family information dummy | 0.067*** | 0.036* | 0.056*** | 0.050** | 0.044** | 0.048** | 0.054** | 0.052** | 0.040* | 0.021 |
| | (0.021) | (0.020) | (0.021) | (0.020) | (0.020) | (0.020) | (0.021) | (0.021) | (0.021) | (0.020) |
| Constant | -1.391*** | -1.001*** | -0.550** | -0.493** | -0.047 | -0.121 | -1.262*** | -1.005*** | -0.481** | -0.519** |
| | (0.205) | (0.215) | (0.218) | (0.210) | (0.214) | (0.206) | (0.229) | (0.215) | (0.237) | (0.239) |
| Observations | 13263 | 13226 | 13202 | 13156 | 13143 | 13245 | 13158 | 13164 | 13107 | 13024 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects. To control for absolute ability, 114 dummies reflecting each discrete level of ability scores are added.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A15. Mediation for the relationship between ability rank (decile) and Wave 2 depressive symptoms variables, Female*

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanism variables | Baseline | Psychological factors | Educational expectations (A) | Mortality expectations and hopefulness (B) | Future expectations (A)+(B) | School attachment (C) | Relationship with friends (D) | Relationship with teachers (E) | Social relationship (C)+(D)+(E) | All (A)+(B)+(C)+(D)+(E) |
| Decile 1 | 0.147 | 0.145* | 0.123 | 0.107 | 0.091 | 0.128 | 0.148 | 0.157* | 0.142 | 0.115 |
| | (0.095) | (0.085) | (0.094) | (0.095) | (0.094) | (0.093) | (0.093) | (0.092) | (0.090) | (0.084) |
| Decile 2 | 0.091 | 0.071 | 0.083 | 0.048 | 0.043 | 0.073 | 0.057 | 0.094 | 0.062 | 0.047 |
| | (0.078) | (0.074) | (0.078) | (0.077) | (0.077) | (0.077) | (0.076) | (0.074) | (0.073) | (0.071) |
| Decile 3 | 0.086 | 0.075 | 0.080 | 0.051 | 0.048 | 0.064 | 0.042 | 0.091 | 0.042 | 0.034 |
| | (0.065) | (0.066) | (0.066) | (0.066) | (0.067) | (0.064) | (0.064) | (0.064) | (0.062) | (0.064) |
| Decile 4 | 0.035 | 0.044 | 0.030 | 0.017 | 0.012 | 0.018 | 0.013 | 0.050 | 0.017 | 0.024 |
| | (0.065) | (0.065) | (0.066) | (0.064) | (0.065) | (0.063) | (0.063) | (0.060) | (0.059) | (0.061) |
| Decile 5 | 0.075 | 0.075 | 0.054 | 0.053 | 0.039 | 0.043 | 0.042 | 0.058 | 0.022 | 0.029 |
| | (0.057) | (0.060) | (0.058) | (0.053) | (0.054) | (0.056) | (0.055) | (0.058) | (0.056) | (0.057) |
| Decile 6 (Ref.) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 7 | -0.015 | 0.003 | -0.007 | -0.020 | -0.014 | -0.020 | -0.058 | -0.038 | -0.061 | -0.037 |
| | (0.063) | (0.061) | (0.063) | (0.061) | (0.062) | (0.063) | (0.061) | (0.059) | (0.060) | (0.061) |
| Decile 8 | 0.020 | 0.062 | 0.022 | 0.015 | 0.018 | 0.016 | -0.014 | 0.033 | 0.003 | 0.036 |
| | (0.065) | (0.065) | (0.065) | (0.065) | (0.065) | (0.067) | (0.064) | (0.064) | (0.065) | (0.065) |
| Decile 9 | -0.024 | 0.035 | -0.020 | -0.007 | -0.000 | -0.023 | -0.061 | -0.002 | -0.035 | 0.015 |
| | (0.077) | (0.075) | (0.078) | (0.073) | (0.073) | (0.080) | (0.078) | (0.073) | (0.077) | (0.074) |
| Decile 10 | -0.083 | -0.054 | -0.080 | -0.083 | -0.076 | -0.061 | -0.124 | -0.042 | -0.074 | -0.059 |
| | (0.084) | (0.089) | (0.085) | (0.083) | (0.082) | (0.089) | (0.083) | (0.083) | (0.085) | (0.087) |
| More intelligent than the average | | 0.002 | | | | | | | | 0.060** |
| | | (0.027) | | | | | | | | (0.027) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Self-esteem | | -0.397*** | | | | | | | | -0.286*** |
| | | (0.013) | | | | | | | | (0.014) |
| I want to go to college | | | -0.033 | | -0.010 | | | | | 0.015 |
| | | | (0.022) | | (0.022) | | | | | (0.022) |
| I will likely go to college | | | -0.147*** | | -0.105*** | | | | | -0.047** |
| | | | (0.019) | | (0.019) | | | | | (0.019) |
| Expectations to live to 35 | | | | -0.156*** | -0.139*** | | | | | -0.068*** |
| | | | | (0.017) | (0.017) | | | | | (0.016) |
| Expectations killed by 21 | | | | 0.119*** | 0.115*** | | | | | 0.062*** |
| | | | | (0.017) | (0.017) | | | | | (0.015) |
| Hopeful about future | | | | -0.220*** | -0.202*** | | | | | -0.079*** |
| | | | | (0.016) | (0.017) | | | | | (0.014) |
| Feel part of school | | | | | | -0.138*** | | | -0.104*** | -0.036** |
| | | | | | | (0.018) | | | (0.018) | (0.017) |
| Happy to be at school | | | | | | -0.096*** | | | -0.033** | -0.005 |
| | | | | | | (0.016) | | | (0.015) | (0.016) |
| Feel close to people at school | | | | | | -0.036** | | | -0.009 | -0.012 |
| | | | | | | (0.017) | | | (0.017) | (0.015) |
| Difficulty getting along with other students | | | | | | | 0.181*** | | 0.098*** | 0.075*** |
| | | | | | | | (0.014) | | (0.014) | (0.014) |
| Friends care about you | | | | | | | -0.161*** | | -0.099*** | -0.035* |
| | | | | | | | (0.021) | | (0.020) | (0.018) |
| Students are prejudiced | | | | | | | 0.068*** | | 0.036*** | 0.032*** |
| | | | | | | | (0.012) | | (0.012) | (0.011) |
| Difficulty getting along with teachers | | | | | | | | 0.162*** | 0.127*** | 0.104*** |
| | | | | | | | | (0.015) | (0.015) | (0.014) |
| Teachers care about you | | | | | | | | -0.147*** | -0.089*** | -0.047*** |
| | | | | | | | | (0.013) | (0.014) | (0.014) |
| Teachers treat students fairly | | | | | | | | -0.071*** | -0.030** | -0.007 |
| | | | | | | | | (0.015) | (0.015) | (0.014) |
| Age | 0.112*** | 0.086*** | 0.089*** | 0.099*** | 0.086*** | 0.083*** | 0.097*** | 0.109*** | 0.087*** | 0.073*** |
| | (0.020) | (0.019) | (0.020) | (0.019) | (0.019) | (0.019) | (0.019) | (0.020) | (0.019) | (0.019) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Black | 0.091* | 0.155*** | 0.111** | 0.078* | 0.094** | 0.044 | 0.054 | 0.055 | 0.025 | 0.096** |
| | (0.047) | (0.037) | (0.047) | (0.044) | (0.045) | (0.042) | (0.043) | (0.045) | (0.042) | (0.038) |
| Hispanic | 0.039 | -0.006 | 0.040 | 0.007 | 0.009 | 0.046 | 0.046 | 0.041 | 0.050 | 0.005 |
| | (0.046) | (0.043) | (0.045) | (0.047) | (0.046) | (0.046) | (0.045) | (0.044) | (0.045) | (0.044) |
| Other race/ethnicity | 0.174** | 0.156** | 0.230*** | 0.182*** | 0.217*** | 0.206*** | 0.189** | 0.226*** | 0.232*** | 0.208*** |
| | (0.071) | (0.068) | (0.075) | (0.067) | (0.070) | (0.071) | (0.076) | (0.071) | (0.075) | (0.072) |
| First-born | -0.009 | -0.018 | -0.017 | -0.002 | -0.007 | -0.010 | -0.019 | -0.002 | -0.012 | -0.017 |
| | (0.023) | (0.022) | (0.022) | (0.021) | (0.021) | (0.022) | (0.022) | (0.021) | (0.021) | (0.021) |
| Grade 8 | 0.071 | 0.050 | 0.090* | 0.069 | 0.080* | 0.076 | 0.078 | 0.033 | 0.054 | 0.050 |
| | (0.053) | (0.049) | (0.051) | (0.049) | (0.048) | (0.052) | (0.051) | (0.049) | (0.049) | (0.047) |
| Grade 9 | -0.059 | -0.120 | -0.039 | -0.048 | -0.036 | -0.060 | -0.035 | -0.109 | -0.073 | -0.111 |
| | (0.080) | (0.074) | (0.080) | (0.079) | (0.079) | (0.077) | (0.079) | (0.080) | (0.079) | (0.074) |
| Grade 10 | -0.164* | -0.206** | -0.119 | -0.152* | -0.124 | -0.155* | -0.127 | -0.186** | -0.148* | -0.181** |
| | (0.089) | (0.079) | (0.090) | (0.087) | (0.088) | (0.085) | (0.086) | (0.087) | (0.085) | (0.081) |
| Grade 11 | -0.313*** | -0.282*** | -0.239** | -0.255** | -0.212** | -0.285*** | -0.259** | -0.317*** | -0.264*** | -0.237** |
| | (0.102) | (0.094) | (0.104) | (0.098) | (0.099) | (0.098) | (0.099) | (0.102) | (0.099) | (0.093) |
| Grade 12 | -0.547*** | -0.471*** | -0.438*** | -0.477*** | -0.410*** | -0.475*** | -0.469*** | -0.489*** | -0.429*** | -0.383*** |
| | (0.134) | (0.121) | (0.132) | (0.126) | (0.125) | (0.129) | (0.127) | (0.127) | (0.122) | (0.117) |
| Mother's education | -0.023*** | -0.014* | -0.012 | -0.015** | -0.008 | -0.020*** | -0.018** | -0.022*** | -0.016** | -0.008 |
| | (0.008) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| Family income | -0.077** | -0.067** | -0.059** | -0.068** | -0.057** | -0.066** | -0.075** | -0.057** | -0.056** | -0.053** |
| | (0.030) | (0.026) | (0.029) | (0.027) | (0.026) | (0.028) | (0.029) | (0.028) | (0.027) | (0.025) |
| Rural | 0.014 | 0.001 | 0.003 | -0.007 | -0.011 | -0.008 | 0.005 | -0.000 | -0.013 | -0.022 |
| | (0.037) | (0.038) | (0.037) | (0.035) | (0.035) | (0.036) | (0.038) | (0.033) | (0.034) | (0.034) |
| Missing family information dummy | 0.064** | 0.037 | 0.059** | 0.060** | 0.056** | 0.049* | 0.060** | 0.066** | 0.055* | 0.038 |
| | (0.029) | (0.027) | (0.028) | (0.028) | (0.027) | (0.028) | (0.030) | (0.029) | (0.029) | (0.028) |
| Constant | -1.376*** | -1.138*** | -0.446 | -0.398 | 0.071 | 0.057 | -1.029*** | -0.893*** | -0.193 | -0.436 |
| | (0.314) | (0.301) | (0.329) | (0.307) | (0.310) | (0.323) | (0.334) | (0.325) | (0.335) | (0.318) |
| Observations | 6804 | 6783 | 6774 | 6751 | 6745 | 6794 | 6748 | 6751 | 6720 | 6683 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects. To control for absolute ability, 114 dummies reflecting each discrete level of ability scores are added.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A16. Mediation for the relationship between ability rank (decile) and Wave 2 depressive symptoms variables, Male***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|
| Mechanism variables | Baseline | Psychological factors | Educational expectations (A) | Mortality expectations and hopefulness (B) | Future expectations (A)+(B) | School attachment (C) | Relationship with friends (D) | Relationship with teachers (E) | Social relationship (C)+(D)+(E) | All (A)+(B)+(C)+(D)+(E) |
| Decile 1 | 0.134$^{*}$ | 0.107 | 0.099 | 0.114 | 0.098 | 0.101 | 0.085 | 0.093 | 0.064 | 0.066 |
| | (0.080) | (0.077) | (0.078) | (0.075) | (0.074) | (0.079) | (0.078) | (0.078) | (0.077) | (0.073) |
| Decile 2 | 0.032 | 0.034 | 0.011 | 0.016 | 0.003 | 0.004 | 0.039 | 0.006 | 0.008 | 0.020 |
| | (0.070) | (0.064) | (0.070) | (0.068) | (0.067) | (0.065) | (0.067) | (0.068) | (0.065) | (0.061) |
| Decile 3 | 0.020 | -0.005 | -0.012 | 0.004 | -0.014 | -0.002 | 0.003 | 0.002 | -0.007 | -0.020 |
| | (0.057) | (0.053) | (0.057) | (0.051) | (0.051) | (0.054) | (0.056) | (0.058) | (0.055) | (0.050) |
| Decile 4 | 0.061 | 0.034 | 0.043 | 0.021 | 0.012 | 0.042 | 0.050 | 0.052 | 0.041 | 0.009 |
| | (0.056) | (0.050) | (0.055) | (0.053) | (0.052) | (0.054) | (0.057) | (0.056) | (0.055) | (0.048) |
| Decile 5 | 0.021 | -0.009 | 0.010 | 0.001 | -0.005 | 0.023 | 0.011 | 0.010 | 0.009 | -0.009 |
| | (0.044) | (0.040) | (0.045) | (0.042) | (0.042) | (0.041) | (0.042) | (0.044) | (0.041) | (0.038) |
| Decile 6 (Ref.) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 7 | 0.003 | -0.018 | -0.006 | -0.000 | -0.005 | -0.005 | -0.010 | 0.003 | -0.005 | -0.010 |
| | (0.044) | (0.039) | (0.044) | (0.042) | (0.042) | (0.043) | (0.044) | (0.043) | (0.043) | (0.039) |
| Decile 8 | -0.058 | -0.065 | -0.058 | -0.046 | -0.049 | -0.073 | -0.079 | -0.065 | -0.083$^{*}$ | -0.071 |
| | (0.050) | (0.044) | (0.050) | (0.047) | (0.048) | (0.047) | (0.050) | (0.049) | (0.048) | (0.043) |
| Decile 9 | -0.058 | -0.106$^{*}$ | -0.062 | -0.060 | -0.065 | -0.080 | -0.076 | -0.075 | -0.092 | -0.107$^{*}$ |
| | (0.059) | (0.056) | (0.058) | (0.056) | (0.057) | (0.056) | (0.058) | (0.058) | (0.057) | (0.055) |
| Decile 10 | -0.165$^{***}$ | -0.187$^{***}$ | -0.157$^{**}$ | -0.165$^{***}$ | -0.163$^{***}$ | -0.161$^{***}$ | -0.144$^{**}$ | -0.146$^{**}$ | -0.138$^{**}$ | -0.149$^{***}$ |
| | (0.062) | (0.056) | (0.062) | (0.056) | (0.057) | (0.061) | (0.063) | (0.059) | (0.061) | (0.053) |
| More intelligent than the average | | -0.056$^{**}$ | | | | | | | | -0.019 |
| | | (0.023) | | | | | | | | (0.023) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Self-esteem | | -0.371*** | | | | | | | | -0.267*** |
| | | (0.014) | | | | | | | | (0.015) |
| I want to go to college | | | -0.020 | | -0.005 | | | | | 0.013 |
| | | | (0.015) | | (0.014) | | | | | (0.014) |
| I will likely go to college | | | -0.110*** | | -0.079*** | | | | | -0.033** |
| | | | (0.017) | | (0.016) | | | | | (0.015) |
| Expectations to live to 35 | | | | -0.128*** | -0.114*** | | | | | -0.054*** |
| | | | | (0.014) | (0.014) | | | | | (0.014) |
| Expectations killed by 21 | | | | 0.111*** | 0.104*** | | | | | 0.058*** |
| | | | | (0.017) | (0.017) | | | | | (0.017) |
| Hopeful about future | | | | -0.154*** | -0.142*** | | | | | -0.062*** |
| | | | | (0.013) | (0.014) | | | | | (0.011) |
| Feel part of school | | | | | | -0.080*** | | | -0.048*** | -0.005 |
| | | | | | | (0.014) | | | (0.014) | (0.014) |
| Happy to be at school | | | | | | -0.111*** | | | -0.065*** | -0.037*** |
| | | | | | | (0.012) | | | (0.012) | (0.011) |
| Feel close to people at school | | | | | | -0.050*** | | | -0.016 | -0.008 |
| | | | | | | (0.014) | | | (0.013) | (0.013) |
| Difficulty getting along with other students | | | | | | | 0.144*** | | 0.091*** | 0.071*** |
| | | | | | | | (0.014) | | (0.013) | (0.012) |
| Friends care about you | | | | | | | -0.140*** | | -0.100*** | -0.047*** |
| | | | | | | | (0.014) | | (0.015) | (0.014) |
| Students are prejudiced | | | | | | | 0.064*** | | 0.038*** | 0.040*** |
| | | | | | | | (0.010) | | (0.011) | (0.010) |
| Difficulty getting along with teachers | | | | | | | | 0.123*** | 0.091*** | 0.077*** |
| | | | | | | | | (0.014) | (0.013) | (0.013) |
| Teachers care about you | | | | | | | | -0.100*** | -0.042*** | -0.008 |
| | | | | | | | | (0.014) | (0.015) | (0.014) |
| Teachers treat students fairly | | | | | | | | -0.049*** | -0.015 | -0.004 |
| | | | | | | | | (0.013) | (0.013) | (0.013) |
| Age | 0.094*** | 0.064*** | 0.063*** | 0.076*** | 0.057*** | 0.076*** | 0.093*** | 0.089*** | 0.081*** | 0.055*** |
| | (0.017) | (0.016) | (0.018) | (0.016) | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.016) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Black | 0.092$^{*}$ | 0.155$^{***}$ | 0.116$^{**}$ | 0.081$^{*}$ | 0.096$^{**}$ | 0.102$^{**}$ | 0.117$^{**}$ | 0.102$^{**}$ | 0.114$^{***}$ | 0.154$^{***}$ |
| | (0.050) | (0.042) | (0.050) | (0.046) | (0.047) | (0.045) | (0.046) | (0.047) | (0.043) | (0.038) |
| Hispanic | 0.071$^{*}$ | 0.066$^{*}$ | 0.079$^{*}$ | 0.033 | 0.039 | 0.083$^{**}$ | 0.105$^{***}$ | 0.082$^{**}$ | 0.101$^{***}$ | 0.072$^{*}$ |
| | (0.040) | (0.038) | (0.041) | (0.038) | (0.039) | (0.039) | (0.039) | (0.040) | (0.038) | (0.037) |
| Other race/ethnicity | 0.226$^{***}$ | 0.150$^{***}$ | 0.269$^{***}$ | 0.199$^{***}$ | 0.227$^{***}$ | 0.238$^{***}$ | 0.227$^{***}$ | 0.274$^{***}$ | 0.254$^{***}$ | 0.179$^{***}$ |
| | (0.050) | (0.046) | (0.051) | (0.048) | (0.050) | (0.055) | (0.053) | (0.050) | (0.054) | (0.050) |
| First-born | -0.024 | -0.011 | -0.020 | -0.009 | -0.008 | -0.020 | -0.025 | -0.017 | -0.020 | -0.004 |
| | (0.021) | (0.020) | (0.020) | (0.021) | (0.020) | (0.020) | (0.021) | (0.021) | (0.020) | (0.019) |
| Grade 8 | 0.019 | 0.042 | 0.051 | 0.028 | 0.046 | 0.008 | 0.017 | 0.009 | 0.008 | 0.038 |
| | (0.041) | (0.036) | (0.040) | (0.041) | (0.040) | (0.039) | (0.038) | (0.038) | (0.036) | (0.034) |
| Grade 9 | -0.010 | -0.013 | 0.037 | -0.023 | 0.006 | 0.009 | -0.009 | -0.022 | 0.001 | -0.002 |
| | (0.067) | (0.050) | (0.066) | (0.063) | (0.062) | (0.069) | (0.060) | (0.064) | (0.062) | (0.051) |
| Grade 10 | -0.041 | -0.022 | 0.042 | -0.033 | 0.018 | -0.017 | -0.054 | -0.044 | -0.030 | -0.010 |
| | (0.071) | (0.059) | (0.071) | (0.067) | (0.067) | (0.072) | (0.067) | (0.070) | (0.069) | (0.058) |
| Grade 11 | -0.135 | -0.096 | -0.021 | -0.122 | -0.050 | -0.104 | -0.148$^{*}$ | -0.129 | -0.114 | -0.078 |
| | (0.082) | (0.070) | (0.084) | (0.078) | (0.079) | (0.082) | (0.077) | (0.082) | (0.078) | (0.070) |
| Grade 12 | -0.171 | -0.079 | -0.002 | -0.109 | -0.005 | -0.117 | -0.147 | -0.117 | -0.084 | -0.005 |
| | (0.106) | (0.093) | (0.108) | (0.101) | (0.101) | (0.106) | (0.102) | (0.103) | (0.102) | (0.092) |
| Mother's education | -0.020$^{***}$ | -0.012$^{**}$ | -0.011$^{*}$ | -0.013$^{**}$ | -0.008 | -0.019$^{***}$ | -0.017$^{***}$ | -0.016$^{***}$ | -0.015$^{***}$ | -0.008 |
| | (0.006) | (0.005) | (0.006) | (0.005) | (0.005) | (0.005) | (0.006) | (0.006) | (0.005) | (0.005) |
| Family income | -0.037$^{*}$ | -0.007 | -0.023 | -0.032 | -0.023 | -0.026 | -0.029 | -0.032 | -0.023 | -0.008 |
| | (0.021) | (0.018) | (0.019) | (0.020) | (0.018) | (0.021) | (0.019) | (0.022) | (0.020) | (0.018) |
| Rural | -0.037 | -0.028 | -0.039 | -0.048 | -0.049 | -0.027 | -0.027 | -0.033 | -0.022 | -0.028 |
| | (0.033) | (0.028) | (0.033) | (0.030) | (0.030) | (0.031) | (0.032) | (0.031) | (0.030) | (0.027) |
| Missing family information dummy | 0.061$^{**}$ | 0.026 | 0.043$^{*}$ | 0.034 | 0.024 | 0.041$^{*}$ | 0.041$^{*}$ | 0.035 | 0.023 | -0.001 |
| | (0.024) | (0.023) | (0.024) | (0.024) | (0.024) | (0.023) | (0.024) | (0.024) | (0.023) | (0.023) |
| Constant | -1.399$^{***}$ | -0.925$^{***}$ | -0.572$^{**}$ | -0.532$^{*}$ | -0.081 | -0.236 | -1.310$^{***}$ | -1.086$^{***}$ | -0.641$^{**}$ | -0.547$^{*}$ |
| | (0.273) | (0.265) | (0.287) | (0.283) | (0.292) | (0.276) | (0.293) | (0.278) | (0.314) | (0.304) |
| Observations | 6459 | 6443 | 6428 | 6405 | 6398 | 6451 | 6410 | 6413 | 6387 | 6341 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects. To control for absolute ability, 114 dummies reflecting each discrete level of ability scores are added.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

***Table A17. Mediation for the relationship between ability rank (linear) and Wave 2 depressive symptoms variables, by gender***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) | (9) Depressive symptoms (W2) | (10) Depressive symptoms (W2) | (11) Depressive symptoms (W2) | (12) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | All | All | All | All | Female | Female | Female | Female | Male | Male | Male | Male |
| Mechanism variables | Baseline | Psychological factors | Future expectations | Social relationship | Baseline | Psychological factors | Future expectations | Social relationship | Baseline | Psychological factors | Future expectations | Social relationship |
| Ability rank | -0.191$^{**}$ | -0.170$^{*}$ | -0.119 | -0.145 | -0.179 | -0.118 | -0.077 | -0.149 | -0.210$^{*}$ | -0.230$^{**}$ | -0.142 | -0.168 |
| | (0.094) | (0.092) | (0.091) | (0.092) | (0.138) | (0.135) | (0.134) | (0.140) | (0.122) | (0.113) | (0.117) | (0.116) |
| PVT score | 0.100$^{***}$ | 0.070$^{**}$ | 0.099$^{**}$ | 0.136$^{***}$ | 0.122$^{***}$ | 0.070 | 0.112$^{*}$ | 0.184$^{***}$ | 0.085$^{*}$ | 0.063 | 0.098$^{*}$ | 0.114$^{**}$ |
| | (0.038) | (0.034) | (0.041) | (0.040) | (0.047) | (0.052) | (0.060) | (0.058) | (0.048) | (0.046) | (0.051) | (0.047) |
| PVT score square | -0.002$^{**}$ | -0.001 | -0.002$^{**}$ | -0.003$^{***}$ | -0.002$^{*}$ | -0.001 | -0.002 | -0.003$^{***}$ | -0.002 | -0.001 | -0.002$^{*}$ | -0.002$^{**}$ |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000$^{*}$ | 0.000$^{**}$ | 0.000 | 0.000 | 0.000 | 0.000$^{**}$ | 0.000 | 0.000 | 0.000 | 0.000$^{*}$ |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000$^{**}$ | -0.000 | -0.000 | -0.000 | -0.000$^{**}$ | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| More intelligent than the average | | -0.026 | | | | 0.001 | | | | -0.055$^{**}$ | | |
| | | (0.017) | | | | (0.026) | | | | (0.023) | | |
| Self-esteem | | -0.387$^{***}$ | | | | -0.396$^{***}$ | | | | -0.371$^{***}$ | | |
| | | (0.010) | | | | (0.013) | | | | (0.014) | | |
| I want to go to college | | | -0.012 | | | | -0.018 | | | | -0.007 | |
| | | | (0.012) | | | | (0.021) | | | | (0.014) | |
| I will likely go to college | | | -0.086$^{***}$ | | | | -0.101$^{***}$ | | | | -0.079$^{***}$ | |
| | | | (0.010) | | | | (0.019) | | | | (0.016) | |
| Expectations to live to 35 | | | -0.130$^{***}$ | | | | -0.141$^{***}$ | | | | -0.120$^{***}$ | |
| | | | (0.010) | | | | (0.017) | | | | (0.013) | |
| Expectations killed by 21 | | | 0.106$^{***}$ | | | | 0.111$^{***}$ | | | | 0.096$^{***}$ | |
| | | | (0.013) | | | | (0.017) | | | | (0.017) | |
| Hopeful about future | | | -0.169$^{***}$ | | | | -0.197$^{***}$ | | | | -0.137$^{***}$ | |
| | | | (0.012) | | | | (0.016) | | | | (0.014) | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feel part of school | | | | -0.075*** | | | | -0.101*** | | | | -0.052*** |
| | | | | (0.012) | | | | (0.019) | | | | (0.014) |
| Happy to be at school | | | | -0.051*** | | | | -0.038** | | | | -0.062*** |
| | | | | (0.010) | | | | (0.016) | | | | (0.012) |
| Feel close to people at school | | | | -0.009 | | | | -0.006 | | | | -0.012 |
| | | | | (0.011) | | | | (0.017) | | | | (0.014) |
| Difficulty getting along with other students | | | | 0.094*** | | | | 0.097*** | | | | 0.090*** |
| | | | | (0.009) | | | | (0.014) | | | | (0.012) |
| Friends care about you | | | | -0.098*** | | | | -0.096*** | | | | -0.099*** |
| | | | | (0.013) | | | | (0.020) | | | | (0.015) |
| Students are prejudiced | | | | 0.038*** | | | | 0.038*** | | | | 0.037*** |
| | | | | (0.009) | | | | (0.012) | | | | (0.010) |
| Difficulty getting along with teachers | | | | 0.100*** | | | | 0.122*** | | | | 0.088*** |
| | | | | (0.010) | | | | (0.015) | | | | (0.013) |
| Teachers care about you | | | | -0.064*** | | | | -0.089*** | | | | -0.043*** |
| | | | | (0.010) | | | | (0.014) | | | | (0.015) |
| Teachers treat students fairly | | | | -0.027*** | | | | -0.031** | | | | -0.017 |
| | | | | (0.010) | | | | (0.015) | | | | (0.013) |
| Female | 0.239*** | 0.112*** | 0.269*** | 0.292*** | | | | | | | | |
| | (0.022) | (0.017) | (0.021) | (0.020) | | | | | | | | |
| Age | 0.093*** | 0.067*** | 0.063*** | 0.077*** | 0.109*** | 0.084*** | 0.085*** | 0.084*** | 0.088*** | 0.059*** | 0.052*** | 0.076*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.020) | (0.019) | (0.019) | (0.019) | (0.017) | (0.016) | (0.017) | (0.017) |
| Black | 0.092** | 0.161*** | 0.093*** | 0.073** | 0.097** | 0.160*** | 0.100** | 0.032 | 0.097* | 0.163*** | 0.103** | 0.123*** |
| | (0.037) | (0.029) | (0.035) | (0.032) | (0.048) | (0.038) | (0.046) | (0.043) | (0.049) | (0.042) | (0.046) | (0.042) |
| Hispanic | 0.056** | 0.031 | 0.022 | 0.073*** | 0.043 | -0.004 | 0.009 | 0.050 | 0.065* | 0.060* | 0.035 | 0.095** |
| | (0.027) | (0.024) | (0.026) | (0.026) | (0.043) | (0.041) | (0.043) | (0.042) | (0.039) | (0.036) | (0.038) | (0.038) |
| Other race/ethnicity | 0.201*** | 0.152*** | 0.217*** | 0.238*** | 0.169** | 0.147** | 0.216*** | 0.227*** | 0.226*** | 0.150*** | 0.225*** | 0.251*** |
| | (0.047) | (0.044) | (0.046) | (0.054) | (0.073) | (0.069) | (0.071) | (0.079) | (0.051) | (0.046) | (0.051) | (0.056) |
| First-born | -0.017 | -0.015 | -0.008 | -0.018 | -0.008 | -0.018 | -0.006 | -0.013 | -0.017 | -0.005 | -0.002 | -0.014 |
| | (0.015) | (0.015) | (0.014) | (0.015) | (0.023) | (0.022) | (0.022) | (0.021) | (0.021) | (0.020) | (0.020) | (0.020) |
| Grade 8 | 0.050 | 0.052 | 0.072** | 0.032 | 0.076 | 0.052 | 0.089* | 0.056 | 0.020 | 0.043 | 0.048 | 0.009 |
| | (0.034) | (0.031) | (0.033) | (0.030) | (0.052) | (0.048) | (0.048) | (0.048) | (0.040) | (0.036) | (0.040) | (0.036) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade 9 | -0.011 | -0.048 | 0.004 | -0.023 | -0.048 | -0.117 | -0.026 | -0.071 | 0.017 | 0.007 | 0.031 | 0.022 |
| | (0.055) | (0.046) | (0.052) | (0.053) | (0.081) | (0.072) | (0.078) | (0.076) | (0.067) | (0.049) | (0.063) | (0.063) |
| Grade 10 | -0.074 | -0.093* | -0.028 | -0.071 | -0.149 | -0.203** | -0.113 | -0.140* | -0.014 | -0.000 | 0.045 | -0.006 |
| | (0.061) | (0.050) | (0.060) | (0.059) | (0.090) | (0.078) | (0.087) | (0.084) | (0.070) | (0.057) | (0.066) | (0.069) |
| Grade 11 | -0.185*** | -0.159*** | -0.099 | -0.165** | -0.288*** | -0.270*** | -0.193* | -0.248** | -0.111 | -0.078 | -0.028 | -0.093 |
| | (0.070) | (0.060) | (0.066) | (0.066) | (0.105) | (0.094) | (0.100) | (0.098) | (0.082) | (0.069) | (0.078) | (0.078) |
| Grade 12 | -0.325*** | -0.246*** | -0.180** | -0.241*** | -0.531*** | -0.462*** | -0.401*** | -0.426*** | -0.134 | -0.050 | 0.028 | -0.055 |
| | (0.085) | (0.071) | (0.079) | (0.081) | (0.136) | (0.118) | (0.124) | (0.121) | (0.105) | (0.091) | (0.100) | (0.101) |
| Mother's education | -0.022*** | -0.013** | -0.009** | -0.016*** | -0.024*** | -0.014* | -0.009 | -0.017** | -0.020*** | -0.012** | -0.008 | -0.016*** |
| | (0.005) | (0.005) | (0.004) | (0.004) | (0.007) | (0.007) | (0.007) | (0.007) | (0.006) | (0.005) | (0.005) | (0.005) |
| Family income | -0.055*** | -0.035** | -0.037** | -0.039** | -0.072** | -0.063** | -0.051* | -0.055** | -0.039* | -0.009 | -0.025 | -0.025 |
| | (0.020) | (0.017) | (0.018) | (0.017) | (0.032) | (0.027) | (0.028) | (0.027) | (0.021) | (0.019) | (0.019) | (0.021) |
| Rural | -0.008 | -0.012 | -0.026 | -0.016 | 0.015 | 0.003 | -0.012 | -0.014 | -0.035 | -0.028 | -0.045 | -0.023 |
| | (0.027) | (0.026) | (0.025) | (0.025) | (0.036) | (0.037) | (0.035) | (0.034) | (0.034) | (0.029) | (0.030) | (0.031) |
| Missing family information dummy | 0.064*** | 0.034* | 0.043** | 0.038* | 0.064** | 0.038 | 0.058** | 0.055* | 0.055** | 0.022 | 0.020 | 0.021 |
| | (0.021) | (0.019) | (0.020) | (0.020) | (0.028) | (0.026) | (0.026) | (0.028) | (0.024) | (0.023) | (0.024) | (0.022) |
| Constant | -2.649*** | -1.771*** | -1.220** | -2.078*** | -3.183*** | -1.890** | -1.541* | -2.725*** | -2.135*** | -1.561** | -0.989 | -1.753*** |
| | (0.529) | (0.470) | (0.592) | (0.571) | (0.642) | (0.804) | (0.926) | (0.933) | (0.652) | (0.604) | (0.726) | (0.614) |
| Observations | 13263 | 13226 | 13143 | 13107 | 6804 | 6783 | 6745 | 6720 | 6459 | 6443 | 6398 | 6387 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A18. Robustness check: Addressing contextual-level confounders, All*

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) |
|---|---|---|---|---|---|
| Grade-level mean ability | No | Yes | No | Yes | No |
| Grade-level standard deviation ability | No | No | Yes | Yes | No |
| School-by-grade FE | No | No | No | No | Yes |
| Ability rank | -0.764$^{**}$ | -0.837$^{**}$ | -0.731$^{**}$ | -0.836$^{**}$ | -0.859$^{**}$ |
| | (0.346) | (0.337) | (0.347) | (0.338) | (0.340) |
| Ability rank square | 1.369$^{*}$ | 1.458$^{**}$ | 1.326$^{*}$ | 1.455$^{**}$ | 1.464$^{**}$ |
| | (0.708) | (0.684) | (0.709) | (0.686) | (0.688) |
| Ability rank cubic | -0.924$^{**}$ | -0.991$^{**}$ | -0.914$^{*}$ | -1.013$^{**}$ | -1.025$^{**}$ |
| | (0.460) | (0.442) | (0.462) | (0.445) | (0.448) |
| Grade-level mean ability | | -0.005 | | -0.007 | |
| | | (0.006) | | (0.005) | |
| Grade-level standard deviation ability | | | -0.011$^{*}$ | -0.012$^{**}$ | |
| | | | (0.006) | (0.006) | |
| PVT score | 0.082$^{**}$ | 0.082$^{**}$ | 0.082$^{**}$ | 0.084$^{**}$ | 0.083$^{**}$ |
| | (0.041) | (0.041) | (0.041) | (0.041) | (0.040) |
| PVT score square | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.240$^{***}$ | 0.240$^{***}$ | 0.240$^{***}$ | 0.240$^{***}$ | 0.236$^{***}$ |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |
| Age | 0.093$^{***}$ | 0.093$^{***}$ | 0.093$^{***}$ | 0.093$^{***}$ | 0.090$^{***}$ |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.014) |
| Black | 0.093$^{**}$ | 0.093$^{**}$ | 0.093$^{**}$ | 0.093$^{**}$ | 0.095$^{**}$ |
| | (0.037) | (0.038) | (0.037) | (0.038) | (0.038) |
| Hispanic | 0.056$^{**}$ | 0.056$^{**}$ | 0.054$^{**}$ | 0.054$^{**}$ | 0.072$^{**}$ |

| | | | | | |
|---|---|---|---|---|---|
| | (0.027) | (0.027) | (0.026) | (0.027) | (0.028) |
| Other race/ethnicity | 0.201*** | 0.202*** | 0.200*** | 0.201*** | 0.212*** |
| | (0.047) | (0.047) | (0.047) | (0.046) | (0.045) |
| First-born | -0.017 | -0.017 | -0.017 | -0.017 | -0.017 |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.016) |
| Grade 8 | 0.050 | 0.053 | 0.048 | 0.052 | |
| | (0.035) | (0.034) | (0.034) | (0.034) | |
| Grade 9 | -0.011 | -0.005 | -0.011 | -0.002 | |
| | (0.055) | (0.054) | (0.055) | (0.054) | |
| Grade 10 | -0.074 | -0.066 | -0.076 | -0.063 | |
| | (0.061) | (0.059) | (0.062) | (0.060) | |
| Grade 11 | -0.186*** | -0.175** | -0.189*** | -0.172** | |
| | (0.070) | (0.069) | (0.069) | (0.068) | |
| Grade 12 | -0.327*** | -0.312*** | -0.336*** | -0.314*** | |
| | (0.085) | (0.083) | (0.085) | (0.083) | |
| Mother's education | -0.022*** | -0.022*** | -0.022*** | -0.022*** | -0.021*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | -0.055*** | -0.055*** | -0.055*** | -0.055*** | -0.057*** |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| Rural | -0.008 | -0.008 | -0.008 | -0.008 | -0.012 |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.028) |
| Missing family information dummy | 0.064*** | 0.063*** | 0.063*** | 0.063*** | 0.062*** |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) |
| Constant | -2.438*** | -1.990*** | -2.272*** | -1.579** | -2.483*** |
| | (0.543) | (0.688) | (0.565) | (0.692) | (0.544) |
| Observations | 13263 | 13263 | 13263 | 13263 | 13263 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A19. Robustness check: Different operationalization of ability rank, All*

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|
| Yitzhaki index | -0.003 | -0.001 | | | | |
| | (0.005) | (0.010) | | | | |
| Yitzhaki index square | | -0.000 | | | | |
| | | (0.000) | | | | |
| Yitzhaki index cubic | | 0.000 | | | | |
| | | (0.000) | | | | |
| Deaton index | | | -0.365 | 0.022 | | |
| | | | (0.586) | (1.040) | | |
| Deaton index square | | | | -1.152 | | |
| | | | | (4.764) | | |
| Deaton index cubic | | | | -0.512 | | |
| | | | | (8.200) | | |
| d-measure | | | | | -0.251 | 0.077 |
| | | | | | (1.621) | (1.818) |
| d-measure square | | | | | | -2.194 |
| | | | | | | (11.144) |
| d-measure cubic | | | | | | 10.865 |
| | | | | | | (7.919) |
| PVT score | 0.088** | 0.083 | 0.088** | 0.039 | 0.084 | 0.326 |
| | (0.038) | (0.085) | (0.038) | (0.226) | (0.054) | (0.266) |
| PVT score square | -0.002* | -0.002 | -0.002* | -0.001 | -0.001 | -0.005 |
| | (0.001) | (0.001) | (0.001) | (0.004) | (0.001) | (0.004) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.240*** | 0.240*** | 0.240*** | 0.240*** | 0.240*** | 0.240*** |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Age | 0.094*** | 0.094*** | 0.094*** | 0.094*** | 0.094*** | 0.093*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Black | 0.091** | 0.091** | 0.091** | 0.092** | 0.091** | 0.091** |
| | (0.038) | (0.037) | (0.038) | (0.037) | (0.037) | (0.037) |
| Hispanic | 0.055** | 0.055** | 0.055** | 0.056** | 0.055** | 0.053* |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Other race/ethnicity | 0.200*** | 0.200*** | 0.199*** | 0.201*** | 0.199*** | 0.198*** |
| | (0.047) | (0.047) | (0.047) | (0.047) | (0.047) | (0.047) |
| First-born | -0.017 | -0.017 | -0.017 | -0.017 | -0.017 | -0.017 |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) |
| Grade 8 | 0.055 | 0.055 | 0.055 | 0.055 | 0.054 | 0.053 |
| | (0.035) | (0.034) | (0.035) | (0.034) | (0.035) | (0.035) |
| Grade 9 | -0.001 | -0.002 | -0.001 | -0.002 | -0.004 | -0.006 |
| | (0.055) | (0.054) | (0.054) | (0.054) | (0.055) | (0.055) |
| Grade 10 | -0.060 | -0.061 | -0.060 | -0.061 | -0.063 | -0.065 |
| | (0.061) | (0.061) | (0.061) | (0.061) | (0.062) | (0.061) |
| Grade 11 | -0.167** | -0.168** | -0.166** | -0.168** | -0.171** | -0.173** |
| | (0.069) | (0.068) | (0.069) | (0.068) | (0.070) | (0.069) |
| Grade 12 | -0.301*** | -0.302*** | -0.300*** | -0.302*** | -0.306*** | -0.308*** |
| | (0.084) | (0.083) | (0.084) | (0.083) | (0.086) | (0.085) |
| Mother's education | -0.022*** | -0.022*** | -0.022*** | -0.022*** | -0.022*** | -0.023*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | -0.054*** | -0.054*** | -0.054*** | -0.054*** | -0.054*** | -0.054*** |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| Rural | -0.009 | -0.009 | -0.009 | -0.009 | -0.009 | -0.009 |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Missing family information dummy | 0.064*** | 0.064*** | 0.064*** | 0.064*** | 0.064*** | 0.063*** |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) |
| Constant | -2.278*** | -2.074 | -2.169*** | -0.707 | -2.270 | -7.666 |
| | (0.674) | (2.061) | (0.755) | (5.448) | (1.790) | (6.581) |
| Observations | 13263 | 13263 | 13263 | 13263 | 13263 | 13263 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

*Table A20. Robustness check: Controlling for rank measures of other characteristics, All*

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|
| Ability rank | -0.764** | -0.754** | -0.737** | -0.790** | -0.789** | -0.780** | -0.762** |
| | (0.346) | (0.349) | (0.347) | (0.345) | (0.345) | (0.348) | (0.346) |
| Ability rank square | 1.369* | 1.361* | 1.333* | 1.418** | 1.410** | 1.410** | 1.375* |
| | (0.708) | (0.713) | (0.711) | (0.706) | (0.705) | (0.711) | (0.707) |
| Ability rank cubic | -0.924** | -0.916* | -0.902* | -0.958** | -0.952** | -0.949** | -0.931** |
| | (0.460) | (0.464) | (0.463) | (0.459) | (0.458) | (0.462) | (0.461) |
| SES percentile rank | | -0.159*** | -0.437 | | | -0.158*** | -0.420 |
| | | (0.040) | (0.283) | | | (0.040) | (0.285) |
| SES percentile rank square | | | 0.459 | | | | 0.429 |
| | | | (0.661) | | | | (0.666) |
| SES percentile rank cubic | | | -0.190 | | | | -0.175 |
| | | | (0.437) | | | | (0.440) |
| BMI percentile rank | | | | 0.074** | 0.157 | 0.074** | 0.163 |
| | | | | (0.033) | (0.251) | (0.033) | (0.250) |
| BMI percentile rank square | | | | | -0.444 | | -0.459 |
| | | | | | (0.636) | | (0.632) |
| BMI percentile rank cubic | | | | | 0.411 | | 0.419 |
| | | | | | (0.442) | | (0.439) |
| PVT score | 0.082** | 0.081* | 0.081* | 0.079* | 0.080* | 0.078* | 0.079* |
| | (0.041) | (0.041) | (0.041) | (0.041) | (0.041) | (0.041) | (0.041) |
| PVT score square | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| PVT score cubic | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| PVT score quartic | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Female | 0.240*** | 0.241*** | 0.241*** | 0.235*** | 0.235*** | 0.237*** | 0.237*** |
| | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) | (0.022) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Age | 0.093*** | 0.089*** | 0.089*** | 0.092*** | 0.092*** | 0.089*** | 0.089*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Black | 0.093** | 0.088** | 0.086** | 0.086** | 0.086** | 0.081** | 0.080** |
| | (0.037) | (0.037) | (0.038) | (0.037) | (0.037) | (0.037) | (0.038) |
| Hispanic | 0.056** | 0.053** | 0.053* | 0.050* | 0.050* | 0.048* | 0.047* |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Other race/ethnicity | 0.201*** | 0.197*** | 0.197*** | 0.201*** | 0.200*** | 0.198*** | 0.196*** |
| | (0.047) | (0.045) | (0.045) | (0.046) | (0.046) | (0.045) | (0.044) |
| First-born | -0.017 | -0.020 | -0.020 | -0.018 | -0.018 | -0.021 | -0.021 |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) |
| Grade 8 | 0.050 | 0.052 | 0.052 | 0.054 | 0.054 | 0.057 | 0.057 |
| | (0.035) | (0.035) | (0.035) | (0.034) | (0.034) | (0.035) | (0.034) |
| Grade 9 | -0.011 | -0.004 | -0.004 | -0.005 | -0.005 | 0.002 | 0.002 |
| | (0.055) | (0.055) | (0.055) | (0.055) | (0.055) | (0.055) | (0.055) |
| Grade 10 | -0.074 | -0.065 | -0.064 | -0.066 | -0.067 | -0.057 | -0.057 |
| | (0.061) | (0.061) | (0.061) | (0.061) | (0.061) | (0.061) | (0.061) |
| Grade 11 | -0.186*** | -0.172** | -0.172** | -0.176** | -0.177** | -0.163** | -0.163** |
| | (0.070) | (0.070) | (0.070) | (0.070) | (0.070) | (0.070) | (0.070) |
| Grade 12 | -0.327*** | -0.315*** | -0.314*** | -0.315*** | -0.316*** | -0.304*** | -0.303*** |
| | (0.085) | (0.085) | (0.085) | (0.084) | (0.084) | (0.084) | (0.084) |
| Mother's education | -0.022*** | -0.020*** | -0.020*** | -0.022*** | -0.022*** | -0.020*** | -0.019*** |
| | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) | (0.005) |
| Family income | -0.055*** | -0.006 | -0.012 | -0.054*** | -0.054*** | -0.006 | -0.011 |
| | (0.020) | (0.020) | (0.022) | (0.020) | (0.020) | (0.020) | (0.022) |
| Rural | -0.008 | -0.008 | -0.007 | -0.011 | -0.012 | -0.011 | -0.011 |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Missing family information dummy | 0.064*** | 0.128*** | 0.128*** | 0.062*** | 0.061*** | 0.124*** | 0.123*** |
| | (0.021) | (0.038) | (0.038) | (0.021) | (0.021) | (0.038) | (0.038) |
| Missing SES percentile rank dummy | | -0.082* | -0.066 | | | -0.080* | -0.064 |
| | | (0.042) | (0.044) | | | (0.042) | (0.044) |
| Missing BMI percentile rank | | | | 0.221*** | 0.232*** | 0.217*** | 0.227*** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| dummy | | | | | | | |
| | | | | (0.059) | (0.060) | (0.059) | (0.061) |
| Constant | -2.438*** | -2.361*** | -2.326*** | -2.489*** | -2.496*** | -2.413*** | -2.387*** |
| | (0.543) | (0.543) | (0.544) | (0.541) | (0.544) | (0.541) | (0.544) |
| Observations | 13263 | 13263 | 13263 | 13263 | 13263 | 13263 | 13263 |

*Note.* In all models, robust standard errors are clustered at the school level. All models include school fixed effects.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

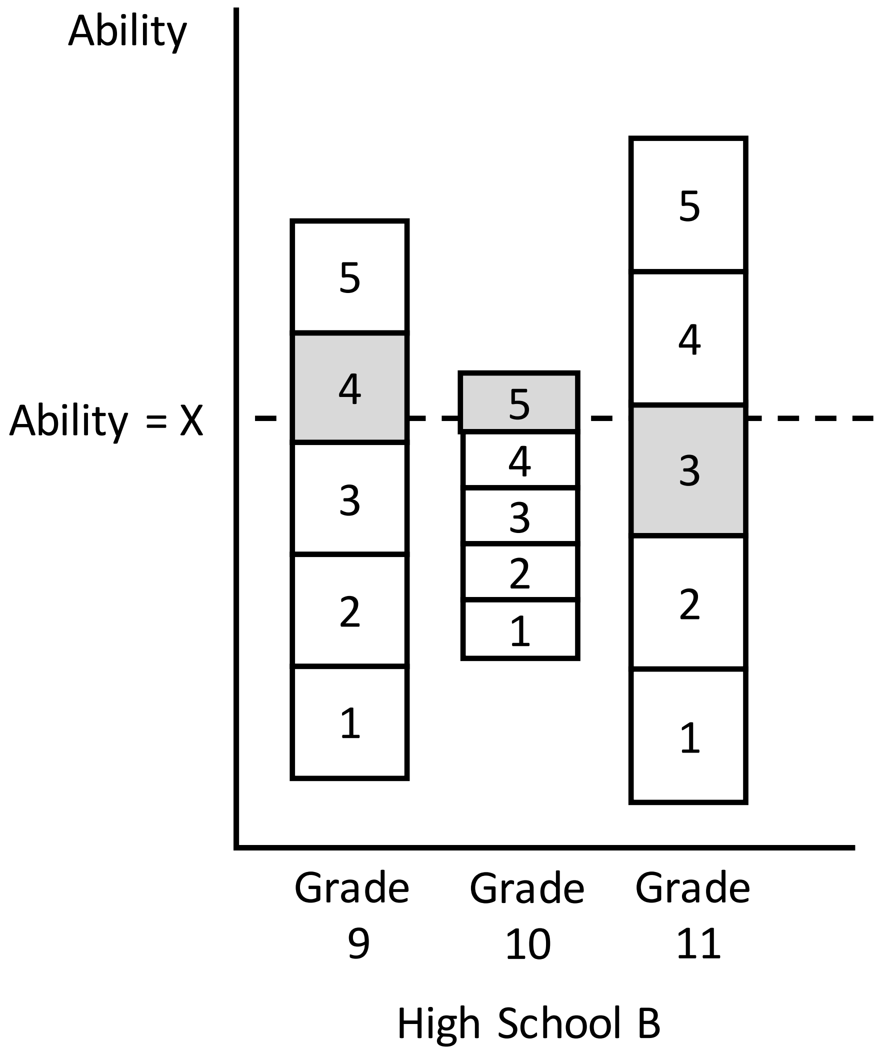
***Table A21. Robustness check: Family fixed effects models, All***

| | (1)<br>Depressive symptoms (W2) | (2)<br>Depressive symptoms (W2) | (3)<br>Depressive symptoms (W2) | (4)<br>Depressive symptoms (W2) |
|---|---|---|---|---|
| Ability rank | -0.345* | -0.363* | -0.252 | -0.355* |
| | (0.184) | (0.195) | (0.206) | (0.213) |
| PVT score | -0.002 | -0.005 | 0.077** | 0.310*** |
| | (0.004) | (0.014) | (0.034) | (0.095) |
| PVT score square | | 0.000 | -0.001** | -0.006*** |
| | | (0.000) | (0.000) | (0.002) |
| PVT score cubic | | | 0.000** | 0.000*** |
| | | | (0.000) | (0.000) |
| PVT score quartic | | | | -0.000** |
| | | | | (0.000) |
| Female | 0.076 | 0.076 | 0.075 | 0.082* |
| | (0.049) | (0.049) | (0.049) | (0.049) |
| Age | -0.012 | -0.012 | -0.011 | -0.013 |
| | (0.041) | (0.041) | (0.041) | (0.042) |
| First-born | -0.017 | -0.018 | -0.015 | -0.013 |
| | (0.043) | (0.043) | (0.043) | (0.043) |
| Grade 8 | 0.026 | 0.025 | 0.025 | 0.025 |
| | (0.096) | (0.096) | (0.096) | (0.095) |
| Grade 9 | 0.094 | 0.093 | 0.100 | 0.094 |
| | (0.116) | (0.116) | (0.116) | (0.115) |
| Grade 10 | 0.054 | 0.054 | 0.055 | 0.053 |
| | (0.150) | (0.150) | (0.151) | (0.150) |
| Grade 11 | 0.125 | 0.124 | 0.127 | 0.116 |
| | (0.185) | (0.185) | (0.184) | (0.184) |
| Grade 12 | 0.064 | 0.063 | 0.068 | 0.062 |
| | (0.226) | (0.226) | (0.226) | (0.226) |
| Constant | 0.414 | 0.542 | -1.408 | -4.731*** |
| | (0.651) | (0.892) | (1.042) | (1.444) |
| Observations | 3635 | 3635 | 3635 | 3635 |

*Note.* In all models, robust standard errors are clustered at the family level. All models include family fixed effects.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

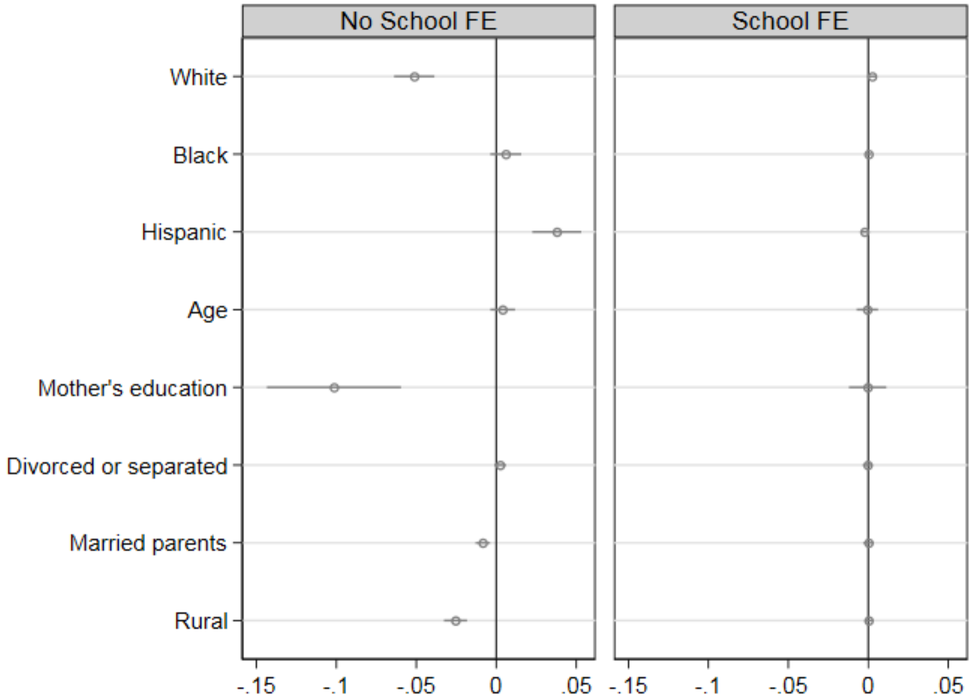
**10. Appendix figures**

***Figure A1. Rank dependent on distribution of ability (standard deviation)***




*Note*: This figure illustrates that students with the same ability can have different ranks depending on different school-cohort distributions of ability (standard deviation). This is based on the illustration from Elsner and Isphording (2017).

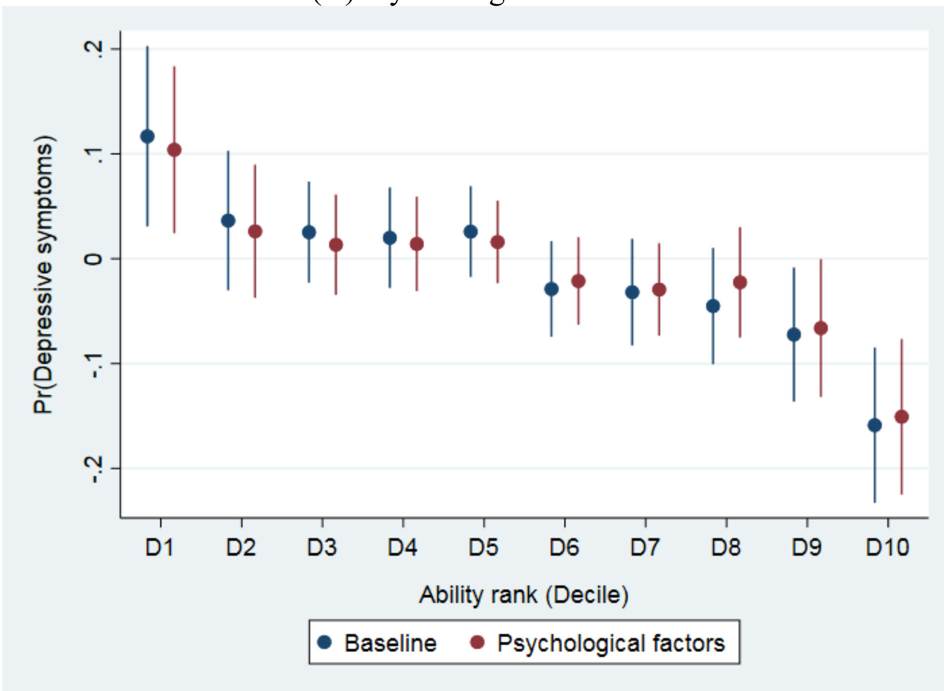
***Figure A2. Balancing tests of grade-level standard deviation of ability***



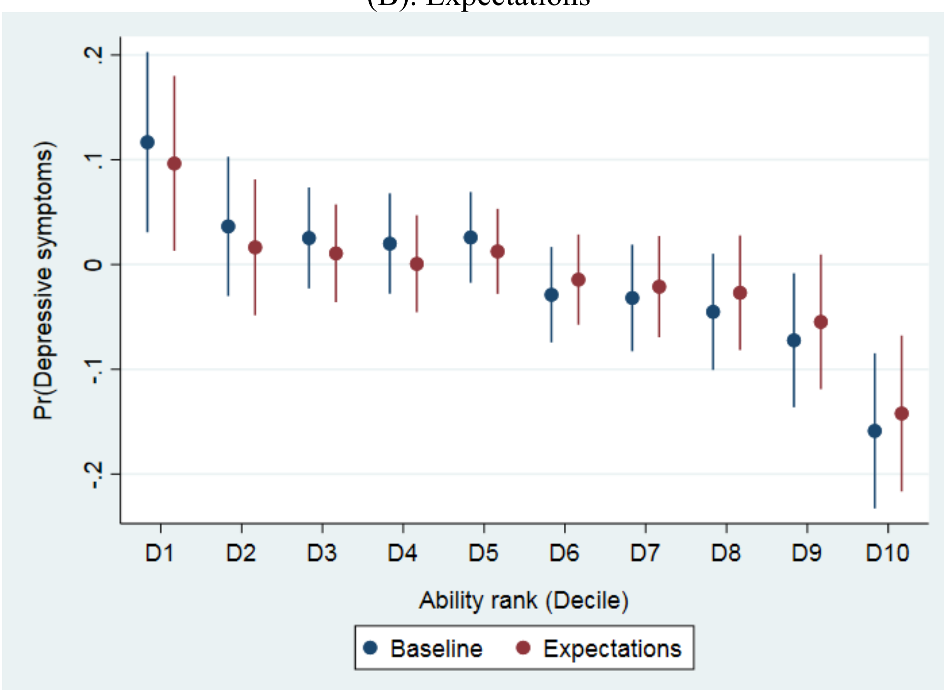

*Note*: Each dot is the coefficient from a separate regression that includes a set of grade dummies. Robust standard errors are clustered at the school level. The spikes present 90% confidence intervals.

***Figure A3. Mediation for the relationship between ability rank (decile) and Wave 2 depressive symptoms variables, All***

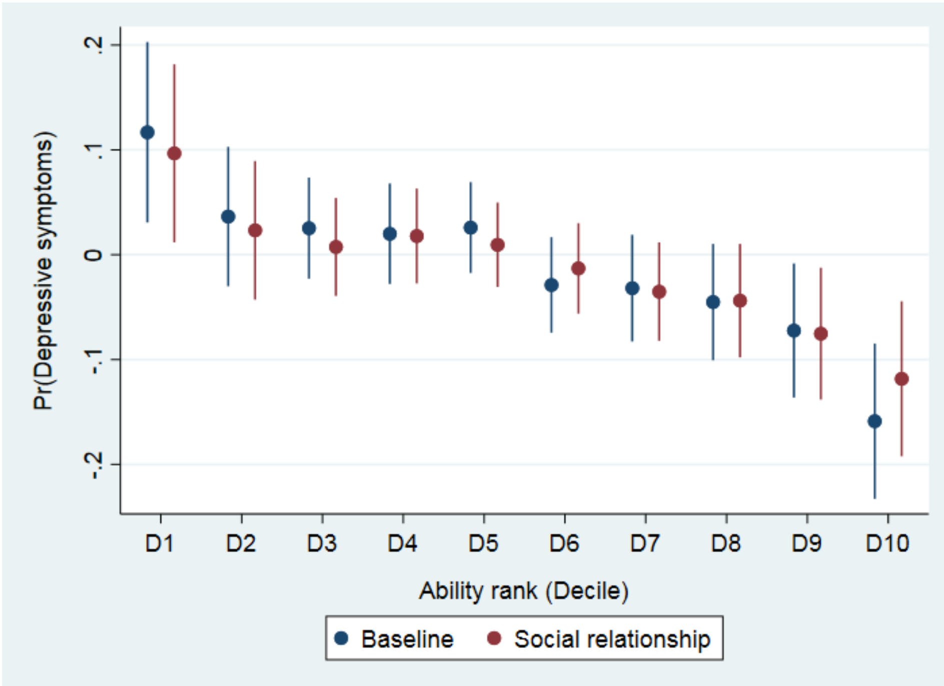
(A). Pyshcological factors




(B). Expectations



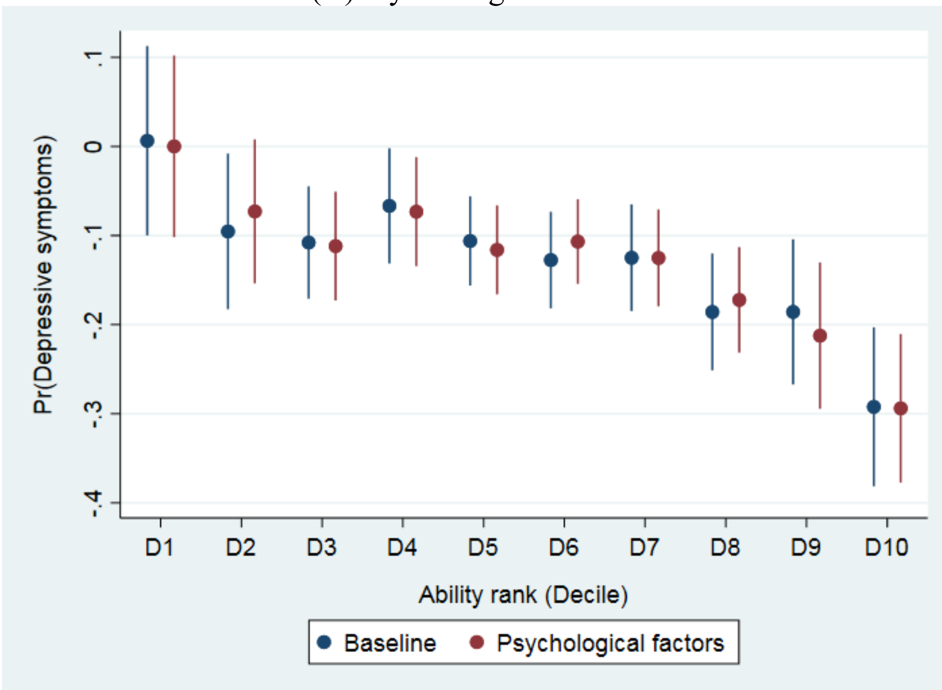

(C). Social relationship



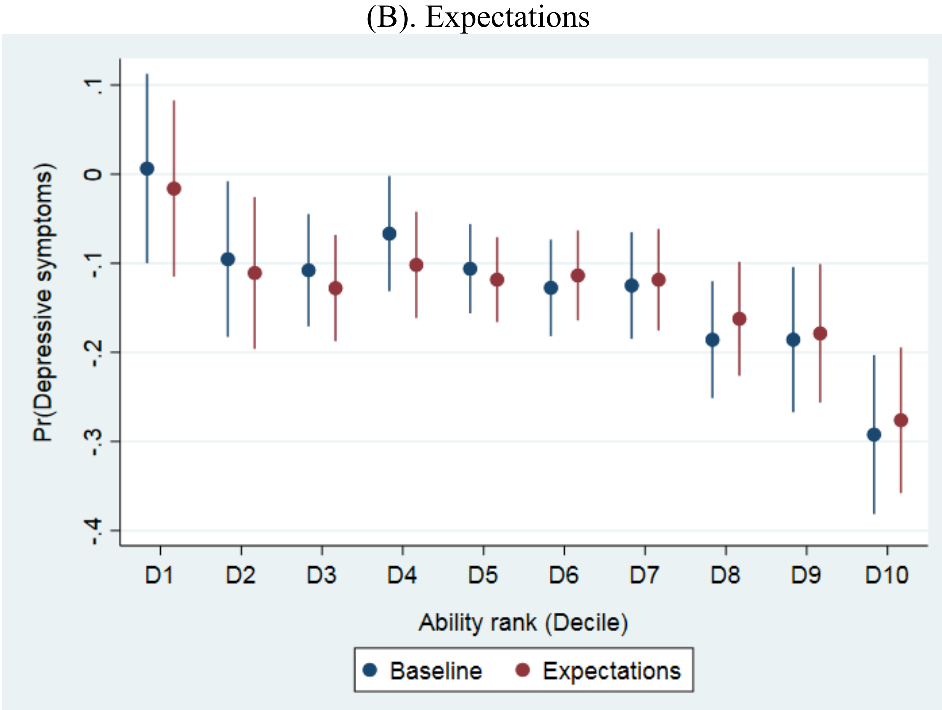
.2
.1
0
-.1
-.2
Pr(Depressive symptoms)
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
Ability rank (Decile)
Baseline
Social relationship

***Figure A4. Mediation for the relationship between ability rank (decile) and Wave 2 depressive symptoms variables, Male***

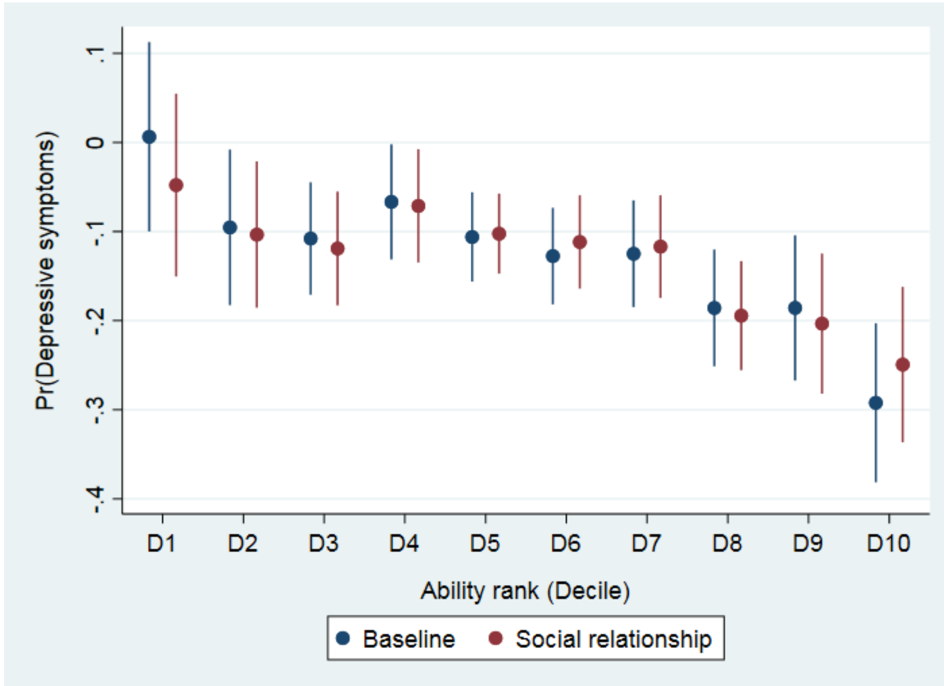
(A). Pyshcological factors




(B). Expectations



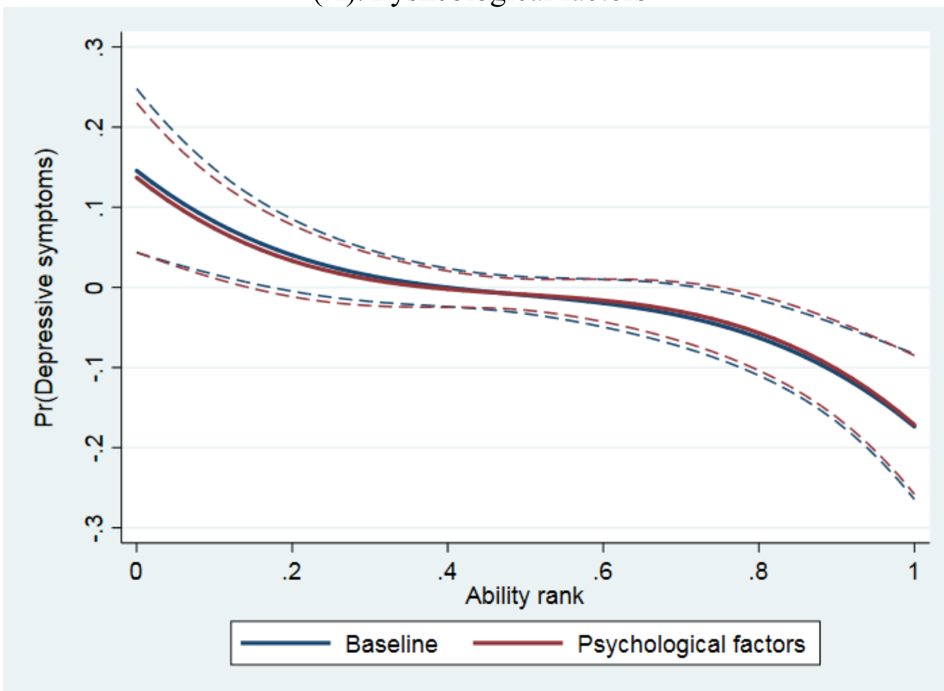

(C). Social relationship



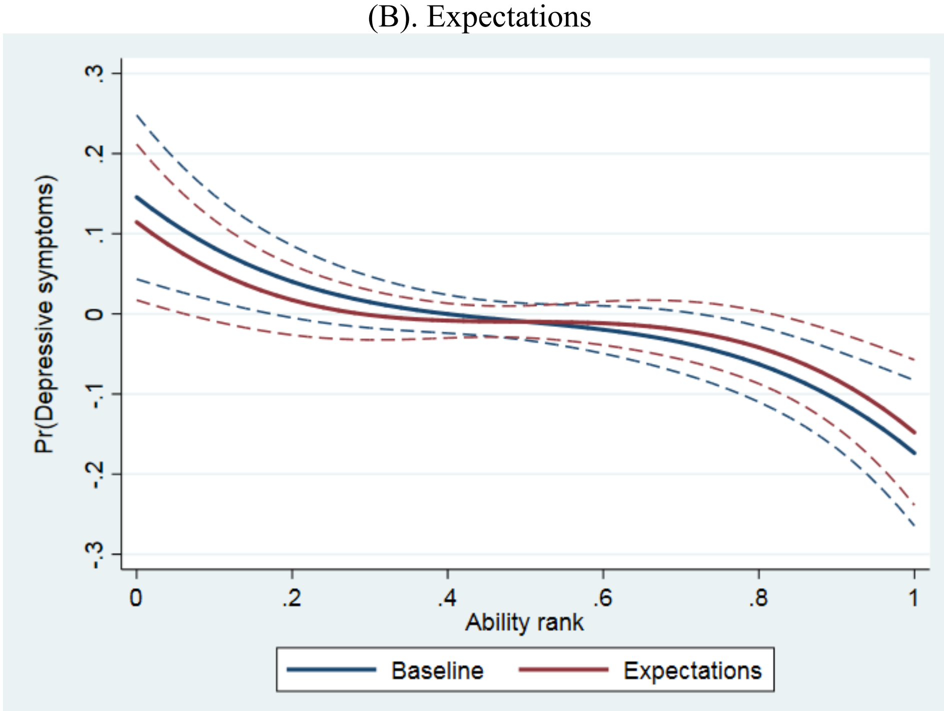
Pr(Depressive symptoms)
.1
0
-.1
-.2
-.3
-.4
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
Ability rank (Decile)
Baseline
Social relationship

***Figure A5. Mediation for the relationship between ability rank and Wave 2 depressive symptoms variables, All***

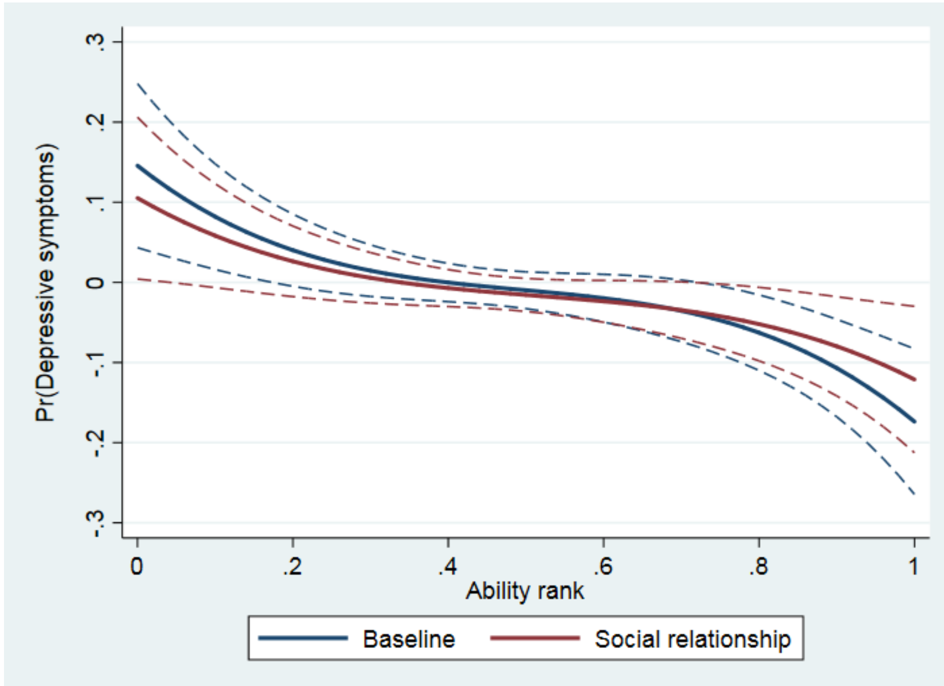
(A). Pyshcological factors




(B). Expectations




(C). Social relationship



Pr(Depressive symptoms)
.3
.2
.1
0
-.1
-.2
-.3
0
.2
.4
.6
.8
1
Ability rank
Baseline
Social relationship

# Chapter 4. Separating Social and Biological Processes: Relative Versus Absolute Body Weight and Youth Outcomes

Jinho Kim* and Jason M. Fletcher

**ABSTRACT**

A large literature has shown that people, especially women, with higher body mass index (BMI) face a range of negative life outcomes, including lower human capital accumulation and worse mental health. While both biological and sociological theories would suggest these relationships, social scientists interested in uncovering the social effects of BMI have been forced to use absolute (i.e., biological) rather than relative (i.e., social) BMI in their analyses. However, absolute measures of body mass conflate biological and social effects, and more importantly, fail to operationalize sociological theories. This, in turn, leads to mixed evidence on the links between BMI and adolescent outcomes as well as a lack of understanding of the social effects of BMI. This study uses data from the National Longitudinal Study of Adolescent to Adult Health (Add Health), leverages a quasi-experimental research design, and utilizes a relative measure of body mass. Results show that women with high relative BMI in U.S. high schools face substantial mental health burdens that translate into lower levels of school attachment as well as higher levels of school dropout, even after adjusting for absolute BMI. A component of these effects is from classmate, but not teacher nor close-friend, discrimination. Based on our results, we argue that it is essential to operationalize sociological theories, in part by shifting away from the empirical focus on absolute BMI in the literature, to make further progress in understanding how BMI affects life outcomes.

Keywords: Body Mass Index; Ordinal Rank; Health; Education; Social Comparison; Social Relationship; Social Stigma; Discrimination; Adolescence

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**1. Introduction**

Obesity is one of the major health concerns in American society. Obesity has become increasingly prevalent among adolescents in the United States (Preston et al. 2014), and is associated to other health conditions (e.g., hypertension, coronary heart disease, stroke, etc.) and socioeconomic outcomes (Himes 2000; Lundborg, Nystedt, and Rooth 2014; Masters et al. 2013; Williams et al. 2015). A wide body of literature has documented that high body mass is negatively associated with adolescents' mental health (Russell-Mayhew et al. 2012) and educational attainment (Crosnoe 2007; Crosnoe and Muller 2004). Although both biological and social theories would suggest the link between obesity and negative psychological outcomes (see, Luppino et al. 2010, for a review), social scientists and epidemiologists interested in uncovering the "social" effects of body mass rely primarily on sociological theories to guide their studies. Social psychology theory and the social stigma model are commonly used to undergird the argument that the stigma of having excessive fat leads to negative self-perceptions and weight-based discrimination, thereby reducing psychological well-being and impairing academic progress (Puhl and Heuer 2009; Schafer and Ferraro 2011).

Contrary to what sociological theories suggest, a vast majority of empirical models include a measure of "absolute" body mass (e.g., obesity status or continuous BMI scale) as the key explanatory variable. Given that sociological theories guide a vast majority of those studies, the operationalization of BMI is inconsistent and warrants critical attention. Absolute measures combine biological and social dimensions of body mass, and thereby limit our ability to investigate social mechanisms that link excessive fat and adolescent outcomes. In particular, the use of absolute body mass rests on the implicit assumption that the appropriate reference group is global (or national) rather than local. However, the notion that comparisons are made across individuals' body mass irrespective of social and geographic space is incompatible with social-psychological perspectives.

A few empirical studies have attempted to operationalize sociological theories explaining the effect of having excessive body fat by estimating the cross-level interaction of individual- and contextual-level measures of obesity status (Crosnoe and Muller 2004; Wadsworth and Pendergast 2014). In spite of the clear relevance of this approach for social-psychological theories, several methodological limitations need to be considered in interpreting the results of these studies. Their findings may be prone to biases due to the potential endogeneity of body mass (and obesity risk), as well as the inability to disentangle contextual effects from selection effects (e.g., selection into a particular neighborhood and school). Furthermore, these studies are still limited by the use of absolute body mass, a flawed measure of fatness (Burkhauser and Cawley 2008; Maralani and McKee 2017). Several scholars have argued that the use of absolute body mass is misleading by showing that weight perceptions—rather than actual weight—are associated with psychological outcomes (Atlantis and Ball 2008; Daniels 2005; Frisco, Houle, and Martin 2010; Pesa, Syre, and Jones 2000; Roberts and Duong 2013). Studies have also suggested that the mismatch between one's actual and perceived weight matters for mental health (Frisco et al. 2010), indicating the potential limitation for absolute measures and the need to consider body mass as a relative construct—i.e., body mass is meaningful in reference to others.

In addition, due to several methodological challenges, the observed associations between body mass and adolescent outcomes in extant literature may not be interpreted as causal (Nemiary et al. 2012; Russell-Mayhew et al. 2012). The association could be confounded by common causes of body mass and mental illness/low levels of educational attainment (e.g., measured and unmeasured family- and neighborhood-level characteristics). The direction of the association also remains unclear due to potential bi-directionality (e.g., depression could also lead to obesity). A few scholars have attempted to adjust for confounding factors that simultaneously predict weight and outcomes by employing models that control for lagged dependent variables, individual fixed effects models, and instrumental variables methods (e.g., Bjørngaard et al. 2015; Crosnoe and Muller 2004; Kaestner and Grossman 2009), but these studies do not disentangle social effects from biological effects.

In this study, we advance existing literature in two important ways. First, we estimate the social impacts of body mass by using a "relative" measure of body mass that allows us to separate biological and social effects. In order to operationalize relative body mass[1], we use school-based data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) to compute students' ordinal ranking as the percentile in the BMI distribution of their classmates (i.e., school cohort)[2]. Second, we leverage a quasi-experimental research design in order to estimate causal effects of relative body mass. We rely on idiosyncratic variation in cohort composition within the same school to generate quasi-random variation in relative body mass. This strategy is based on the plausible assumption that conditional on attending a given school, the cohort composition is as good as random because parents and their children only sort across schools based on the characteristics of the school, not on features of the child's cohort—i.e., school entry is determined by a student's birth date. Using "balancing tests," we show that assignment of students to ordinal ranks is quasi-random conditional on the absolute body mass and on being in a given school.

In this study, we focus on the effects of relative body mass on both psychological well-being and educational attainment among female adolescents in U.S. middle and high schools. In

[1] In this study, the term "relative body mass" is used to as a shorthand for a "relative measure of body mass," which is measured by a student's ordinal rank (or relative position) in the BMI distribution of his/her classmates.
[2] In this study, the term "classmates" refers to all students that belong to the same grade within the same school.

addition, we explore a potential channel linking these two critical adolescent outcomes: how psychological distress caused by having relatively high body mass could produce poor educational outcomes. By contextualizing excessive body fat (Maralani and McKee 2017), this research not only enhances our understanding of how being excessively fat can have a social impact on a variety of adolescent outcomes, but also helps inform public health interventions to reduce weight stigma and its ramifications among adolescents.

## 2. Background

### *2.1 The social meaning of body mass*

#### **2.1.1 Psychological process of social comparison**

Social-psychological perspectives shed light on mechanisms that may drive the effects of having excessive body fat on adolescent outcomes. In particular, the social comparison theory and reflected self-appraisal (or looking-glass self) perspective may be used to explain the process by which individuals develop and maintain self-appraisal in social contexts (e.g., Crosnoe and Muller 2004; Crosnoe 2007). Both perspectives emphasize the importance of social contexts and interpersonal interactions in the self-analysis process (Alicke et al. 2012): personal identity is constructed as well as maintained through comparing to and interacting with others in a given social environment.

Social comparison theory posits that individuals construct a self-identity by comparing their beliefs, abilities, behaviors, and characteristics to those of others who belong to a reference group in their social environment (Festinger 1954; Suls and Wheeler 2000). Similarly, the reflected self-appraisal perspective indicates that individuals develop self-understanding by interpreting others' appraisals of one's beliefs, abilities, behaviors and characteristics (Cooley 1902). This process of self-evaluation is rooted in Cooley's looking-glass self (1902) and Mead's idea of "role-taking" (1934). According to Cooley (1902), peoples' self-concepts are shaped largely by their own perceptions of how others perceive them. Hence, self-esteem may be more strongly associated with the perceived appraisals of others than with actual appraisals. For example, self-perceptions are known to be influenced more strongly by how individuals believe they are viewed by others than how they are actually viewed (Kenny and DePaulo 1993). From the symbolic interactionist perspective, Mead (1934) argues that self-image is formed through social interaction, and is an outcome of the individual's recognition of and reaction to the values and expectations of "generalized others." Since people's perceptions of themselves appear to be a social creation that relies on the individuals as well as groups of individuals one is surrounded by, empirical studies that link body mass and psychological outcomes should reflect this reality.

Social comparison theory and reflected self-appraisal perspective imply that an adolescents' own perception of their body mass compared against their reference peer group may be more important than the medically defined categories of excessive body fat such as overweight and obesity (Maralani and McKee 2017; Schafer and Ferraro 2011). For example, adolescents may have a good understanding of how their body mass compares to that of people they regularly interact with, and this comparison can provide them with a signal about their body image (Mueller et al. 2010). Therefore, two individuals with excessive body fat may hold distinct perceptions about their bodies if they are surrounded by a set of peers with different body mass composition: an adolescent who is surrounded by a group of thinner peers may perceive herself to be heavier than she actually is (e.g., Maralani and McKee 2017).

### 2.1.2 Social stigma and adolescent outcomes

The sociological tradition of social psychology explicitly focuses on the process of social stigmatization as well as its consequences (Link and Phelan 2001; Major and O'Brien 2005; Schafer and Ferraro 2011). Although there is some variability in the definition of stigma (Link and Phelan 2001), most scholars agree with the following: "people who are stigmatized have (or are believed to have) an attribute that marks them as different and leads them to be devalued in the eyes of others" (Major and O'Brien 2005:395). According to Goffman (1963), those with physical deformations or a social disability such as obesity are among the main groups of people who are likely to experience stigma. Therefore, in school settings that value thinness, adolescents with excessive fat are more likely to experience social stigmatization.

Weight-based social stigmatization is often defined as "negative weight-related attitudes and beliefs that are manifested by stereotypes, rejection, and prejudice towards individuals because they are overweight or obese" (Puhl et al. 2008:347). Stigma takes a variety of different forms and include labeling, negative stereotyping, exclusion, and discrimination (Link and Phelan 2001). In the school setting, there could be two major sources of stigmatization, including peers and teachers (Puhl and Latner 2007). For example, students may think excessive fat is an undesirable trait and prefer to exclude obese peers from their social networks (Crosnoe, Frank, and Mueller 2008; Puhl and Latner 2007). Those with more negative attitudes towards excessive fat are likely to rate peers with excessive fat negatively, and tease as well as bully them (Puhl and Latner 2007). Teachers may also discriminate against students with excessive fat by considering them less capable than their counterparts and thus having lower expectations for them (Kenney et al. 2015). In addition, the social penalties for excessive fat can vary by cultural context (Fletcher 2014).

Adolescents with excessive fat internalize both covert (e.g., bullying) and overt (e.g., ignoring, excluding, gossiping) forms of negative appraisals by groups of peers, which could lead to low self-esteem (Carr and Friedman 2005; Gray, Kahhan, and Janicke 2009). Various stigma-related stressors such as exclusion and discrimination by friends and teachers could increase psychological distress such as depression (Branigan 2017; Carr, Friedman, and Jaffe 2007; Russell-Mayhew et al. 2012). These negative psychological consequences of weight-based stigmatization could also impede adolescents' academic progress (Major and O'Brien 2005). For example, low self-esteem may decrease educational aspirations and expectations (Ball, Crawford, and Kenardy 2004). Adolescents with excessive fat may be dissatisfied with and detached from school, lack friends as well as social support, and exhibit lower academic engagement as a result. Teacher discrimination against students with excess weight (e.g., showing lower expectations) could also lead them to make less effort and achieve lower outcomes via expectancy confirmation processes, known as the "self-fulfilling prophecy" (Jussim and Harber 2005).

Local norms (in a school or class) about body mass may be more relevant sources of the stigmatization associated with excessive fat than global norms (e.g., Hechter and Opp 2001). In a social setting like a school or a classroom, friends and peers are the most important source of local norms (Coleman 1961). Adolescents' appraisal of excessive fat is likely to be based on their peers because they communicate local norms about body mass and dictate corresponding sanctions. Therefore, it is possible that excessive fat may be stigmatized in one social context but not in others. In a social setting with a lower proportion of those with excessive body fat, where local norms are likely to be less accepting of adolescents with excessive fat, peers will stigmatize those with relatively high body mass who would otherwise not have been stigmatized in a social setting more permissive of excessive body fat (e.g., Wadsworth and Pendergast 2014).

### *2.2 Challenges of measurement and causal inference*

#### 2.2.1 Absolute versus relative weight

A major challenge to understanding whether and how the effects of having excessive fat on adolescent outcomes could be "social" lies in disentangling the social effect of body mass from other effects (e.g., Maralani and McKee 2017). The majority of past research has used a measure of "absolute" body mass as the key explanatory variable. Although we have learned much from these studies, absolute measures conflate social and biological channels[3] that may drive the link between body mass and adolescent outcomes. Assuming that there is no biological effect of body mass, the effect of absolute body mass can be interpreted as a social effect only if the reference group is national, rather than local. This erroneously implies that individuals with excessive fat will be stigmatized even if everyone in their local context (local reference group) has excessive fat. Therefore, the use of absolute body mass may be incompatible with sociological theories that suggest the possibility that even people in the normal BMI range (i.e., based on absolute body mass) may suffer from stigma if their local reference group has lower body mass, on average.

A few empirical studies have attempted to examine the social impact of having excessive body fat. By estimating the cross-level interaction of individual- and contextual-level measures of body mass, Crosnoe and Muller (2004) found that being overweight is more strongly associated with negative academic achievement in schools with two prevailing characteristics—greater romantic activity and lower mean BMI, hinting at how excessive weight may matter more in certain school environments. Crosone (2007) also found that obese girls are less likely to report truancy if they attend schools where at least 10% of the student population comprised of other obese girls. Similarly, using data from the Behavioral Risk Factor Surveillance System (BRFSS), Wadsworth and Pendergast (2014) found that in U.S. counties where obesity is more prevalent the association between obesity and life satisfaction is weaker.

While closely in line with social psychological theory or a social stigma model, these studies are limited for two principal reasons. First, the use of absolute body mass is a flawed measure of fatness (Burkhauser and Cawley 2008; Maralani and McKee 2017). Second, these

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[3] In fact, absolute body weight could influence outcomes through non-biological factors, such as spurious factors related to parenting, home environments, or neighborhood exposures and discrimination occurring outside of school. Although the biological/social dichotomy is coarse, we use it as a shorthand in this study.

studies may suffer the inability to separate contextual effects of body mass from selection effects. Because people in local areas have similar body mass compared to those farther away (i.e., homophily) (Christakis and Fowler 2007; Cohen-Cole and Fletcher 2008), the use of absolute body mass in empirical analysis poses additional challenges. On one hand, high absolute body mass is correlated with exposure to a reference group who also has high absolute body mass, potentially confounding the interpretation of own-weight on outcomes. On the other hand, homophily would dampen the "effects" of absolute body mass when used as a proxy for relative body mass because some people with high absolute body mass will have low relative body mass and vice versa. These measurement issues limit the interpretation of past studies because they presumably threaten the ability to detect effects of having excessive fat that actually exist.

Several studies have used alternatives to the measure of absolute body mass by using weight perceptions, which likely reflect one's internalized social view of their body mass (Atlantis and Ball 2008; Daniels 2005; Frisco et al. 2010; Pesa et al. 2000; Roberts and Duong 2013). These studies have shown that weight perceptions—rather than actual weight—are associated with psychological outcomes, lending indirect support to the idea that a social-psychological mechanism drives the link between excessive body fat and psychological well-being. In addition, recent findings on the mismatch between one's actual and perceived weight matters for mental health (Frisco et al. 2010) hint at the need to consider body mass as a relative construct—i.e., body mass is meaningful in reference to others.

Despite the evident strengths of a relative rather than absolute measure of body mass, it is difficult to measure relative body mass in practice. Identifying an appropriate reference group with which to compare one's body mass is a major obstacle (e.g., Eibner and Evans 2005). However, based on the social psychology literature suggesting that one's reference group tends to be determined on the basis of either similarity (e.g., demographic lines such as gender and race) or geographic proximity (Singer 1981), fellow students attending the same school or school cohort may be a clearly defined and reasonable comparison groups for adolescents (e.g., Balsa, French, and Regan 2014; Crosnoe and Muller 2004; Crosnoe 2007). In this study, students' classmates are the reference group because this group is one that individuals frequently observe and interact with (Balsa et al. 2014)[4].

### 2.2.2 Additional methodological challenges

In addition to the challenge of operationalizing relative body mass, the endogeneity of body mass limits the causal interpretation of the association between excessive fat and adolescent outcomes for several reasons. First, unobserved characteristics may affect excessive body fat and adolescent outcomes simultaneously, confounding the relationship. For example, adolescents who grew up in a disadvantaged home or neighborhood are likely to be obese and show poor health as well as educational outcomes (Ludwig et al. 2011; Scharoun-Lee et al. 2011). Second, causality could be bi-directional. For example, depression could influence the risk of weight gain through a variety of channels, such as physical inactivity, unhealthy diets, and psychotropic medication use (Blaine 2008; Daumit et al. 2005; Dent et al. 2012).

Only a few studies have attempted to reduce the sources of confounding and address the issue of reverse causality. Some studies have added a set of control variables including a lagged dependent variable to adjust for initial group differences (Crosnoe 2007; Crosnoe and Muller 2004) or employed a first-difference approach (Kaestner and Grossman 2009). Other studies have adopted an instrumental variable strategy wherein offspring BMI is used as an instrument for parental BMI (Bjørngaard et al. 2015). Although these efforts are statistically sophisticated

[4] While peer groups based on nominations of best friends could serve as an alternative primary reference group and peer network data is available in Add Health, we did not consider using the data because the measure of relative body mass in the peer network would be endogenous.

attempts at estimating the causal effect of body mass, serious gaps in methodological approaches remain. To our knowledge, no study has used the idea of "relative" body mass to address methodological challenges to understanding a social mechanism underlying the effects of being excessively fat.

### *2.3 The present study*

In this study, drawing on Add Health data, we compute students' ordinal ranking as the percentile in the BMI distribution of their classmates. In order to empirically analyze the social effects of body mass, net of biological effects, we control for students' own body mass in the analysis. The relevance of this approach is couched in the idea that, regardless of an individual's actual body mass, those who have higher body mass relative to their peers (local contexts) could be adversely affected. Thus, relative body mass (after controlling for absolute body mass) is of clear conceptual interest because it exclusively conveys a social channel through which body mass affects adolescent outcomes.

In order to identify a causal effect of relative body mass, we rely on idiosyncratic variation in the cohort composition within the same school over time. The core assumption of our approach to generate quasi-experimental variation in relative body mass (holding absolute body mass constant) is that students are not purposely sorted into specific school-cohorts based on their own body mass (or based other attributes that predict both body mass and outcome variables). We present evidence consistent with our key assumption to show that cohort composition is exogenous to a host of student and family characteristics, conditional on attending a given school. Therefore, adolescents' ordinal rank in terms of the distribution of body mass in a school cohort is quasi-randomly assigned. In this study, we compare students in different cohorts in the same school who belong to the same decile of absolute BMI, but belong to a different decile of the ordinal rank of body mass in their own school cohort (due to being situated in different BMI distributions of a school cohort).

This study links relative body mass to three domains of interest. First, we investigate whether, net of absolute body mass, being relatively fat has immediate effects on a variety of measures of adolescent psychological well-being including self-esteem and depression. Second, we attempt to unpack potential mechanisms through which relative body mass may shape psychological well-being. Finally, by examining the relationship between relative body mass and educational outcomes, we explore whether the immediate effects on self-esteem and psychological distress persist through human capital channels.

Female adolescents are the focus of this study because they compose a high-risk group for weight gain as well as excessive weight, and the social stigma attached to excessive body fat is clearly more pronounced among girls than boys (Puhl and Latner 2007; Tang-Péronard and Heitmann 2008). Girls report disliking peers with excessive fat more than boys do because thinness is a salient weight category for girls and, as a result, being overweight or obese may be undesirable (Carlson Jones 2004; Kraig and Keel 2001; Ricciardelli and McCabe 2003). Thus, having excessive body fat tends to be stigmatized more often among girls than boys, leading to greater physiological as well as psychological health consequences and social marginalization that limits friendships as well as romantic relationships (Crow et al. 2008; Tang-Péronard and Heitmann 2008; Wardle, Waller, and Jarvis 2002).

## 3. Data and methods

### *3.1 Data*

The data used in this study come from the restricted version of Add Health. Add Health is a school-based, longitudinal study of the health-related behaviors of adolescents and their outcomes in young adulthood. Beginning with an in-school questionnaire administered to a nationally representative sample of students in grades 7 through 12 in 1994–1995, the study follows up with participants via a series of in-home interviews approximately one year (Wave 2), six years (Wave 3), and thirteen years later (Wave 4). Other sources of data include questionnaires for parents, siblings, fellow students, and school administrators. By design, the Add Health survey included a sample stratified by region, urbanicity, school type, ethnic mix, and size.

An unusual feature of Add Health is that the survey covers multiple cohorts within the same school. This feature is essential for the identification strategy of this study because we can compare students in different cohorts within the same school, and use school fixed effects to account for selection into schools. In addition, the longitudinal nature of the data allows us to link the relative BMI during high school to later educational outcomes.

Of the 20,745 individuals who completed the Wave 1 survey, 10,482 respondents were female. Because our explanatory variable of interest, relative BMI, is computed based on classmates' BMI, we dropped 473 respondents who had missing values on school identification code and grade level. Furthermore, we dropped 185 respondents from the grades where the number of sampled individuals was fewer than 5, leaving 9,824 students. Nonresponse to one or more control variables and height or weight information (474 students) leaves an analytic sample of 9,350[5]. When using Wave 2 outcomes, due to the Add Health sampling design, where Wave 1 12th graders were not re-surveyed at Wave 2, the final sample sums up 6,694. The final sizes of the analytic samples slightly differ across models because of different levels of missingness on each dependent variable.

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[5] In order to maximize the available sample, we imputed Wave 1 family income and mother's education level for about 2,500 respondents. We employed single imputation techniques and included in our estimation models a dummy variable identifying the cases with imputed values. We used the following variables in the imputation process: age, gender, race/ethnicity, test score, rural status, and parental socioeconomic status (if available). The analyses using other imputation methods yielded substantially similar results as the ones reported in this paper (available upon request).

***3.2 Measures***

**3.2.1 Dependent variables**

In this study, we use two measures of psychological well-being: self-esteem and depressive symptoms. The self-esteem measure is the standardized average index created from six items with a Cronbach alpha of .85 (Meier 2007): a greater summative score indicates a higher level of self-esteem. The measure of depression is the standardized average index using 19 of the 20 items from the Center for Epidemiological Studies Depression Scale (CES-D) available in Add Health (Cornwell 2003).

Two long term educational outcomes are examined in the study: high school dropout and years of schooling measured at Wave 4. Before examining the effect of relative body mass on educational attainment, we study grade point average (GPA) measures and college aspirations as intermediary outcomes. We use GPA measures from two different sources, one is self-reported and the other is from official school transcripts. Derived from official transcripts, transcript GPA is cumulative GPA on the same subjects as in self-reported GPA. A more detailed description of the dependent variables of the study is available in Table A1 in the Appendix.

**3.2.2 Key independent variable**

The key explanatory variable of this study is a student's ordinal rank in the BMI distribution of a female high-school cohort. We use self-reported height and weight in Wave 1 to compute respondents' BMI. BMI is calculated by dividing weight in kilograms (kg) by height in meter (m) squared (Center for Disease Control and Prevention 2016). Then, we compute students' ordinal rank as their percentile in the BMI distribution of the relevant female school cohort. Since the absolute rank measure does not account for different sizes of the cohort, the percentile rank is standardized to cohort size:

$$Percentile\ rank = \frac{absolute\ rank - 1}{number\ of\ students\ in\ grade} \cdots (1)$$

Since we are interested in comparing students with the same level of absolute BMI in the same school who differ in their ordinal rank because they are "exogenously" situated in different cohorts, we control for students' absolute level of BMI. Figure 1 describes to what extent relative BMI varies for a given decile in absolute BMI and shows that there are quite large differences between absolute and relative BMI. We compute VIF (Variance inflation factor) to test multicollinearity between BMI and BMI percentile rank. As a rule of thumb, a variable whose VIF values are greater than 10 may be problematic. We find that VIFs for all variables were below the rule-of-thumb cutoff of 10 with a mean VIF of 6.42, suggesting that multicollinearity is not of primary concern (See Table A2 in the Appendix). The results were almost identical when using continuous measures of BMI and BMI percentile rank (results not shown).

(Figure 1 about here)

In this study, all regression models include a set of individual-level control variables race/ethnicity, standardized PVT score, an indicator of first-born child, mother's education, family income, a dummy of missing parent information, living in a rural setting, and grade-level. Summary statistics for female samples are calculated based on the analytic sample used for estimating the effect or relative rank on Wave 1 depressive symptoms ($N$ = 9,350), and are presented in Table 1.

(Table 1 about here)

### *3.3 Analytic strategy*

The aim of the study is to estimate a causal effect of female adolescents' relative BMI (i.e., ordinal rank in terms of BMI in a school cohort) on their psychological well-being and educational outcomes. To identify a causal effect, we exploit idiosyncratic variation in cohort composition within the same school across grades. The idea is that students with the same level of absolute BMI have a different rank if they are situated in cohorts with distinct BMI distributions. The variation in cohort composition can be due to differences in mean BMI or in the dispersion of BMI within a school cohort (Elsner and Isphording 2017). Exploiting within-school variation[6], we compare the outcomes of students in cohorts within the same school (Bifulco et al. 2011; Hoxby 2000). The primary empirical specification of this paper is as follows:

$$Y_{igs} = X_{igs}B + \beta oridnal\ rank_{igs} + \delta BMI_{igs} + W_s\theta + U_g\gamma + \varepsilon_{igs}\ \cdots (2)$$

where $Y_{igs}$ is psychological and educational outcomes of individual $i$ in grade $g$ in school $s$, individual and family characteristics are contained in a vector *X*. $W_s$ is a set of school dummies that controls for unobserved school-level characteristics or confounding factors shared by all individuals within the same school while $U_g$ is a set of grade dummies that removes the mean differences in all variables between the grade levels in the sample. By separately controlling for sets of school and grade fixed effects, we rely on the variation across grades within school.

Without controlling for own BMI, the ordinal rank is a proxy for BMI. This is because a person's ordinal rank is a function of his or her own BMI. To ensure that $\beta$, our coefficients of interest, exclusively capture the impact of ordinal rank (i.e., social effects of body mass), we control for adolescents' own BMI, $\delta$, which captures a biological channel through which BMI influences psychological and educational outcomes. We use deciles of individual-level BMI because it is a more flexible functional form than analyses that use a linear measure of BMI or overweight/obesity indicators. Thus, our coefficients of interest, $\beta$, measure the impact of being in a certain decile of BMI percentile rank within a high-school cohort, compared to the fourth decile (the reference group)[7]. In particular, we are interested in the higher deciles because they are

[6] The within-school variation in BMI rank is about a standard deviation of 0.15. Given that the rank is bound between 0 and 1, a standard deviation of 0.15 is quite large. This means that at the mean cohort size of 50 female students, for a given BMI, the rank could vary on average by about 8 absolute rank positions.
[7] We use the fourth decile as the reference group because students in that decile tend to have normal weight in both absolute and relative terms: the fourth decile contains the largest proportion of students (99.4%) with normal or

those who are categorized as having "relatively" high body mass. Lastly, $\varepsilon_{igs}$ is the error term that captures all unobservable factors that affect psychological and educational outcomes. The robust standard errors are allowed to be clustered at the school level.

## 4. Results

### *4.1 Relative BMI and psychological well-being*

#### 4.1.1 Main results

Before examining the relationship between the ordinal rank in BMI and adolescents' psychological well-being, we start by showing that adolescents perceive their relative body weight in a way consistent with our assumptions. Table 2 presents odd ratios from a multinomial logistic regression in which the outcome variable is adolescents' self-perceptions about their body weight, which is measured by the following question: "How do you think of yourself in terms of weight?" (slightly/very underweight, about the right weight [reference category], and slightly/very overweight). The results show that, controlling for absolute BMI, adolescents with relatively high (low) BMI reported that they perceive themselves to be overweight (underweight). This finding implies that adolescents' relative position in terms of BMI (even controlling for their absolute body mass) is closely tied to their body image (e.g., Schafer and Ferraro 2011). Body image, in turn, could affect girls' psychological well-being and educational outcomes[8].

(Table 2 about here)

healthy weight (i.e., 5th percentile to less than the 85th percentile of the BMI-for-age percentile growth charts (Ogden et al. 2014; Ogden and Flegal 2010).

[8] It may also be interesting to examine why body weight matters less for males, and where exactly in the chain of events males are differently affected by having relatively high weight. A part of the mechanism could be that males may be oblivious to their relative body weight. If males do not perceive what their weights are relative to other classmates, the relative body mass might not affect their self-esteem or psychological distress. However, we do find that male adolescents are also well aware of their relative position within a school cohort in terms of body weight (similar results as females on Table 2 [not shown but available upon request]), whereas they are not affected by the relative body mass in terms of measures of psychological well-being and educational outcomes. These results rule out the possibility that males are not affected by their relative BMI because they do not perceive their relative body mass correctly. Perhaps, weight effects for males may work in different direction such as sports activity or something related to masculinity, which presents an important direction for future research.

Table 3 presents OLS estimates of the relationship between the ordinal rank in BMI and psychological well-being: self-esteem and depressive symptoms (both measured in Wave 1 and Wave 2). The full results for Table 3 can be found in Table A3 in the Appendix. All models include individual demographic controls, family-level controls, decile of individual-level BMI, and grade as well as school fixed effects. Columns 1 and 2 show that students in higher deciles are more likely to have lower scores on the self-esteem scale, compared to students in the fourth decile. Columns 3 and 4 present similar findings for the depression scale: those with relatively higher weight are more likely to have depressive symptoms compared to their lower weight counterparts. These findings suggest a statistically significant "social" effect of relative body mass on adolescents' psychological well-being. In other words, students who have the same absolute body mass but a distinct relative position in terms of body mass could be affected differently. The fact that our findings are very similar for Wave 1 and Wave 2 outcomes indicates that there is limited evidence for the possibility that our results may be explained by reverse causality, though there is the sample size reduction in the longitudinal model (i.e., Columns 2 and 4) due to the Add Health sampling design, where Wave 1 12th graders were not re-surveyed at Wave 2.

(Table 3 about here)

**4.1.2 Potential mechanisms**

In order to shed light on the potential mechanisms linking relative BMI to adolescents' psychological well-being and educational outcomes, we estimate some auxiliary regressions. All results are presented in Figure 2. Our examination of potential mediating variables that link relative BMI and psychological well-being centers around students' social relationships in the school settings that may server as a potential source of discrimination or stigmatization, resulting in psychological distress: school attachment, relationship with teachers and fellow students, and friendship network. A more detailed description on the measures representing the relationship with teachers and fellow students in the same school, school attachment, and friendship network are presented in Table A1 in the Appendix.

Based on existing evidence demonstrating that students with higher weights may feel discriminated against in school by both teachers and fellow students (Puhl and Latner 2007), we explore whether these sources of discrimination or stigmatization may contribute to negative psychological outcomes. First, having relatively high body mass has a consistent negative effect on students' sense of attachment to school. Panel A of Figure 2 shows that students with relatively high body mass are more likely to have lower school attachment in general: they are less likely to feel close to people at school, feel like part of school, and be happy to be at school.

(Figure 2 about here)

Panels B and C of Figure 2 present the OLS estimates of the ordinal rank as well as sets of measures representing the student-peer relationship and student-teacher relationship, respectively. As shown in the figures, we find no clear evidence that students with relatively higher weight have worse relationships with their teachers and fellow classmates. Although the sources of discrimination or stigmatization that might contribute to their school detachment still seem unclear, the results from Panel D of Figure 2 shed some light on this question. The figure presents the link between the ordinal rank and friendship nominations[9]. Results show that relatively heavy adolescents appear to send out as many nominations as other students do; however, these students receive fewer in-degree friendship nominations from fellow students (i.e., less popular among classmates).

[9] The reduced sample size reflects the fact that in Add Health, only schools where more than 50% of the student body completed the questionnaire are used to calculate network measures, including friendship nominations (Carolina Population Center 2001). To retain sample size for the mediation analysis to follow, missing data on friend network are imputed with the mean of the sample and a dummy variable indicating missingness is included.

I further investigate the mechanism process by examining to what extent the effects of ordinal BMI rank are attenuated by the inclusion of each set of mechanism variables. Tables A4 and A5 present results for depressive symptoms and self-esteem, respectively. First, it is interesting that even after controlling for self-perception of weight status, the effects of the ordinal BMI rank remain statistically significant, though the magnitude of the effect on depression and self-esteem is reduced by 18 and 25 percent, respectively. In addition, results show that controlling for the measures of school attachment attenuates the effects on depression by 13 percent and on self-esteem by 21 percent, suggesting that the negative effects of ordinal BMI rank on psychological outcomes are in part due to adolescents' school detachment. However, we find weak evidence of potential mediating roles of disadvantage in friendship network resulting from having relatively higher BMI.

In sum, our findings are inconsistent with the hypotheses suggesting that teachers or close friends stigmatize excessive body fat, and instead suggest that classmates who are not close friends could be a potential source of stigmatization. It is worth noting that about 30 and 45 percent of the effects of ordinal BMI rank on depression and self-esteem are explained by the inclusion of self-perception of weight status, school attachment, and friendship network. Therefore, more research is needed to investigate specific mechanisms through which general students (classmates) disrupt school attachment among students with relatively high BMI, thereby lowering their psychological well-being.

### *4.2 Relative BMI and educational outcomes*

We turn to the next research question to investigate whether the immediate effects of the ordinal rank on psychological well-being persist through a human capital channel. First, we examine whether the ordinal rank affects adolescents' short-term educational outcomes, such as academic achievement in school and college aspirations. Columns 1 and 2 in Table 4 present the OLS estimates of the relationship between the ordinal rank and self-reported GPA as well as transcript GPA[10]. Two main findings emerge. First, actual academic performance is not influenced by ordinal rank: the results demonstrates that the effect of ordinal rank is not significant for transcript GPA (Column 1). Second, Column 2 shows that the effect of ordinal rank is significant for self-reported GPA. Furthermore, there is a gradient rather than a threshold effect of the ordinal rank scale. In our case, a gradient is not necessarily expected because of measurement errors in the self-reports of grades. As such, this result adds depth to our finding that adolescents with relatively high body mass show lower self-esteem (Table 3).

(Table 4 about here)

Despite the absence of the effect of ordinal rank on actual academic achievement, the concentration of the misperceptions about academic performance on those with relatively high body mass suggests that the effect of the relative BMI may extend to educational attainment. That is, relative BMI does not appear to affect actual school performance (transcript GPA) but instead appears to affect perceptions of school performance (self-reported GPA), consistent with the feelings of school detachment in Panel A of Figure 2. Consistent with this view, Column 3 shows that students with a higher ordinal rank are likely to have lower college aspirations. Based on evidence of potential intermediary psychological links, we examine whether the effect of the ordinal rank persists through a human capital channel.

(Table 5 about here)

[10] The reduced sample size reflects some schools' denial to provide students' transcript records. The sample for Column 2 is restricted to those who have both transcript and self-reported GPA. However, using anyone who reports GPA yields considerably consistent results as in Column 2 (results not shown). Because it is difficult to calculate a semester GPA in a prior year that reflects the courses that respondent's self-reported GPA pertains to, we instead use cumulative GPA from the transcript files, which is the measure of cumulative human capital throughout high school. In addition, by using cumulative GPA, we can retain the seventh, eighth, and ninth graders whose transcript data of prior years of survey are not available in the AHAA (transcript) data.

Table 5 presents the OLS estimates of the relationship between the ordinal rank and educational attainment: high school dropout and years of schooling completed by Wave 4 (when respondents are 28-29 years old, on average). Column 1 demonstrates that students with a high ordinal rank are more likely to drop out of high school. Compared to those in the fourth decile in ordinal rank, those in the 10th decile are almost 8-percentage points more likely to drop out. Column 2 shows that the relationship between the ordinal rank and years of schooling completed is less clear, though there seems to be a positive gradient in the magnitude of the coefficients: students in the 10th decile show 0.13 fewer years of schooling than those in the fourth decile.

In order to investigate whether the effects of ordinal rank on education actually fades away as students transition out of their high school environments, we employ multinomial logistic regression with a categorical measure of education as the outcome: high school dropout, high school graduate (reference category), some college, and college graduate. In Table A6 in the Appendix, the auxiliary analysis suggests that effects of the ordinal rank are highly concentrated in levels of schooling below high school graduation. This finding indicates that once respondents graduate from high school, the effects of the ordinal rank no longer persist. These results suggest that relative body mass has short-term effects on educational attainment but attenuates afterward. Perhaps this occurs because social stigma associated with excessive body fat may work intensively during high school. Another possibility is that the local context changes following high school and our measure of relative BMI during high school no longer captures relative BMI in the years that follow.

Finally, we elucidate the mechanisms through which ordinal BMI rank deteriorates educational attainment. In Table A7 in the Appendix, we examine to what extent the inclusion of psychological distress and intermediate educational outcomes attenuates the link. Results demonstrate that the effect of ordinal BMI rank on high school dropout is attenuated only slightly by psychological distress including low self-esteem and depression (5 and 12 percent, respectively). On the other hand, it rather seems that intermediate educational outcomes better explain the link between ordinal BMI rank and high school dropout: about 15 and 35 percent of the effect on school dropout is explained by the inclusion of college aspirations and self-reported GPA, respectively. The inclusion of all these mechanism variables reduces 42 percent of the effect on school dropout. In sum, these results suggest that relatively higher BMI increases the likelihood of dropping out of high school through an underestimation of own ability rather than a direct effect of psychological distress.

### *4.3 Robustness checks and extensions*

#### 4.3.1 Measurement error

Several studies have suggested that self-reported height and weight among adolescents are quite reliable (Ali et al. 2013; Field et al. 2007; Schafer and Ferraro 2011). Using Wave 2 data that contain both self-reported and measured height and weight, we test whether there is systematic self-reporting bias. First, consistent with previous studies (Crosnoe and Muller 2004; Goodman, Hinden, and Khandelwal 2000), we find that the correlation between BMI calculated with Wave 2 self-reported versus measured height and weight for the female sample is very high ($r$ = 0.92). We also find that the correlation between the percentile rank calculated with self-reported versus measured BMI is very high ($r$ = 0.90). To investigate whether there is systematic misreporting associated with our key independent variable, we regress the difference between Wave 2 measured BMI and self-reported BMI on the ordinal rank from Wave 1 to examine whether students in higher deciles misreport their height and weight differently. As shown in Table A8 in the Appendix, we find no statistically significant association and no gradient by the ordinal rank.

It should also be noted that our calculation of percentile rank is based on a sample of the population of students within schools, so that the measures of percentile rank contain error. However, since the sampling scheme of Add Health was random within grades and by gender, the magnitude of errors is likely to be small. Using a subset of "saturated" schools in Add Health that surveyed all students, we test the reliability of our calculated percentile rank from a sample of the population. Adopting the same sampling strategy taken by Add Health, students in each saturated school were stratified by grade and sex. Then, regardless of the size of the school, 17 students were randomly chosen from each stratum (Harris 2013). Using this randomly sampled group of students, we calculated percentile rank in terms of BMI, and then took the absolute distance from the "true" percentile rank computed from the population. We iterated this process 100 times. Figure A1 in the Appendix shows the distribution of the average of the absolute difference between percentile ranks calculated from a sample versus a population (mean = 0.07, SD = 0.05). The figure demonstrates that for the vast majority of observations, the difference is smaller than 0.1, which is negligible because we use deciles of the ordinal rank in our analysis.

Finally, we assess whether our results are robust to alternative thresholds of required school-grade size (i.e., 5, 10, 15, and 20). In Tables A9-A11, results show that our results are not sensitive to using different samples with different minimum number of students required per school-grade.

#### **4.3.2 Exogeneity of ordinal rank**

In order to further establish a causal relationship of the ordinal rank on adolescent outcomes, we conduct some auxiliary analyses. These examine the potential endogeneity of the ordinal rank. A specific question is whether students react to previous relative BMI by taking actions that change their relative BMI in the future. If they successfully are able to "choose" their relative BMI, then our relative BMI measure at Wave 1 is potentially endogenous to the mental health processes of interest. In order to pursue this question, we first regress Wave 2 BMI on the ordinal rank at Wave 1; additionally, we regress the difference between Wave 2 and Wave 1 BMI on the ordinal range at Wave 1. Thus, the two regressions examine the possible endogeneity in both levels of BMI and changes in BMI. In Table A12 in the Appendix, Column 1 suggests that those in higher deciles gain more weight in Wave 2. Column 2 shows no evidence that the ordinal rank endogenously determines *changes* in weight between the waves. In sum, we interpret these results to be inconsistent with the possibility of endogeneity of the ordinal rank.

As a second effort to examine the potential endogeneity of relative BMI, we conduct "balancing tests" that examine whether moments of the cohort BMI distribution (i.e. the mean and standard deviation) in terms of across cohort BMI are correlated with predetermined student attributes (e.g., family characteristics). In Table A13 in the Appendix, Column 1 shows that grade-level mean BMI excluding the focal student is significantly associated with a variety of individual characteristics. However, when controlling for school fixed effects from our preferred empirical specification, the associations disappear (Column 2). Columns 3 and 4 present similar results with grade-level standard deviation of BMI. In sum, these results indicate that students are not sorted purposefully into particular school-cohort characteristics, and therefore, relative position with respect to BMI distribution in a school cohort is plausibly exogenous. Figure A2 plots these results.

#### 4.3.3 Miscellaneous sensitivity checks

In order to provide more stringent test of the causal effects of BMI rank, this study exploits exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school. Although a sibling comparison model is better at addressing several important possible threats to internal validity of this study (e.g., eliminating potential confounding such as family background characteristics and school selection), it could produce biased estimates in case of violation of the central assumption that there are no spillovers between siblings (Fletcher and Wolfe 2008). In Table A14 in the Appendix, family-fixed effects models produce qualitatively similar results: after controlling for shared unobserved heterogeneity at the family level, ordinal BMI rank appears to have an impact on adolescent psychological well-being and educational attainment, though in some models the standard errors are too large to find statistically significant results. However, again, these fixed effects estimates should be interpreted cautiously due to potential sibling spillover effects.

In addition, I further address the possibility of contextual-level confounders. In the baseline model, I include separate fixed effects for schools and cohorts, allowing for comparisons of students with the same absolute ability who belong to different cohorts in the same school. The school fixed effects control for observed and unobserved factors that affect selection into schools. However, school-cohort specific confounding factors (e.g., teacher quality and classroom environment) cannot be captured by these separate school and cohort fixed effects.

An alternative specification would be to include school by grade fixed effects rather than school fixed effects and grade fixed effects. A disadvantage of using this specification is that relative and absolute body mass would be confounded more explicitly, whereby in order for a student to have a higher relative body mass than another student in the same school-grade, he or she must have a higher BMI. Thus, the effects of relative body mass would be uncovered in part based on the functional form assumptions we make about the effects of absolute body mass. In our preferred specification of using school fixed effects and grade fixed effects, we are able to compare students across school-grades and thus separate the relative and absolute effects of BMI on outcomes. For example, a relatively heavy student in 10th grade could have lower absolute BMI than a relatively heavy student in 9th grade in a given school. Despite this limitation, I show that the results of this study are robust to controls for several important grade-level characteristics as well as school-by-grade fixed effects (Table A15 in the Appendix).

Given the fact that social position is multidimensional in nature and adolescents may belong to multiple social hierarchies (Sweeting et al. 2011), I examine whether the rank effects found in this study are robust to controlling for rank measures of other salient characteristics for young people. In this supplementary analysis, I control for two additional rank measures created based on ability and parental income. As shown in Tables A16-A18 in the Appendix, even after controlling for these rank measures, the coefficients for the nonlinear effects of ordinal BMI rank remain almost identical and statistically significant across all outcome variables. Interestingly, it seems that these two rank measures appear to have an impact on adolescent depression independently from the effects of ordinal BMI rank.

In Tables A19-A20 in the Appendix, I show results of sensitivity checks with respect to the definition of BMI hierarchies. In order to test whether the results of this study are robust to alternative operationalization of the hierarchies. Borrowing from the relative deprivation literature, I use several relative deprivation measures (so-called "upward-looking" measure) that are designed to capture average distance between an individual's characteristic (affluence) and aggregate-level characteristic for those above the individual, within a social reference group (Adjaye-Gbewonyo and Kawachi 2012; Runciman 1966; Stewart 2006). Results do not show any evidence on the relationship between these alternative measures of ability hierarchy and adolescent depression. One of the possible explanations is that students may not be sophisticated enough or lack more detailed information to assess or measure the "quantity" of relative advantage or disadvantage in terms of BMI while they have a relatively good understanding of where one stands in relation to the reference group (Tversky and Kahneman 1974). This also appears to provide further support for the nonlinear nature of the effects of ordinal BMI rank on adolescent outcomes since it is much easier and reliable to figure out who is at the top or bottom of the BMI distribution (due to the visibility of BMI) than to correctly rank students at the middle of the distribution.

Finally, in order to assess whether estimates of the effect of relative BMI are an artifact of a highly non-linear relationship between BMI and adolescent outcomes, I allow for a more flexible functional form of absolute BMI. Specifically, I test whether the results of this study are robust to replacing BMI deciles with 40 dummies for each discrete level of BMI (equivalent to BMI fixed effects). Using this specification, the empirical results remain substantially similar (Table A21 in the Appendix).

**5. Discussion and conclusion**

This paper examines the social effects of body mass on psychological well-being and educational attainment among female adolescents enrolled in middle and high school in the United States. In this study, we address several important limitations that much of the extant research on this topic contains. For example, past research has been limited by the use of theoretically problematic measures of body weight and by the endogeneity of excess weight. This study overcomes important conceptual and methodological limitations by focusing on “relative” body mass. Furthermore, our ability to leverage quasi-random variation in relative body mass allows us to focus on estimating causal effects.

We find that our measure of the ordinal rank has a statistically significant negative effect on adolescents’ psychological well-being including self-esteem and depression. We further explore the mechanisms of the effects of relative body mass by examining whether teacher and friends could be potential sources of stigmatization or discrimination. We find no evidence that disadvantages in relationship with teachers and friends are a plausible pathway. Rather, evidence suggests that, school detachment as well as (non-friend) classmate discrimination form part of the mechanism through which relative body mass affect adolescents' psychological well-being.

In addition to the adverse effects of relative body mass on adolescents' psychological well-being, this study also finds negative effects on educational attainment. Our findings, however, suggest that these negative effects of having relatively high mass on education are short-term. While the ordinal rank increases the probability of dropping out of high school, the effect fades away for individuals who graduate from high school. Results also suggest a particular pathway linking relative body mass, psychological well-being, and educational attainment: those with relatively high body mass tend to perceive themselves to perform worse academically (i.e., lower self-reported GPA) than they actually do and have lower college aspirations. Combined with our earlier finding of the negative effect of relative body mass on self-esteem, these findings highlight the potential psychological processes that may underpin the relationship between ordinal rank and high school dropout. To summarize, results of this study suggest that there is a pure social effect of body mass on adolescent outcomes, and social context plays an important role in it. In other words, whether body mass (or excessive body fat) matters for your psychological well-being and educational attainment highly depends on where one is situated or by whom one is surrounded.

This study is not without limitations. First, we use self-reported (not measured) height and weight to compute BMI. In order to overcome this potential limitation, we show evidence of high reliability of self-reported height and weight in the Add Health. In short, using Wave 2 data that contain both self-reported and measured height and weight, we demonstrate that there is no systematic misreporting associated with our key independent variable. In addition, several studies have suggested that self-reported height and weight among adolescents are quite reliable (Ali, Minor, and Amialchuk 2013; Field, Aneja, and Rosner 2007; Schafer and Ferraro 2011). A second limitation associated with the data is potential measurement error in percentile ranks arising from using sampled students within schools, rather than the population of schools. Although a robustness test using a subset of “saturated” schools in Add Health that surveyed all students provides strong evidence of the validity and reliability of percentile ranks with statistically negligible error, readers should interpret our findings with caution. Potential measurement error may lead to attenuation bias.

This study argues that it is critically necessary to operationalize sociological theories to advance our understanding of how body mass shapes adolescent outcomes. In the present study, we suggest the need to shift away from the empirical focus on absolute body mass in the literature. The use of absolute body mass implicitly sets an implausible reference group to which students compares their body mass, obscuring the fact that the most relevant associations between body mass and adolescent outcomes are shaped by social contexts (school contexts in this study) rather than any given value of BMI. The conceptualization of body mass as a relative construct—rather than an objective standard—and the measurement of “relative” body mass in this study is a first step toward explaining the “social” effects of body mass on health and educational outcomes among adolescents.

Even with the increased prevalence of overweight/obesity, stigmatization has not decreased, but rather increased in the past 40 years (Latner and Stunkard 2003; Ogden et al. 2014). The findings of this study are relevant to policy in several ways. Our findings that the effects of body mass depend on a social context (e.g., BMI distribution of a school cohort) suggest that interventions aimed specifically at obese adolescents may miss adolescents at risk who are not obese but have relatively higher body mass compared to members of their social group. In addition, the finding that stigmatization appears to originate from fellow students in general (e.g., classmates) rather than teachers and close friends suggests that school-based programs focused on the promotion of social integration of the students at the school level may be more effective than interventions such as providing psychological counseling and services tailored for adolescents who are obese.

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**7. Tables**

***Table 1. Summary statistics for female adolescents, National Longitudinal Study of Adolescent to Adult Health (N = 6,694)***

| | Wave | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| *Body weight* | | | | | |
| BMI Percentile rank | 1 | 0.492 | 0.304 | 0.0 | 1.0 |
| BMI | 1 | 22.206 | 4.458 | 12.0 | 49.1 |
| *Dependent variables* | | | | | |
| Self-esteem | 1 | -0.123 | 1.041 | -5.2 | 1.5 |
| Self-esteem | 2 | -0.088 | 1.020 | -5.4 | 1.4 |
| Depressive symptom | 1 | 0.095 | 1.067 | -1.5 | 5.6 |
| Depressive symptom | 2 | 0.092 | 1.059 | -1.5 | 5.1 |
| HS dropout | 4 | 0.114 | 0.318 | 0.0 | 1.0 |
| Years of schooling | 4 | 13.634 | 1.944 | 8.0 | 19.0 |
| Think underweight | 1 | 0.120 | 0.324 | 0.0 | 1.0 |
| Think about the right weight | 1 | 0.491 | 0.500 | 0.0 | 1.0 |
| Think overweight | 1 | 0.389 | 0.488 | 0.0 | 1.0 |
| Transcript GPA | 1 | 2.512 | 0.847 | 0.0 | 4.0 |
| Self-reported GPA | 1 | 2.822 | 0.841 | 0.5 | 4.0 |
| Want to go to college | 1 | 0.749 | 0.433 | 0.0 | 1.0 |
| *Mechanism variables* | | | | | |
| Feel close to people at school | 1 | 0.206 | 0.404 | 0.0 | 1.0 |
| Feel like part of school | 1 | 0.264 | 0.441 | 0.0 | 1.0 |
| Happy to be at school | 1 | 0.243 | 0.429 | 0.0 | 1.0 |
| Difficulty getting along with teachers | 1 | 0.065 | 0.247 | 0.0 | 1.0 |
| Teachers care about you | 1 | 0.177 | 0.381 | 0.0 | 1.0 |
| Teachers treat students fairly | 1 | 0.153 | 0.360 | 0.0 | 1.0 |
| Difficulty getting along with other students | 1 | 0.075 | 0.264 | 0.0 | 1.0 |
| Friends care about you | 1 | 0.505 | 0.500 | 0.0 | 1.0 |
| Students are prejudiced | 1 | 0.139 | 0.346 | 0.0 | 1.0 |
| Friend nominations received | 1 | 1.548 | 0.678 | 0.0 | 3.3 |
| Friend nominations sent | 1 | 4.735 | 2.892 | 0.0 | 10.0 |
| Centrality | 1 | 0.875 | 0.626 | 0.0 | 4.2 |
| *Control variables* | | | | | |
| White | 1 | 0.542 | 0.498 | 0.0 | 1.0 |
| Black | 1 | 0.233 | 0.423 | 0.0 | 1.0 |
| Hispanic | 1 | 0.153 | 0.360 | 0.0 | 1.0 |
| Other race/ethnicity | 1 | 0.072 | 0.258 | 0.0 | 1.0 |
| Age | 1 | 15.735 | 1.571 | 12.0 | 21.0 |
| Standardized PVT score | 1 | -0.010 | 0.936 | -5.6 | 2.5 |
| First-born | 1 | 0.500 | 0.500 | 0.0 | 1.0 |
| Mother's education | 1 | 13.136 | 2.330 | 0.0 | 17.0 |
| Family income | 1 | 0.458 | 0.459 | 0.0 | 10.0 |
| Missing family information dummy | 1 | 0.293 | 0.455 | 0.0 | 1.0 |
| Rural status | 1 | 0.258 | 0.438 | 0.0 | 1.0 |
| Grade 7 | 1 | 0.153 | 0.360 | 0.0 | 1.0 |

| | | | | | |
|---|---|---|---|---|---|
| Grade 8 | 1 | 0.151 | 0.358 | 0.0 | 1.0 |
| Grade 9 | 1 | 0.200 | 0.400 | 0.0 | 1.0 |
| Grade 10 | 1 | 0.227 | 0.419 | 0.0 | 1.0 |
| Grade 11 | 1 | 0.222 | 0.416 | 0.0 | 1.0 |
| Grade 12 | 1 | 0.047 | 0.211 | 0.0 | 1.0 |

*Note.* Family income and maternal education contain imputed values and parent missing data dummy reflects this missingness.

***Table 2. Multinomial logistic regression estimates: Ordinal rank and body image***

| | (1)<br>About the right weight<br>(reference) vs. Underweight<br>(W1) | (2)<br>About the right weight<br>(reference) vs. Overweight<br>(W1) |
|---|---|---|
| *Decile rank* | | |
| Decile 1 | 2.363*** | 0.535* |
| | (0.460) | (0.132) |
| Decile 2 | 1.248 | 0.955 |
| | (0.225) | (0.139) |
| Decile 3 | 1.045 | 1.181 |
| | (0.184) | (0.156) |
| Decile 4 (ref) | 1.000 | 1.000 |
| | (.) | (.) |
| Decile 5 | 0.944 | 1.334* |
| | (0.164) | (0.192) |
| Decile 6 | 0.678+ | 1.214 |
| | (0.148) | (0.179) |
| Decile 7 | 0.741 | 1.307+ |
| | (0.198) | (0.189) |
| Decile 8 | 0.473* | 1.524** |
| | (0.158) | (0.242) |
| Decile 9 | 0.599 | 1.751** |
| | (0.219) | (0.346) |
| Decile 10 | 1.185 | 2.426*** |
| | (0.563) | (0.631) |
| N(School) | 134 | 134 |
| N(Obs) | 9351 | 9351 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table 3. OLS regression estimates: Ordinal rank and psychological well-being***

| | (1)<br>Self-esteem<br>(W1) | (2)<br>Self-esteem<br>(W2) | (3)<br>Depressive<br>symptoms<br>(W1) | (4)<br>Depressive<br>symptoms<br>(W2) |
|---|---|---|---|---|
| *Decile rank* | | | | |
| Decile 1 | -0.055 | 0.033 | 0.096 | -0.030 |
| | (0.069) | (0.075) | (0.069) | (0.084) |
| Decile 2 | -0.055 | 0.035 | 0.108$^{+}$ | 0.016 |
| | (0.058) | (0.062) | (0.057) | (0.070) |
| Decile 3 | -0.050 | 0.016 | 0.069 | 0.034 |
| | (0.048) | (0.060) | (0.050) | (0.056) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) |
| Decile 5 | 0.017 | 0.041 | 0.050 | 0.073 |
| | (0.048) | (0.058) | (0.052) | (0.053) |
| Decile 6 | 0.023 | 0.029 | 0.072 | 0.094 |
| | (0.046) | (0.061) | (0.050) | (0.063) |
| Decile 7 | -0.008 | -0.060 | 0.098$^{+}$ | 0.071 |
| | (0.050) | (0.060) | (0.054) | (0.067) |
| Decile 8 | -0.079 | -0.076 | 0.132$^{*}$ | 0.187$^{*}$ |
| | (0.062) | (0.073) | (0.065) | (0.086) |
| Decile 9 | -0.121$^{+}$ | -0.235$^{**}$ | 0.143$^{*}$ | 0.281$^{**}$ |
| | (0.072) | (0.083) | (0.070) | (0.095) |
| Decile 10 | -0.210$^{*}$ | -0.257$^{**}$ | 0.171$^{*}$ | 0.225$^{*}$ |
| | (0.088) | (0.093) | (0.081) | (0.103) |
| N(School) | 134 | 134 | 134 | 134 |
| N(Obs) | 9342 | 6692 | 9350 | 6694 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table 4. OLS regression estimates: Ordinal rank and GPA and college aspirations***

| | (1)<br>Transcript GPA<br>(W1) | (2)<br>Self-reported GPA<br>(W1) | (3)<br>Want to go to college<br>(W1) |
|---|---|---|---|
| *Decile rank* | | | |
| Decile 1 | -0.009 | -0.039 | -0.032 |
| | (0.067) | (0.065) | (0.025) |
| Decile 2 | -0.044 | $-0.119^{*}$ | 0.005 |
| | (0.056) | (0.057) | (0.023) |
| Decile 3 | -0.002 | -0.022 | 0.005 |
| | (0.049) | (0.043) | (0.018) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) |
| Decile 5 | -0.030 | -0.041 | 0.012 |
| | (0.047) | (0.044) | (0.020) |
| Decile 6 | -0.011 | -0.046 | $-0.041^{*}$ |
| | (0.044) | (0.039) | (0.017) |
| Decile 7 | -0.079 | $-0.104^{*}$ | $-0.045^{*}$ |
| | (0.052) | (0.051) | (0.019) |
| Decile 8 | -0.090 | $-0.142^{*}$ | $-0.052^{*}$ |
| | (0.061) | (0.059) | (0.023) |
| Decile 9 | -0.078 | $-0.157^{*}$ | $-0.054^{+}$ |
| | (0.065) | (0.064) | (0.028) |
| Decile 10 | -0.110 | $-0.250^{**}$ | $-0.085^{*}$ |
| | (0.086) | (0.078) | (0.034) |
| N(School) | 133 | 133 | 134 |
| N(Obs) | 5790 | 5790 | 9329 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

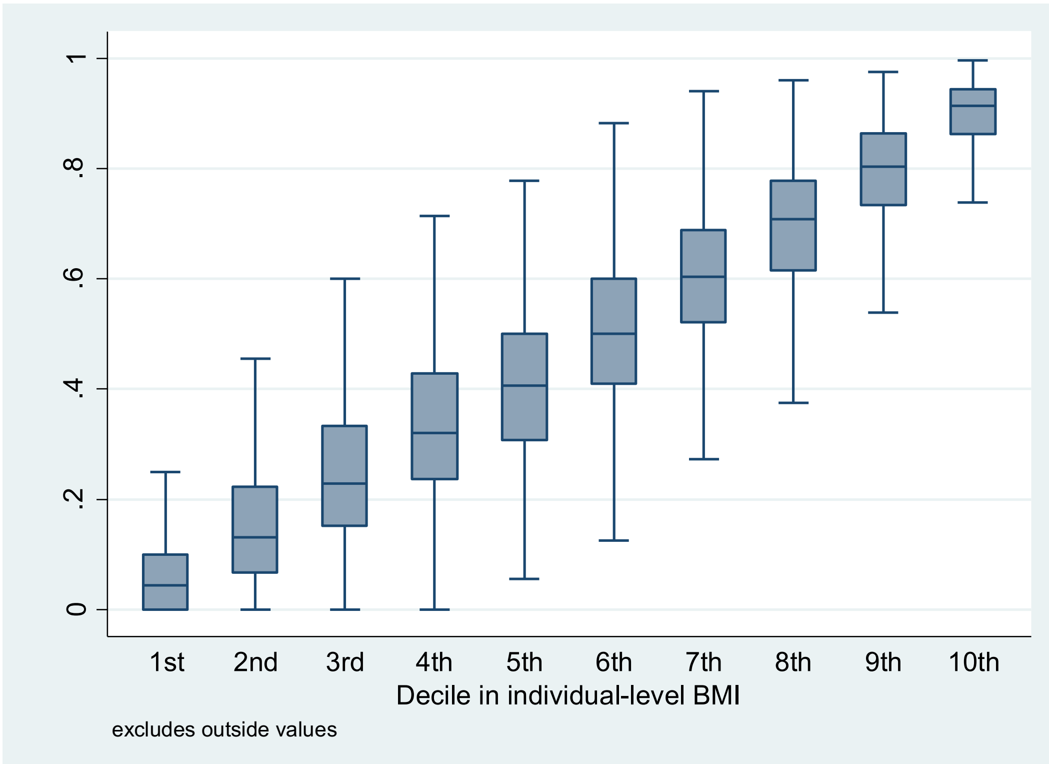
***Table 5. OLS regression estimates: Ordinal rank and educational attainment***

| | (1) High school dropout (W4) | (2) Years of schooling (W4) |
|---|---|---|
| *Decile rank* | | |
| Decile 1 | 0.021 | -0.253* |
| | (0.020) | (0.123) |
| Decile 2 | 0.037* | -0.154 |
| | (0.015) | (0.111) |
| Decile 3 | 0.027* | -0.132 |
| | (0.013) | (0.095) |
| Decile 4 (ref) | 0.000 | 0.000 |
| | (.) | (.) |
| Decile 5 | 0.003 | 0.012 |
| | (0.014) | (0.095) |
| Decile 6 | -0.001 | -0.028 |
| | (0.014) | (0.084) |
| Decile 7 | 0.011 | 0.017 |
| | (0.018) | (0.104) |
| Decile 8 | 0.022 | -0.072 |
| | (0.021) | (0.132) |
| Decile 9 | 0.042+ | -0.105 |
| | (0.024) | (0.125) |
| Decile 10 | 0.073** | -0.131 |
| | (0.027) | (0.158) |
| N(School) | 134 | 134 |
| N(Obs) | 7584 | 7584 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

## 8. Figures

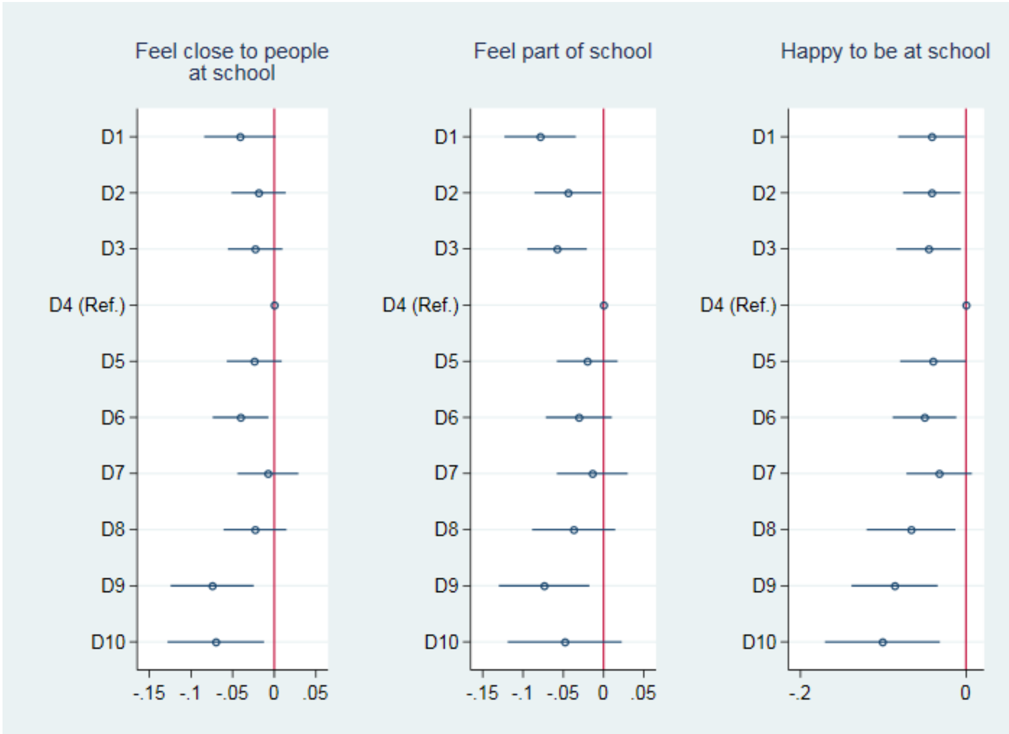
***Figure 1. Individual-level BMI and percentile rank***



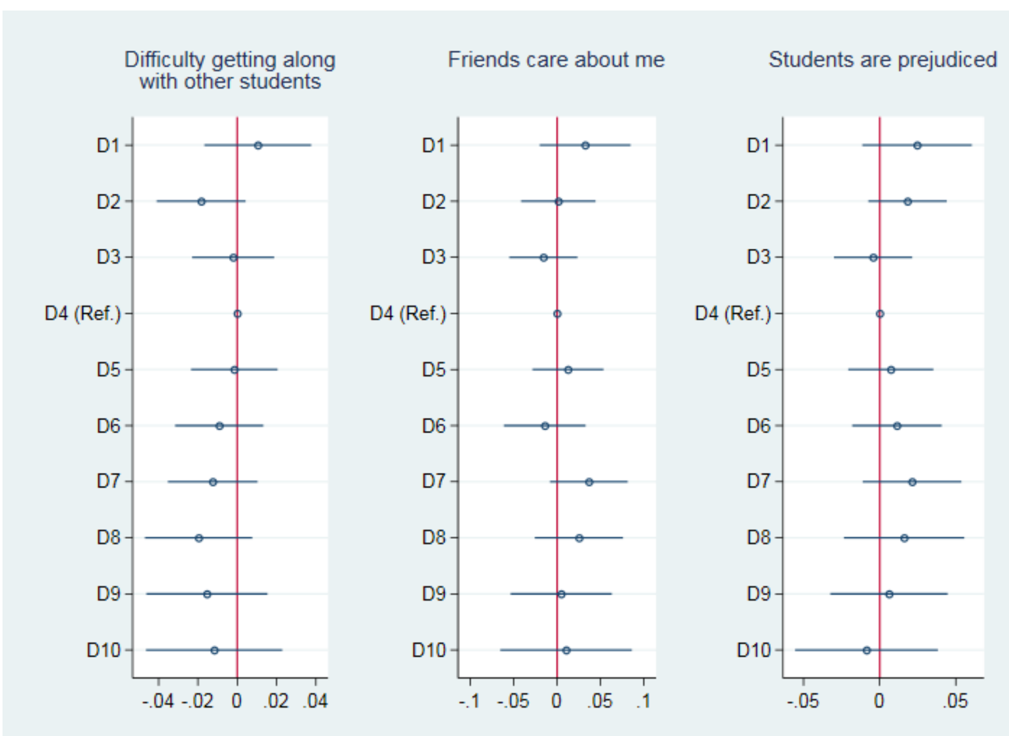

*Note*: The figure presents the variation in the relative rank for a given decile in individual-level BMI. The boxes represent the interquartile range with the median indicated by blue line, and the whiskers extend to the most extreme data point within 1.5 times the interquartile range from the edge of the box.

***Figure 2. Relationship between ordinal BMI rank and social relationships***

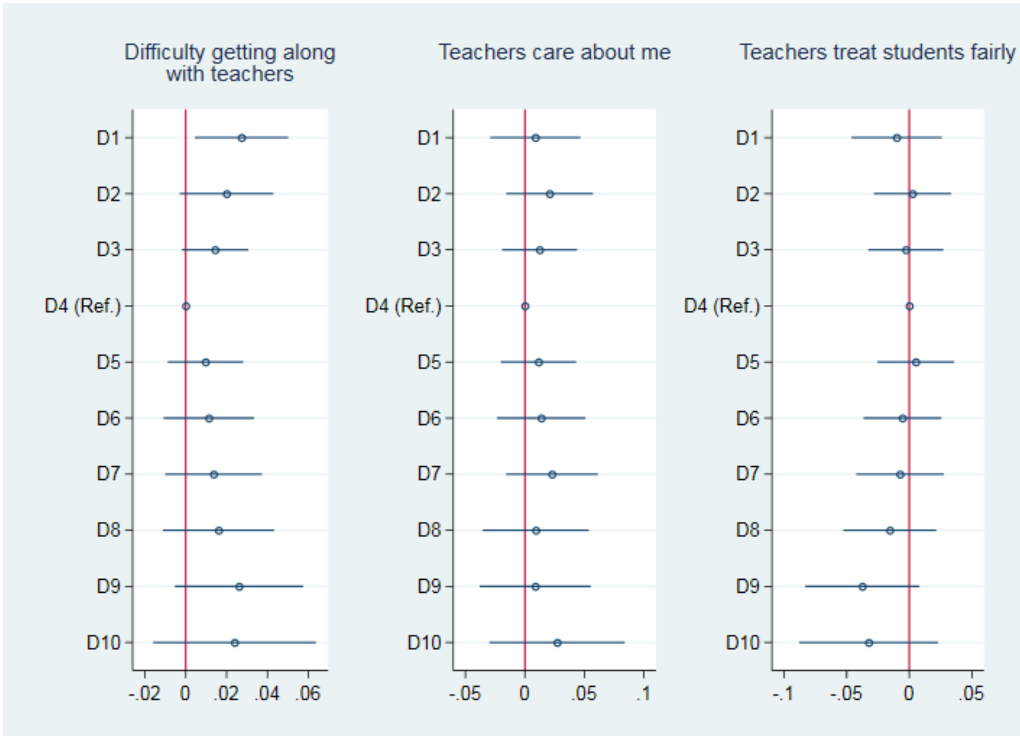
(A) School attachment



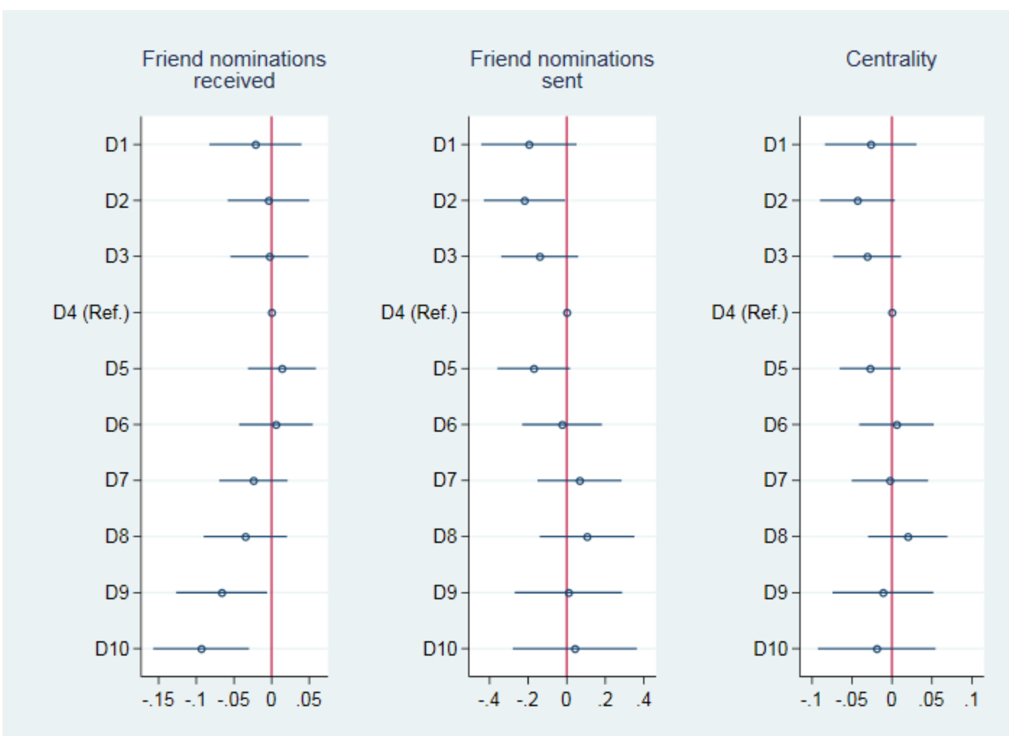

(B) Relationship with friends



(C) Relationship with teachers




(D) Friendship network



*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

## 9. Appendix tables

***Table A1. Description of dependent and mechanism variables***

| Variable | Description | Range |
|---|---|---|
| ***Dependent variables*** | | |
| *Psychological well-being* | | |
| Self-esteem | Average of six items: (1) I have a lot of good qualities; (2) I have a lot to be proud of; (3) I like myself just the way I am; (4) I feel like I am doing everything just about right; (5) I feel socially accepted; and (6) I feel loved and wanted. | 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree |
| Depressive symptoms | Average of 19 items from the Center for Epidemiological Studies Depression Scale (CES-D) that are available in the Add Health data set: (1) You were bothered by things that usually don't bother you; (2) You didn't feel like eating, your appetite was poor; (3) You felt that you could not shake off the blues, even with help from your family and your friends; (4) You felt that you were just as good as other people (R); (5) You had trouble keeping your mind on what you were doing; (6) You felt depressed; (7) You felt that you were too tired to do things; (8) You felt hopeful about the future (R); (9) You thought your life had been a failure; (10) You felt fearful; (11) You were happy (R); (12) You talked less than usual; (13) You felt lonely; (14) People were unfriendly to you; (15) You enjoyed life (R); (16) You felt sad; (17) You felt that people disliked you; (18) It was hard to get started doing things; and (19) You felt life was not worth living | 0 = rarely or none of the time; 1 = some of the time; 2 = occasionally; and 3 = all of the time |
| *Educational outcomes* | | |
| High school dropout | Whether the respondent reported completing less than twelfth grade | 0 = no; 1 = yes |
| Years of schooling | "What is the highest grade or year of regular school you have completed?" | 8 – 19 |
| Transcript GPA | Cumulative GPA from the official school transcripts on the following subjects: English/language arts, math, science, and social studies/history | 0 – 4 |
| Self-reported GPA | Average of self-reported grades in English/language arts, math, science, and social studies/history | 0.5 = D or lower; 2 = C; 3 = B; 4 = A |

| | | |
|---|---|---|
| Want to go to college | "On a scale of 1 to 5, where 1 is low and 5 is high, how much do you want to go to college?" | 0 = 0 – 4; 1 = 5 |
| ***Mechanism variables*** | | |
| Difficulty getting along with teachers | "How often the respondent had trouble getting along with teachers?" | 0 = never/just a few times/about once a week; 1 = almost every day/every day |
| Teachers care about you | "How much the respondent agrees that teachers care about them?" | 0 = not at all/very little/somewhat/quite a bit; 1 = very much |
| Teachers treat students fairly | "How much the respondent feels that teachers at school treat students fairly?" | 0 = strongly disagree/disagree/neither agree nor disagree/agree; 1 = strongly agree |
| Difficulty getting along with other students | "How often the respondent had trouble getting along with other students?" | 0 = never/just a few times/about once a week; 1 = almost every day/every day |
| Friends care about you | "How much the respondent agrees that friends care about her?" | 0 = not at all/very little/somewhat/quite a bit; 1 = very much |
| Students are prejudiced | "How much the respondent feels that students at school are prejudiced?" | 0 = strongly disagree/disagree/neither agree nor disagree/agree; 1 = strongly agree |
| Feel close to people at school | "Do you feel close to people at school?" | 0 = strongly disagree/disagree/neither agree nor disagree/agree; 1 = strongly agree |
| Feel like part of school | "Do you feel like being part of school?" | 0 = strongly disagree/disagree/neither agree nor disagree/agree; 1 = strongly agree |
| Happy to be at school | "Are you happy to be at school?" | 0 = strongly disagree/disagree/neither agree nor disagree/agree; 1 = strongly agree |
| Friend nominations sent* | Number of nominations that each individual sent to other high school classmates | 0 – 10 |
| Friend nominations received*⁺ | Natural log of the number of nominations that each individual received from other high school classmates | 0 – 3.5 |

*Note*: (R) indicates a reverse-coded item. * The network measures are provided by the in-school data of the Add Health. The network measures were calculated using in-school survey data, and only schools where more than 50% of the student body completed the questionnaire were used, to increase the reliability of the measures (see Carolina Population Center 2001, for more details). ⁺ We take the natural logarithm of in-degree to account for the high skewness in this variable.

***Table A2. Tests for multicollinearity between BMI and BMI percentile rank***

| | (1) | | (2) | |
|---|---|---|---|---|
| | VIF | Tolerance (1/VIF) | VIF | Tolerance (1/VIF) |
| *Decile rank* | | | | |
| Decile 1 | 4.14 | 0.24 | 3.88 | 0.26 |
| Decile 2 | 2.51 | 0.40 | 2.42 | 0.41 |
| Decile 3 | 2.00 | 0.50 | 1.98 | 0.51 |
| Decile 4 (ref) | - | - | - | - |
| Decile 5 | 1.89 | 0.53 | 1.87 | 0.54 |
| Decile 6 | 2.39 | 0.42 | 2.30 | 0.43 |
| Decile 7 | 2.83 | 0.35 | 2.65 | 0.38 |
| Decile 8 | 3.42 | 0.29 | 3.11 | 0.32 |
| Decile 9 | 4.57 | 0.22 | 3.95 | 0.25 |
| Decile 10 | 5.04 | 0.20 | 4.31 | 0.23 |
| *BMI deciles* | | | | |
| Decile 1 (ref) | - | - | - | - |
| Decile 2 | 2.31 | 0.43 | 2.22 | 0.45 |
| Decile 3 | 3.24 | 0.31 | 3.04 | 0.33 |
| Decile 4 | 3.85 | 0.26 | 3.54 | 0.28 |
| Decile 5 | 4.29 | 0.23 | 3.85 | 0.26 |
| Decile 6 | 5.05 | 0.20 | 4.42 | 0.23 |
| Decile 7 | 5.79 | 0.17 | 4.93 | 0.20 |
| Decile 8 | 6.55 | 0.15 | 5.43 | 0.18 |
| Decile 9 | 7.51 | 0.13 | 6.05 | 0.17 |
| Decile 10 | 9.49 | 0.11 | 7.45 | 0.13 |
| Mean VIF | 6.42 | | 3.66 | |

*Note.* VIF (Variance inflation factor) is calculated as a diagnostic of multicollinearity between BMI and BMI percentile rank. As a rule of thumb, a variable whose VIF values are greater than 10 may be problematic. VIF in Column 1 is obtained by using the Stata's *vif* command after the regression of Column 1, Table 3. The results in Column 1 should be interpreted carefully because fixed effects models often generate relatively large VIF scores. VIF in Column 2 is obtained by using the Stata's *collin* command which does not need to be run following a regression. In this command, we compute VIF for all independent variables included in the regression of Column 1, Table 3. Without a set of school dummies, the VIF values in Column 2 are smaller than in the ones in Column 1.

***Table A3. Full results for Table 3 of OLS regression estimates: Ordinal rank and psychological well-being***

| | (1) Self-esteem (W1) | (2) Self-esteem (W2) | (3) Depressive symptoms (W1) | (4) Depressive symptoms (W2) |
|---|---|---|---|---|
| *Decile rank* | | | | |
| Decile 1 | -0.055 | 0.033 | 0.096 | -0.030 |
| | (0.069) | (0.075) | (0.069) | (0.084) |
| Decile 2 | -0.055 | 0.035 | $0.108^{+}$ | 0.016 |
| | (0.058) | (0.062) | (0.057) | (0.070) |
| Decile 3 | -0.050 | 0.016 | 0.069 | 0.034 |
| | (0.048) | (0.060) | (0.050) | (0.056) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) |
| Decile 5 | 0.017 | 0.041 | 0.050 | 0.073 |
| | (0.048) | (0.058) | (0.052) | (0.053) |
| Decile 6 | 0.023 | 0.029 | 0.072 | 0.094 |
| | (0.046) | (0.061) | (0.050) | (0.063) |
| Decile 7 | -0.008 | -0.060 | $0.098^{+}$ | 0.071 |
| | (0.050) | (0.060) | (0.054) | (0.067) |
| Decile 8 | -0.079 | -0.076 | $0.132^{*}$ | $0.187^{*}$ |
| | (0.062) | (0.073) | (0.065) | (0.086) |
| Decile 9 | $-0.121^{+}$ | $-0.235^{**}$ | $0.143^{*}$ | $0.281^{**}$ |
| | (0.072) | (0.083) | (0.070) | (0.095) |
| Decile 10 | $-0.210^{*}$ | $-0.257^{**}$ | $0.171^{*}$ | $0.225^{*}$ |
| | (0.088) | (0.093) | (0.081) | (0.103) |
| *BMI deciles* | | | | |
| Decile 1 (ref) | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) |
| Decile 2 | 0.037 | 0.007 | 0.006 | 0.008 |
| | (0.053) | (0.052) | (0.052) | (0.058) |
| Decile 3 | -0.024 | 0.014 | 0.060 | -0.005 |
| | (0.063) | (0.061) | (0.064) | (0.076) |
| Decile 4 | -0.092 | -0.039 | 0.110 | -0.054 |
| | (0.072) | (0.073) | (0.079) | (0.086) |
| Decile 5 | -0.114 | -0.053 | 0.077 | 0.011 |
| | (0.076) | (0.078) | (0.076) | (0.095) |
| Decile 6 | -0.130 | -0.041 | 0.066 | -0.036 |
| | (0.088) | (0.091) | (0.086) | (0.113) |
| Decile 7 | -0.122 | -0.003 | 0.061 | -0.073 |
| | (0.095) | (0.096) | (0.089) | (0.114) |
| Decile 8 | -0.133 | 0.020 | 0.076 | -0.099 |
| | (0.094) | (0.100) | (0.090) | (0.113) |
| Decile 9 | -0.154 | 0.044 | $0.176^{+}$ | -0.157 |
| | (0.105) | (0.111) | (0.092) | (0.118) |

| | | | | |
|---|---|---|---|---|
| Decile 10 | -0.146 | 0.101 | 0.099 | -0.187 |
| | (0.119) | (0.121) | (0.105) | (0.132) |
| *Control variables* | | | | |
| Black | 0.244*** | 0.226*** | 0.046 | 0.083+ |
| | (0.045) | (0.039) | (0.052) | (0.049) |
| Hispanic | -0.047 | -0.080 | 0.074 | 0.048 |
| | (0.049) | (0.057) | (0.045) | (0.044) |
| Other race/ethnicity | -0.061 | -0.057 | 0.105 | 0.188** |
| | (0.065) | (0.065) | (0.065) | (0.070) |
| Age | -0.038* | -0.018 | 0.133*** | 0.120*** |
| | (0.018) | (0.022) | (0.018) | (0.021) |
| Standardized PVT score | 0.008 | 0.021 | -0.157*** | -0.154*** |
| | (0.012) | (0.018) | (0.011) | (0.015) |
| First-born | -0.036 | 0.011 | 0.034+ | -0.019 |
| | (0.023) | (0.025) | (0.021) | (0.022) |
| Mother's education | 0.020** | 0.016* | -0.028*** | -0.022** |
| | (0.006) | (0.006) | (0.005) | (0.007) |
| Family income | 0.028 | 0.067* | -0.050 | -0.083* |
| | (0.027) | (0.029) | (0.032) | (0.034) |
| Missing family information dummy | -0.057* | -0.085** | 0.044* | 0.057* |
| | (0.025) | (0.030) | (0.021) | (0.029) |
| Rural status | 0.025 | -0.061 | -0.041 | 0.004 |
| | (0.041) | (0.042) | (0.034) | (0.032) |
| Grade 8 | -0.096* | -0.190*** | -0.009 | 0.098+ |
| | (0.047) | (0.056) | (0.046) | (0.051) |
| Grade 9 | -0.174* | -0.241** | -0.072 | -0.057 |
| | (0.076) | (0.076) | (0.065) | (0.083) |
| Grade 10 | -0.167+ | -0.204* | -0.194* | -0.164+ |
| | (0.085) | (0.090) | (0.075) | (0.094) |
| Grade 11 | -0.079 | -0.137 | -0.369*** | -0.313** |
| | (0.093) | (0.104) | (0.087) | (0.110) |
| Grade 12 | 0.035 | -0.128 | -0.534*** | -0.558*** |
| | (0.111) | (0.128) | (0.108) | (0.138) |
| Constant | 0.415+ | 0.147 | -1.647*** | -1.420*** |
| | (0.250) | (0.315) | (0.246) | (0.312) |
| N(School) | 134 | 134 | 134 | 134 |
| N(Obs) | 9342 | 6692 | 9350 | 6694 |

*Note.* Robust standard errors are clustered at the school level. All models control for school fixed effects.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A4. Mediation analysis, Depressive symptoms***

| | (1) Depressive symptoms (W2) | (2) Depressive symptoms (W2) | (3) Depressive symptoms (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) |
|---|---|---|---|---|---|
| *Decile rank* | | | | | |
| Decile 1 | -0.022 | -0.036 | -0.046 | -0.026 | -0.061 |
| | (0.083) | (0.083) | (0.081) | (0.084) | (0.081) |
| Decile 2 | 0.013 | 0.008 | -0.002 | 0.002 | -0.015 |
| | (0.069) | (0.069) | (0.068) | (0.070) | (0.067) |
| Decile 3 | 0.040 | 0.033 | 0.021 | 0.034 | 0.009 |
| | (0.056) | (0.055) | (0.055) | (0.056) | (0.055) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.076 | 0.063 | 0.068 | 0.068 | 0.049 |
| | (0.052) | (0.051) | (0.051) | (0.052) | (0.051) |
| Decile 6 | 0.098 | 0.090 | 0.085 | $0.102^{+}$ | 0.081 |
| | (0.062) | (0.061) | (0.060) | (0.062) | (0.059) |
| Decile 7 | 0.073 | 0.060 | 0.063 | 0.074 | 0.052 |
| | (0.067) | (0.066) | (0.066) | (0.067) | (0.065) |
| Decile 8 | $0.193^{*}$ | $0.155^{+}$ | $0.170^{*}$ | $0.201^{*}$ | $0.143^{+}$ |
| | (0.086) | (0.084) | (0.084) | (0.085) | (0.081) |
| Decile 9 | $0.285^{**}$ | $0.244^{**}$ | $0.254^{**}$ | $0.290^{**}$ | $0.220^{*}$ |
| | (0.094) | (0.092) | (0.090) | (0.093) | (0.088) |
| Decile 10 | $0.231^{*}$ | $0.179^{+}$ | $0.201^{+}$ | $0.240^{*}$ | 0.161 |
| | (0.104) | (0.100) | (0.103) | (0.104) | (0.100) |
| Think underweight | | $0.133^{**}$ | | | $0.125^{*}$ |
| | | (0.049) | | | (0.049) |
| Think overweight | | $0.311^{***}$ | | | $0.303^{***}$ |
| | | (0.031) | | | (0.030) |
| Feel close to people at school | | | 0.002 | | -0.000 |
| | | | (0.038) | | (0.038) |
| Feel like part of school | | | $-0.226^{***}$ | | $-0.211^{***}$ |
| | | | (0.037) | | (0.036) |
| Happy to be at school | | | $-0.148^{***}$ | | $-0.145^{***}$ |
| | | | (0.037) | | (0.037) |
| Friend nominations received | | | | $0.048^{+}$ | $0.065^{*}$ |
| | | | | (0.028) | (0.027) |
| Friend nominations sent | | | | -0.001 | -0.002 |
| | | | | (0.013) | (0.013) |
| Centrality | | | | $-0.123^{*}$ | $-0.099^{+}$ |

| | | | | | |
|---|---|---|---|---|---|
| | | | | (0.058) | (0.057) |
| Missing network data dummy | | | | 0.131** | 0.126** |
| | | | | (0.041) | (0.041) |
| N(School) | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 6617 | 6617 | 6617 | 6617 | 6617 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A5. Mediation analysis, Self-esteem***

| | (1)<br>Self-esteem<br>(W2) | (2)<br>Self-esteem<br>(W2) | (3)<br>Self-esteem<br>(W2) | (4)<br>Self-esteem<br>(W2) | (5)<br>Self-esteem<br>(W2) |
|---|---|---|---|---|---|
| *Decile rank* | | | | | |
| Decile 1 | 0.019 | 0.032 | 0.057 | 0.022 | 0.067 |
| | (0.077) | (0.074) | (0.073) | (0.078) | (0.071) |
| Decile 2 | 0.034 | 0.038 | 0.055 | 0.040 | 0.063 |
| | (0.063) | (0.061) | (0.062) | (0.063) | (0.060) |
| Decile 3 | 0.011 | 0.021 | 0.041 | 0.014 | 0.051 |
| | (0.061) | (0.060) | (0.057) | (0.061) | (0.056) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.046 | 0.063 | 0.060 | 0.049 | 0.079 |
| | (0.059) | (0.056) | (0.056) | (0.058) | (0.054) |
| Decile 6 | 0.030 | 0.041 | 0.054 | 0.027 | 0.061 |
| | (0.061) | (0.057) | (0.058) | (0.061) | (0.055) |
| Decile 7 | -0.067 | -0.049 | -0.051 | -0.065 | -0.034 |
| | (0.060) | (0.058) | (0.062) | (0.060) | (0.059) |
| Decile 8 | -0.078 | -0.028 | -0.042 | -0.081 | 0.003 |
| | (0.072) | (0.070) | (0.070) | (0.072) | (0.067) |
| Decile 9 | $-0.240^{**}$ | $-0.185^{*}$ | $-0.189^{*}$ | $-0.241^{**}$ | $-0.139^{+}$ |
| | (0.083) | (0.080) | (0.078) | (0.082) | (0.074) |
| Decile 10 | $-0.254^{**}$ | $-0.185^{*}$ | $-0.202^{*}$ | $-0.254^{**}$ | -0.138 |
| | (0.094) | (0.091) | (0.091) | (0.093) | (0.088) |
| Think underweight | | $-0.138^{*}$ | | | $-0.127^{*}$ |
| | | (0.055) | | | (0.054) |
| Think overweight | | $-0.412^{***}$ | | | $-0.401^{***}$ |
| | | (0.035) | | | (0.033) |
| Feel close to people at school | | | $0.088^{*}$ | | $0.090^{*}$ |
| | | | (0.036) | | (0.036) |
| Feel like part of school | | | $0.278^{***}$ | | $0.257^{***}$ |
| | | | (0.034) | | (0.034) |
| Happy to be at school | | | $0.237^{***}$ | | $0.235^{***}$ |
| | | | (0.035) | | (0.035) |
| Friend nominations received | | | | 0.020 | -0.006 |
| | | | | (0.025) | (0.023) |
| Friend nominations sent | | | | -0.014 | -0.012 |
| | | | | (0.012) | (0.011) |
| Centrality | | | | $0.154^{**}$ | $0.117^{*}$ |
| | | | | (0.054) | (0.050) |

| | | | | | |
|---|---|---|---|---|---|
| Missing network data dummy | | | | -0.056$^{+}$ | -0.050$^{+}$ |
| | | | | (0.029) | (0.030) |
| N(School) | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 6615 | 6615 | 6615 | 6615 | 6615 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A6. Multinomial logistic regression estimates: Ordinal rank and educational attainment***

| | (1) HS graduate (reference) vs. HS dropout (W4) | (2) HS graduate (reference) vs. Some college (W4) | (3) HS graduate (reference) vs. College graduate (W4) |
|---|---|---|---|
| *Decile rank* | | | |
| Decile 1 | 1.031 | 0.877 | 0.681$^{+}$ |
| | (0.326) | (0.192) | (0.153) |
| Decile 2 | 1.590$^{+}$ | 1.064 | 0.927 |
| | (0.391) | (0.205) | (0.199) |
| Decile 3 | 1.466$^{+}$ | 1.177 | 1.037 |
| | (0.313) | (0.187) | (0.186) |
| Decile 4 (ref) | 1.000 | 1.000 | 1.000 |
| | (.) | (.) | (.) |
| Decile 5 | 1.079 | 1.044 | 1.060 |
| | (0.258) | (0.171) | (0.186) |
| Decile 6 | 1.028 | 1.241 | 1.049 |
| | (0.256) | (0.219) | (0.174) |
| Decile 7 | 1.143 | 1.042 | 0.958 |
| | (0.325) | (0.209) | (0.199) |
| Decile 8 | 1.186 | 1.057 | 0.856 |
| | (0.372) | (0.247) | (0.205) |
| Decile 9 | 1.618 | 1.161 | 0.959 |
| | (0.541) | (0.272) | (0.235) |
| Decile 10 | 2.330$^{*}$ | 1.223 | 1.028 |
| | (0.874) | (0.365) | (0.333) |
| N(School) | 134 | 134 | 134 |
| N(Obs) | 7514 | 7514 | 7514 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A7. Mediation analysis, Educational attainment*

| | (1)<br>High school dropout (W4) | (2)<br>High school dropout (W4) | (3)<br>High school dropout (W4) | (4)<br>High school dropout (W4) | (5)<br>High school dropout (W4) | (6)<br>High school dropout (W4) |
|---|---|---|---|---|---|---|
| *Decile rank* | | | | | | |
| Decile 1 | 0.019 | 0.019 | 0.015 | 0.014 | 0.014 | 0.009 |
| | (0.020) | (0.019) | (0.019) | (0.019) | (0.018) | (0.018) |
| Decile 2 | 0.033$^{*}$ | 0.033$^{*}$ | 0.029$^{*}$ | 0.031$^{*}$ | 0.024$^{+}$ | 0.022 |
| | (0.015) | (0.015) | (0.014) | (0.014) | (0.014) | (0.014) |
| Decile 3 | 0.026$^{+}$ | 0.025$^{+}$ | 0.023$^{+}$ | 0.024$^{+}$ | 0.022$^{+}$ | 0.020 |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.004 | 0.005 | 0.002 | 0.005 | -0.000 | -0.001 |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) | (0.015) |
| Decile 6 | 0.000 | 0.002 | -0.003 | -0.005 | -0.005 | -0.009 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) | (0.014) |
| Decile 7 | 0.011 | 0.012 | 0.008 | 0.005 | 0.004 | -0.001 |
| | (0.018) | (0.018) | (0.018) | (0.018) | (0.017) | (0.017) |
| Decile 8 | 0.021 | 0.019 | 0.014 | 0.014 | 0.010 | 0.003 |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) | (0.021) |
| Decile 9 | 0.043$^{+}$ | 0.041 | 0.037 | 0.036 | 0.028 | 0.023 |
| | (0.025) | (0.025) | (0.024) | (0.024) | (0.024) | (0.024) |
| Decile 10 | 0.073$^{**}$ | 0.069$^{*}$ | 0.066$^{*}$ | 0.065$^{*}$ | 0.050$^{+}$ | 0.045$^{+}$ |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) | (0.027) |
| Self-esteem | | -0.023$^{***}$ | | | | 0.005 |
| | | (0.004) | | | | (0.004) |
| Depressive symptoms | | | 0.039$^{***}$ | | | 0.025$^{***}$ |
| | | | (0.004) | | | (0.004) |
| Want to go to college | | | | -0.104$^{***}$ | | -0.061$^{***}$ |
| | | | | (0.010) | | (0.010) |
| Self-reported GPA | | | | | -0.095$^{***}$ | -0.080$^{***}$ |

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | | | (0.007) | (0.007) |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 7503 | 7503 | 7503 | 7503 | 7503 | 7503 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A8. OLS regression estimates: Ordinal rank and difference between Wave 2 measured and self-reported BMI***

| | (1)<br>W2 measured BMI – W2 self-reported BMI |
|---|---|
| *Decile rank* | |
| Decile 1 | -0.126 |
| | (0.093) |
| Decile 2 | -0.108 |
| | (0.082) |
| Decile 3 | 0.001 |
| | (0.072) |
| Decile 4 (ref) | 0.000 |
| | (.) |
| Decile 5 | 0.006 |
| | (0.085) |
| Decile 6 | 0.039 |
| | (0.101) |
| Decile 7 | -0.055 |
| | (0.129) |
| Decile 8 | -0.000 |
| | (0.177) |
| Decile 9 | 0.120 |
| | (0.175) |
| Decile 10 | -0.039 |
| | (0.290) |
| N(School) | 134 |
| N(Obs) | 6117 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

The twelfth graders, who were generally not interviewed at Wave 2 after graduation, are excluded. In order to avoid measurement bias at the very extreme tails of the BMI distribution, those who are four standard deviations away from the sample mean were dropped (n = 31).

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A9. Robustness check: Sensitivity to sampling-induced measurement error, Self-esteem***

| | Self-esteem (W1) | | | | Self-esteem (W2) | | | |
|---|---|---|---|---|---|---|---|---|
| Required school-grade size | 5 | 10 | 15 | 20 | 5 | 10 | 15 | 20 |
| *Decile rank* | | | | | | | | |
| Decile 1 | -0.055 | -0.077 | -0.086 | -0.128 | 0.033 | 0.019 | 0.006 | -0.063 |
| | (0.069) | (0.072) | (0.075) | (0.105) | (0.075) | (0.079) | (0.083) | (0.120) |
| Decile 2 | -0.055 | -0.057 | -0.063 | -0.091 | 0.035 | 0.046 | 0.030 | -0.002 |
| | (0.058) | (0.060) | (0.062) | (0.078) | (0.062) | (0.066) | (0.067) | (0.094) |
| Decile 3 | -0.050 | -0.043 | -0.045 | -0.064 | 0.016 | 0.032 | 0.021 | 0.033 |
| | (0.048) | (0.049) | (0.050) | (0.064) | (0.060) | (0.061) | (0.061) | (0.085) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.017 | 0.026 | 0.037 | 0.088 | 0.041 | 0.057 | 0.060 | 0.088 |
| | (0.048) | (0.049) | (0.051) | (0.070) | (0.058) | (0.059) | (0.062) | (0.080) |
| Decile 6 | 0.023 | 0.044 | 0.055 | 0.113 | 0.029 | 0.057 | 0.059 | 0.059 |
| | (0.046) | (0.046) | (0.048) | (0.069) | (0.061) | (0.062) | (0.064) | (0.088) |
| Decile 7 | -0.008 | 0.004 | 0.027 | 0.128 | -0.060 | -0.050 | -0.028 | -0.035 |
| | (0.050) | (0.052) | (0.055) | (0.083) | (0.060) | (0.060) | (0.063) | (0.084) |
| Decile 8 | -0.079 | -0.062 | -0.056 | 0.072 | -0.076 | -0.067 | -0.069 | -0.073 |
| | (0.062) | (0.065) | (0.069) | (0.108) | (0.073) | (0.074) | (0.079) | (0.102) |
| Decile 9 | -0.121$^{+}$ | -0.104 | -0.105 | 0.066 | -0.235$^{**}$ | -0.238$^{**}$ | -0.258$^{**}$ | -0.154 |
| | (0.072) | (0.075) | (0.079) | (0.117) | (0.083) | (0.082) | (0.088) | (0.122) |
| Decile 10 | -0.210$^{*}$ | -0.191$^{*}$ | -0.204$^{*}$ | -0.103 | -0.257$^{**}$ | -0.261$^{**}$ | -0.279$^{**}$ | -0.246$^{+}$ |
| | (0.088) | (0.092) | (0.098) | (0.148) | (0.093) | (0.094) | (0.101) | (0.141) |
| N(School) | 134 | 127 | 122 | 88 | 134 | 127 | 122 | 88 |
| N(Obs) | 9342 | 9120 | 8617 | 5685 | 6692 | 6502 | 6139 | 4029 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A10. Robustness check: Sensitivity to sampling-induced measurement error, Depressive symptoms***

| | Depressive symptoms (W1) | | | | Depressive symptoms (W2) | | | |
|---|---|---|---|---|---|---|---|---|
| Required school-grade size | 5 | 10 | 15 | 20 | 5 | 10 | 15 | 20 |
| *Decile rank* | | | | | | | | |
| Decile 1 | 0.096 | 0.119$^{+}$ | 0.087 | 0.025 | -0.030 | -0.016 | -0.039 | -0.076 |
| | (0.069) | (0.069) | (0.073) | (0.109) | (0.084) | (0.087) | (0.093) | (0.141) |
| Decile 2 | 0.108$^{+}$ | 0.111$^{+}$ | 0.096 | 0.029 | 0.016 | 0.005 | -0.017 | -0.096 |
| | (0.057) | (0.058) | (0.061) | (0.084) | (0.070) | (0.073) | (0.075) | (0.122) |
| Decile 3 | 0.069 | 0.072 | 0.068 | 0.064 | 0.034 | 0.034 | 0.015 | -0.035 |
| | (0.050) | (0.051) | (0.052) | (0.074) | (0.056) | (0.058) | (0.060) | (0.080) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.050 | 0.043 | 0.023 | -0.021 | 0.073 | 0.051 | 0.032 | -0.024 |
| | (0.052) | (0.053) | (0.055) | (0.073) | (0.053) | (0.054) | (0.056) | (0.074) |
| Decile 6 | 0.072 | 0.057 | 0.036 | 0.004 | 0.094 | 0.062 | 0.028 | 0.017 |
| | (0.050) | (0.051) | (0.054) | (0.074) | (0.063) | (0.064) | (0.067) | (0.091) |
| Decile 7 | 0.098$^{+}$ | 0.090 | 0.063 | 0.050 | 0.071 | 0.048 | 0.008 | 0.025 |
| | (0.054) | (0.054) | (0.058) | (0.076) | (0.067) | (0.068) | (0.072) | (0.098) |
| Decile 8 | 0.132$^{*}$ | 0.127$^{+}$ | 0.122$^{+}$ | 0.050 | 0.187$^{*}$ | 0.158$^{+}$ | 0.132 | 0.052 |
| | (0.065) | (0.066) | (0.070) | (0.096) | (0.086) | (0.089) | (0.094) | (0.131) |
| Decile 9 | 0.143$^{*}$ | 0.139$^{+}$ | 0.139$^{+}$ | -0.017 | 0.281$^{**}$ | 0.254$^{*}$ | 0.218$^{*}$ | 0.061 |
| | (0.070) | (0.072) | (0.079) | (0.102) | (0.095) | (0.098) | (0.104) | (0.144) |
| Decile 10 | 0.171$^{*}$ | 0.153$^{+}$ | 0.149$^{+}$ | 0.054 | 0.225$^{*}$ | 0.189$^{+}$ | 0.141 | 0.117 |
| | (0.081) | (0.083) | (0.090) | (0.128) | (0.103) | (0.106) | (0.110) | (0.153) |
| N(School) | 134 | 127 | 122 | 88 | 134 | 127 | 122 | 88 |
| N(Obs) | 9350 | 9127 | 8624 | 5690 | 6694 | 6504 | 6141 | 4031 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A11. Robustness check: Sensitivity to sampling-induced measurement error, Educational attainment*

| | High school dropout (W4) | | | | Years of schooling (W4) | | | |
|---|---|---|---|---|---|---|---|---|
| Required school-grade size | 5 | 10 | 15 | 20 | 5 | 10 | 15 | 20 |
| *Decile rank* | | | | | | | | |
| Decile 1 | 0.018 | 0.023 | 0.019 | -0.007 | -0.190 | -0.191 | -0.221$^{+}$ | -0.086 |
| | (0.019) | (0.020) | (0.021) | (0.033) | (0.115) | (0.118) | (0.123) | (0.159) |
| Decile 2 | 0.036$^{*}$ | 0.037$^{*}$ | 0.035$^{*}$ | 0.021 | -0.134 | -0.135 | -0.165 | -0.117 |
| | (0.015) | (0.016) | (0.017) | (0.023) | (0.106) | (0.108) | (0.108) | (0.134) |
| Decile 3 | 0.023$^{+}$ | 0.025$^{+}$ | 0.026$^{+}$ | 0.013 | -0.088 | -0.081 | -0.099 | -0.099 |
| | (0.014) | (0.014) | (0.015) | (0.019) | (0.093) | (0.096) | (0.095) | (0.129) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.004 | 0.003 | 0.007 | -0.004 | -0.004 | -0.023 | -0.038 | 0.010 |
| | (0.014) | (0.014) | (0.015) | (0.019) | (0.097) | (0.097) | (0.098) | (0.108) |
| Decile 6 | -0.003 | -0.005 | 0.001 | -0.006 | -0.019 | -0.034 | -0.043 | -0.019 |
| | (0.014) | (0.015) | (0.015) | (0.020) | (0.082) | (0.083) | (0.086) | (0.103) |
| Decile 7 | 0.013 | 0.013 | 0.018 | 0.008 | -0.041 | -0.050 | -0.059 | 0.059 |
| | (0.018) | (0.019) | (0.020) | (0.027) | (0.106) | (0.109) | (0.113) | (0.132) |
| Decile 8 | 0.019 | 0.018 | 0.024 | -0.012 | -0.089 | -0.099 | -0.130 | 0.103 |
| | (0.021) | (0.022) | (0.023) | (0.027) | (0.126) | (0.129) | (0.134) | (0.174) |
| Decile 9 | 0.040$^{+}$ | 0.041$^{+}$ | 0.045$^{+}$ | 0.031 | -0.118 | -0.137 | -0.143 | 0.006 |
| | (0.024) | (0.025) | (0.027) | (0.034) | (0.120) | (0.124) | (0.128) | (0.175) |
| Decile 10 | 0.075$^{**}$ | 0.074$^{**}$ | 0.075$^{*}$ | 0.064$^{+}$ | -0.175 | -0.192 | -0.218 | -0.193 |
| | (0.027) | (0.028) | (0.030) | (0.039) | (0.150) | (0.155) | (0.163) | (0.214) |
| N(School) | 134 | 127 | 122 | 88 | 134 | 127 | 122 | 88 |
| N(Obs) | 7514 | 7321 | 6901 | 4519 | 6694 | 6504 | 6141 | 4031 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A12. Robustness check: Ordinal rank and Wave 2 BMI and difference between Wave 2 and Wave 1 BMI***

| | (1)<br>W2 self-reported BMI | (2)<br>W2 self-reported BMI – W1 self-reported BMI |
|---|---|---|
| *Decile rank* | | |
| Decile 1 | -0.744*** | -0.027 |
| | (0.139) | (0.139) |
| Decile 2 | -0.393** | -0.143 |
| | (0.121) | (0.117) |
| Decile 3 | -0.128 | -0.021 |
| | (0.101) | (0.102) |
| Decile 4 (ref) | 0.000 | 0.000 |
| | (.) | (.) |
| Decile 5 | 0.127 | 0.003 |
| | (0.104) | (0.101) |
| Decile 6 | 0.268* | 0.040 |
| | (0.118) | (0.114) |
| Decile 7 | 0.352* | -0.016 |
| | (0.142) | (0.130) |
| Decile 8 | 0.460* | -0.075 |
| | (0.199) | (0.190) |
| Decile 9 | 0.798*** | -0.059 |
| | (0.181) | (0.168) |
| Decile 10 | 1.689*** | -0.387 |
| | (0.382) | (0.285) |
| N(School) | 134 | 134 |
| N(Obs) | 6197 | 6197 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, rural status, and decile personal BMI.

The twelfth graders, who were generally not interviewed at Wave 2 after graduation, are excluded. In order to avoid measurement bias at the very extreme tails of the BMI distribution, those who are four standard deviations away from the sample mean were dropped (n = 31).

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A13. Robustness check: Balancing tests for moments of school-cohort BMI distribution***

| | (1) Grade-level mean BMI | (2) Grade-level mean BMI | (3) Grade-level standard deviation BMI | (4) Grade-level standard deviation BMI |
|---|---|---|---|---|
| School fixed effects | No | Yes | No | Yes |
| White | -0.090*** | 0.002 | -0.088*** | -0.001 |
| | (0.023) | (0.004) | (0.021) | (0.004) |
| Black | 0.062*** | -0.004 | 0.059** | 0.001 |
| | (0.019) | (0.004) | (0.019) | (0.004) |
| Hispanic | 0.029* | 0.002 | 0.026* | 0.002 |
| | (0.013) | (0.003) | (0.012) | (0.003) |
| Age | 0.054*** | 0.002 | 0.048*** | 0.003 |
| | (0.013) | (0.008) | (0.010) | (0.009) |
| Standardized PVT score | -0.185*** | -0.003 | -0.188*** | -0.015+ |
| | (0.027) | (0.010) | (0.027) | (0.009) |
| Mother's education | -0.351*** | -0.013 | -0.346*** | -0.017 |
| | (0.056) | (0.022) | (0.058) | (0.023) |
| Family income | -0.081*** | -0.002 | -0.080*** | -0.005 |
| | (0.016) | (0.005) | (0.018) | (0.005) |
| Divorced or separated | 0.013** | -0.004 | 0.015*** | -0.002 |
| | (0.004) | (0.005) | (0.004) | (0.004) |
| Married parents | -0.042*** | 0.004 | -0.042*** | 0.003 |
| | (0.007) | (0.005) | (0.008) | (0.005) |
| Rural | 0.032+ | 0.001 | 0.031+ | 0.004 |
| | (0.018) | (0.004) | (0.018) | (0.004) |

*Note.* Robust standard errors are clustered at the school level. Each cell contains coefficients from separate regressions that include a set of grade dummies.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A14. Robustness check: Family fixed effects models*

| | (1) Self-esteem (W1) | (2) Self-esteem (W2) | (3) Depressive symptoms (W1) | (4) Depressive symptoms (W2) | (5) High school dropout (W4) | (6) Years of schooling (W4) |
|---|---|---|---|---|---|---|
| *Decile rank* | | | | | | |
| Decile 1 | 0.153 | 0.179 | 0.052 | -0.307 | -0.039 | -0.248 |
| | (0.216) | (0.237) | (0.206) | (0.233) | (0.066) | (0.360) |
| Decile 2 | -0.063 | 0.029 | 0.153 | 0.028 | 0.026 | -0.036 |
| | (0.185) | (0.182) | (0.160) | (0.183) | (0.062) | (0.291) |
| Decile 3 | 0.030 | -0.065 | 0.191 | -0.046 | 0.009 | 0.225 |
| | (0.156) | (0.172) | (0.145) | (0.148) | (0.049) | (0.241) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.157 | -0.044 | -0.066 | -0.075 | 0.092 | 0.070 |
| | (0.176) | (0.185) | (0.154) | (0.186) | (0.061) | (0.289) |
| Decile 6 | 0.038 | -0.081 | 0.003 | 0.006 | 0.032 | 0.043 |
| | (0.181) | (0.192) | (0.201) | (0.177) | (0.061) | (0.297) |
| Decile 7 | 0.090 | -0.272 | -0.012 | -0.167 | 0.020 | 0.303 |
| | (0.203) | (0.208) | (0.196) | (0.215) | (0.069) | (0.338) |
| Decile 8 | -0.064 | -0.086 | -0.216 | 0.126 | $0.154^{+}$ | -0.243 |
| | (0.241) | (0.244) | (0.239) | (0.248) | (0.081) | (0.384) |
| Decile 9 | -0.034 | -0.418 | -0.286 | 0.109 | 0.112 | 0.349 |
| | (0.265) | (0.280) | (0.250) | (0.329) | (0.084) | (0.430) |
| Decile 10 | $-0.597^{+}$ | -0.430 | -0.095 | 0.257 | $0.253^{*}$ | -0.352 |
| | (0.319) | (0.314) | (0.319) | (0.345) | (0.101) | (0.578) |
| N(Obs) | 1956 | 1821 | 1957 | 1822 | 1697 | 1697 |

*Note.* Robust standard errors are clustered at the family level. All models control for grade fixed effects and family fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, and decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A15. Robustness check: Addressing contextual-level confounders*

| | (1) Self-esteem (W2) | (2) Self-esteem (W2) | (3) Self-esteem (W2) | (4) Depressive symptoms (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) High school dropout (W4) | (8) High school dropout (W4) | (9) High school dropout (W4) |
|---|---|---|---|---|---|---|---|---|---|
| Contextual variables | No | Yes | No | No | Yes | No | No | Yes | No |
| School-by-grade FE | No | No | Yes | No | No | Yes | No | No | Yes |
| *Decile rank* | | | | | | | | | |
| Decile 1 | 0.033 | 0.031 | 0.064 | -0.030 | -0.032 | -0.016 | 0.018 | 0.019 | 0.024 |
| | (0.075) | (0.077) | (0.083) | (0.084) | (0.083) | (0.090) | (0.019) | (0.020) | (0.021) |
| Decile 2 | 0.035 | 0.033 | 0.061 | 0.016 | 0.017 | 0.012 | 0.036* | 0.037* | 0.040* |
| | (0.062) | (0.064) | (0.068) | (0.070) | (0.069) | (0.074) | (0.015) | (0.016) | (0.016) |
| Decile 3 | 0.016 | 0.015 | 0.031 | 0.034 | 0.034 | 0.020 | 0.023+ | 0.024+ | 0.026+ |
| | (0.060) | (0.061) | (0.063) | (0.056) | (0.056) | (0.058) | (0.014) | (0.014) | (0.014) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.041 | 0.042 | 0.033 | 0.073 | 0.074 | 0.059 | 0.004 | 0.004 | -0.002 |
| | (0.058) | (0.057) | (0.059) | (0.053) | (0.054) | (0.056) | (0.014) | (0.014) | (0.014) |
| Decile 6 | 0.029 | 0.029 | 0.015 | 0.094 | 0.096 | 0.096 | -0.003 | -0.003 | -0.006 |
| | (0.061) | (0.061) | (0.065) | (0.063) | (0.064) | (0.066) | (0.014) | (0.014) | (0.015) |
| Decile 7 | -0.060 | -0.059 | -0.086 | 0.071 | 0.071 | 0.074 | 0.013 | 0.012 | 0.004 |
| | (0.060) | (0.060) | (0.064) | (0.067) | (0.068) | (0.074) | (0.018) | (0.019) | (0.020) |
| Decile 8 | -0.076 | -0.076 | -0.104 | 0.187* | 0.186* | 0.182+ | 0.019 | 0.018 | 0.010 |
| | (0.073) | (0.075) | (0.077) | (0.086) | (0.090) | (0.094) | (0.021) | (0.022) | (0.022) |
| Decile 9 | -0.235** | -0.236** | -0.257** | 0.281** | 0.282** | 0.275* | 0.040+ | 0.039 | 0.026 |
| | (0.083) | (0.089) | (0.092) | (0.095) | (0.101) | (0.107) | (0.024) | (0.026) | (0.028) |
| Decile 10 | -0.257** | -0.258* | -0.282** | 0.225* | 0.224* | 0.222+ | 0.075** | 0.072* | 0.057+ |
| | (0.093) | (0.100) | (0.105) | (0.103) | (0.112) | (0.121) | (0.027) | (0.030) | (0.031) |
| Grade-level BMI | | -0.004 | | | 0.001 | | | -0.005 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | (0.025) | | | (0.024) | | | (0.007) | |
| Grade-level White | | -0.234 | | | 0.653 | | | 0.042 | |
| | | (0.370) | | | (0.401) | | | (0.081) | |
| Grade-level Black | | -0.131 | | | 0.268 | | | 0.156+ | |
| | | (0.394) | | | (0.405) | | | (0.088) | |
| Grade-level Standardized PVT score | | -0.045 | | | 0.054 | | | 0.007 | |
| | | (0.114) | | | (0.131) | | | (0.027) | |
| Grade-level Mother's education | | -0.029 | | | -0.054 | | | -0.026 | |
| | | (0.051) | | | (0.047) | | | (0.016) | |
| Grade-level Family income | | -0.160 | | | -0.121 | | | -0.021 | |
| | | (0.273) | | | (0.164) | | | (0.056) | |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 6692 | 6692 | 6692 | 6694 | 6694 | 6694 | 7514 | 7514 | 7514 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A16. Robustness check: Controlling for rank measures of other characteristics, Self-esteem***

| | (1) Self-esteem (W1) | (2) Self-esteem (W1) | (3) Self-esteem (W1) | (4) Self-esteem (W1) | (5) Self-esteem (W2) | (6) Self-esteem (W2) | (7) Self-esteem (W2) | (8) Self-esteem (W2) |
|---|---|---|---|---|---|---|---|---|
| *Decile rank* | | | | | | | | |
| Decile 1 | -0.055 | -0.055 | -0.053 | -0.052 | 0.033 | 0.032 | 0.032 | 0.032 |
| | (0.069) | (0.069) | (0.069) | (0.070) | (0.075) | (0.075) | (0.075) | (0.075) |
| Decile 2 | -0.055 | -0.054 | -0.053 | -0.052 | 0.035 | 0.035 | 0.038 | 0.038 |
| | (0.058) | (0.058) | (0.058) | (0.058) | (0.062) | (0.062) | (0.062) | (0.062) |
| Decile 3 | -0.050 | -0.050 | -0.049 | -0.049 | 0.016 | 0.016 | 0.017 | 0.017 |
| | (0.048) | (0.048) | (0.048) | (0.048) | (0.060) | (0.060) | (0.060) | (0.060) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.017 | 0.017 | 0.017 | 0.017 | 0.041 | 0.041 | 0.041 | 0.041 |
| | (0.048) | (0.048) | (0.048) | (0.048) | (0.058) | (0.058) | (0.058) | (0.058) |
| Decile 6 | 0.023 | 0.022 | 0.024 | 0.024 | 0.029 | 0.029 | 0.032 | 0.032 |
| | (0.046) | (0.046) | (0.046) | (0.046) | (0.061) | (0.061) | (0.061) | (0.061) |
| Decile 7 | -0.008 | -0.008 | -0.007 | -0.007 | -0.060 | -0.060 | -0.059 | -0.059 |
| | (0.050) | (0.050) | (0.050) | (0.050) | (0.060) | (0.060) | (0.060) | (0.060) |
| Decile 8 | -0.079 | -0.079 | -0.079 | -0.079 | -0.076 | -0.076 | -0.074 | -0.074 |
| | (0.062) | (0.062) | (0.062) | (0.062) | (0.073) | (0.072) | (0.072) | (0.072) |
| Decile 9 | -0.121$^{+}$ | -0.122$^{+}$ | -0.119 | -0.119 | -0.235$^{**}$ | -0.236$^{**}$ | -0.231$^{**}$ | -0.231$^{**}$ |
| | (0.072) | (0.072) | (0.072) | (0.072) | (0.083) | (0.082) | (0.082) | (0.082) |
| Decile 10 | -0.210$^{*}$ | -0.211$^{*}$ | -0.208$^{*}$ | -0.209$^{*}$ | -0.257$^{**}$ | -0.258$^{**}$ | -0.256$^{**}$ | -0.257$^{**}$ |
| | (0.088) | (0.087) | (0.088) | (0.087) | (0.093) | (0.093) | (0.093) | (0.093) |
| Ability percentile rank | | 0.012 | | 0.007 | | 0.016 | | 0.010 |
| | | (0.085) | | (0.085) | | (0.098) | | (0.098) |
| SES percentile rank | | | 0.028 | 0.029 | | | 0.147$^{*}$ | 0.147$^{*}$ |
| | | | (0.050) | (0.050) | | | (0.058) | (0.058) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 9342 | 9342 | 9342 | 9342 | 6692 | 6692 | 6692 | 6692 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A17. Robustness check: Controlling for rank measures of other characteristics, Depressive symptoms*

| | (1) Depressive symptoms (W1) | (2) Depressive symptoms (W1) | (3) Depressive symptoms (W1) | (4) Depressive symptoms (W1) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|
| *Decile rank* | | | | | | | | |
| Decile 1 | 0.096 | 0.102 | 0.093 | 0.099 | -0.030 | -0.025 | -0.028 | -0.023 |
| | (0.069) | (0.069) | (0.068) | (0.069) | (0.084) | (0.084) | (0.085) | (0.084) |
| Decile 2 | 0.108$^{+}$ | 0.111$^{+}$ | 0.103$^{+}$ | 0.106$^{+}$ | 0.016 | 0.018 | 0.012 | 0.013 |
| | (0.057) | (0.058) | (0.057) | (0.057) | (0.070) | (0.070) | (0.070) | (0.070) |
| Decile 3 | 0.069 | 0.072 | 0.067 | 0.070 | 0.034 | 0.037 | 0.032 | 0.034 |
| | (0.050) | (0.050) | (0.050) | (0.050) | (0.056) | (0.056) | (0.056) | (0.056) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.050 | 0.051 | 0.050 | 0.051 | 0.073 | 0.074 | 0.071 | 0.073 |
| | (0.052) | (0.052) | (0.052) | (0.052) | (0.053) | (0.053) | (0.054) | (0.054) |
| Decile 6 | 0.072 | 0.073 | 0.067 | 0.068 | 0.094 | 0.095 | 0.089 | 0.089 |
| | (0.050) | (0.050) | (0.050) | (0.050) | (0.063) | (0.063) | (0.063) | (0.064) |
| Decile 7 | 0.098$^{+}$ | 0.099$^{+}$ | 0.094$^{+}$ | 0.096$^{+}$ | 0.071 | 0.072 | 0.066 | 0.068 |
| | (0.054) | (0.054) | (0.054) | (0.054) | (0.067) | (0.067) | (0.067) | (0.067) |
| Decile 8 | 0.132$^{*}$ | 0.133$^{*}$ | 0.130$^{*}$ | 0.131$^{*}$ | 0.187$^{*}$ | 0.186$^{*}$ | 0.182$^{*}$ | 0.181$^{*}$ |
| | (0.065) | (0.065) | (0.064) | (0.064) | (0.086) | (0.086) | (0.086) | (0.086) |
| Decile 9 | 0.143$^{*}$ | 0.145$^{*}$ | 0.136$^{+}$ | 0.137$^{+}$ | 0.281$^{**}$ | 0.284$^{**}$ | 0.274$^{**}$ | 0.277$^{**}$ |
| | (0.070) | (0.070) | (0.070) | (0.070) | (0.095) | (0.095) | (0.095) | (0.094) |
| Decile 10 | 0.171$^{*}$ | 0.174$^{*}$ | 0.165$^{*}$ | 0.169$^{*}$ | 0.225$^{*}$ | 0.230$^{*}$ | 0.222$^{*}$ | 0.227$^{*}$ |
| | (0.081) | (0.081) | (0.081) | (0.081) | (0.103) | (0.102) | (0.102) | (0.101) |
| Ability percentile rank | | -0.291$^{*}$ | | -0.280$^{*}$ | | -0.264$^{*}$ | | -0.257$^{*}$ |
| | | (0.115) | | (0.113) | | (0.113) | | (0.114) |
| SES percentile rank | | | -0.155$^{**}$ | -0.153$^{**}$ | | | -0.270$^{***}$ | -0.269$^{***}$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | (0.055) | (0.055) | | | (0.069) | (0.068) |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 9350 | 9350 | 9350 | 9350 | 6694 | 6694 | 6694 | 6694 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A18. Robustness check: Controlling for rank measures of other characteristics, Educational attainment***

| | (1) High school dropout (W4) | (2) High school dropout (W4) | (3) High school dropout (W4) | (4) High school dropout (W4) | (5) Years of schooling (W4) | (6) Years of schooling (W4) | (7) Years of schooling (W4) | (8) Years of schooling (W4) |
|---|---|---|---|---|---|---|---|---|
| *Decile rank* | | | | | | | | |
| Decile 1 | 0.018 | 0.020 | 0.019 | 0.021 | -0.190 | -0.213$^{+}$ | -0.196$^{+}$ | -0.219$^{+}$ |
| | (0.019) | (0.019) | (0.019) | (0.019) | (0.115) | (0.113) | (0.114) | (0.112) |
| Decile 2 | 0.036$^{*}$ | 0.037$^{*}$ | 0.035$^{*}$ | 0.035$^{*}$ | -0.134 | -0.144 | -0.121 | -0.131 |
| | (0.015) | (0.015) | (0.015) | (0.015) | (0.106) | (0.106) | (0.104) | (0.104) |
| Decile 3 | 0.023$^{+}$ | 0.024$^{+}$ | 0.023$^{+}$ | 0.023$^{+}$ | -0.088 | -0.096 | -0.081 | -0.089 |
| | (0.014) | (0.014) | (0.013) | (0.013) | (0.093) | (0.093) | (0.091) | (0.091) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) | (.) | (.) | (.) | (.) |
| Decile 5 | 0.004 | 0.004 | 0.003 | 0.004 | -0.004 | -0.008 | -0.003 | -0.007 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.097) | (0.097) | (0.095) | (0.095) |
| Decile 6 | -0.003 | -0.003 | -0.004 | -0.004 | -0.019 | -0.023 | -0.010 | -0.013 |
| | (0.014) | (0.014) | (0.014) | (0.014) | (0.082) | (0.083) | (0.082) | (0.083) |
| Decile 7 | 0.013 | 0.013 | 0.012 | 0.012 | -0.041 | -0.050 | -0.032 | -0.041 |
| | (0.018) | (0.018) | (0.018) | (0.019) | (0.106) | (0.105) | (0.108) | (0.107) |
| Decile 8 | 0.019 | 0.019 | 0.018 | 0.018 | -0.089 | -0.092 | -0.077 | -0.080 |
| | (0.021) | (0.021) | (0.021) | (0.021) | (0.126) | (0.127) | (0.126) | (0.126) |
| Decile 9 | 0.040$^{+}$ | 0.042$^{+}$ | 0.038 | 0.039 | -0.118 | -0.131 | -0.095 | -0.107 |
| | (0.024) | (0.024) | (0.024) | (0.024) | (0.120) | (0.120) | (0.121) | (0.121) |
| Decile 10 | 0.075$^{**}$ | 0.076$^{**}$ | 0.073$^{**}$ | 0.075$^{**}$ | -0.175 | -0.193 | -0.159 | -0.176 |
| | (0.027) | (0.027) | (0.026) | (0.027) | (0.150) | (0.152) | (0.150) | (0.152) |
| Ability percentile rank | | -0.093$^{*}$ | | -0.091$^{*}$ | | 1.138$^{***}$ | | 1.120$^{***}$ |
| | | (0.038) | | (0.038) | | (0.194) | | (0.195) |
| SES percentile rank | | | -0.081$^{***}$ | -0.081$^{***}$ | | | 0.734$^{***}$ | 0.728$^{***}$ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | (0.019) | (0.019) | | | (0.097) | (0.094) |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A19. Robustness check: Different operationalization of BMI rank, Psychological health***

| | (1) Self-esteem (W2) | (2) Self-esteem (W2) | (3) Self-esteem (W2) | (4) Self-esteem (W2) | (5) Depressive symptoms (W2) | (6) Depressive symptoms (W2) | (7) Depressive symptoms (W2) | (8) Depressive symptoms (W2) |
|---|---|---|---|---|---|---|---|---|
| *Rank measures* | | | | | | | | |
| BMI Percentile rank | -0.268* | | | | 0.271* | | | |
| | (0.116) | | | | (0.123) | | | |
| Yitzhaki Index | | 0.025 | | | | -0.023 | | |
| | | (0.021) | | | | (0.021) | | |
| Deaton Index | | | 0.785 | | | | -0.651 | |
| | | | (0.543) | | | | (0.516) | |
| d-measure | | | | 0.264 | | | | -0.923 |
| | | | | (1.287) | | | | (1.322) |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 6692 | 6692 | 6692 | 6692 | 6694 | 6694 | 6694 | 6694 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

*Table A20. Robustness check: Different operationalization of BMI rank, Educational attainment*

| | (1) High school dropout (W4) | (2) High school dropout (W4) | (3) High school dropout (W4) | (4) High school dropout (W4) | (5) Years of schooling (W4) | (6) Years of schooling (W4) | (7) Years of schooling (W4) | (8) Years of schooling (W4) |
|---|---|---|---|---|---|---|---|---|
| *Rank measures* | | | | | | | | |
| BMI Percentile rank | 0.021 | | | | 0.032 | | | |
| | (0.033) | | | | (0.163) | | | |
| Yitzhaki Index | | 0.001 | | | | -0.047 | | |
| | | (0.005) | | | | (0.032) | | |
| Deaton Index | | | 0.007 | | | | -1.143 | |
| | | | (0.136) | | | | (0.794) | |
| d-measure | | | | 0.221 | | | | $-3.715^{+}$ |
| | | | | (0.341) | | | | (1.937) |
| N(School) | 134 | 134 | 134 | 134 | 134 | 134 | 134 | 134 |
| N(Obs) | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 | 7514 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

***Table A21. Robustness check: Controlling for BMI dummies instead of BMI deciles***

| | (1) Self-esteem (W1) | (2) Self-esteem (W2) | (3) Depressive symptoms (W1) | (4) Depressive symptoms (W2) |
|---|---|---|---|---|
| *Decile rank* | | | | |
| Decile 1 | -0.067 | -0.031 | 0.083 | -0.012 |
| | (0.071) | (0.080) | (0.071) | (0.086) |
| Decile 2 | -0.052 | 0.028 | 0.086 | -0.005 |
| | (0.056) | (0.063) | (0.058) | (0.070) |
| Decile 3 | -0.039 | 0.025 | 0.060 | 0.015 |
| | (0.047) | (0.059) | (0.050) | (0.058) |
| Decile 4 (ref) | 0.000 | 0.000 | 0.000 | 0.000 |
| | (.) | (.) | (.) | (.) |
| Decile 5 | 0.009 | 0.040 | 0.049 | 0.080 |
| | (0.047) | (0.059) | (0.052) | (0.051) |
| Decile 6 | 0.015 | 0.033 | 0.070 | 0.097 |
| | (0.045) | (0.060) | (0.050) | (0.063) |
| Decile 7 | -0.017 | -0.049 | $0.094^{+}$ | 0.074 |
| | (0.050) | (0.062) | (0.054) | (0.068) |
| Decile 8 | -0.081 | -0.059 | $0.121^{+}$ | $0.190^{*}$ |
| | (0.061) | (0.071) | (0.066) | (0.088) |
| Decile 9 | -0.112 | $-0.213^{*}$ | $0.129^{+}$ | $0.274^{**}$ |
| | (0.072) | (0.084) | (0.073) | (0.096) |
| Decile 10 | $-0.156^{+}$ | $-0.191^{*}$ | $0.169^{+}$ | $0.213^{+}$ |
| | (0.090) | (0.095) | (0.088) | (0.111) |
| N(School) | 134 | 134 | 134 | 134 |
| N(Obs) | 9342 | 6692 | 9350 | 6694 |

*Note.* Robust standard errors are clustered at the school level. All models control for grade fixed effects and school fixed effects. All models include the following set of control variables: race/ethnicity, age, standardized PVT score, first-born, mother's education, family income, missing family information dummy, and rural status. decile personal BMI.

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed tests).

**10. Appendix figures**

***Figure A1. Distribution of average of the absolute difference between percentile rank calculated from sample versus population, saturated sample of schools***

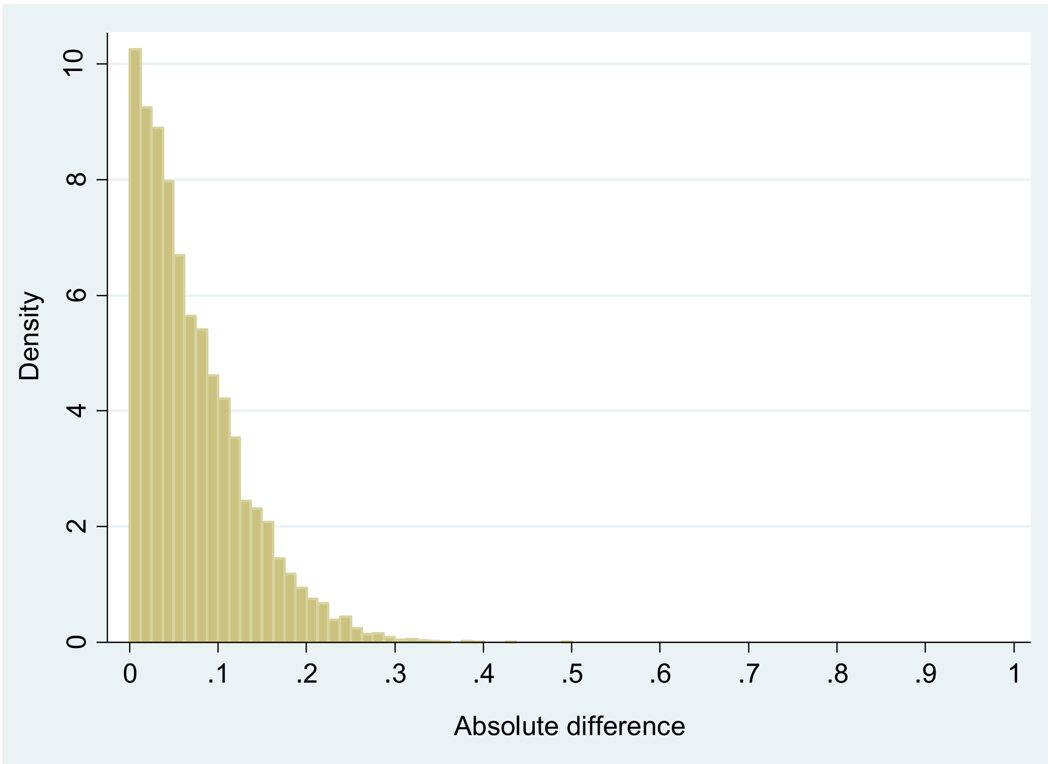
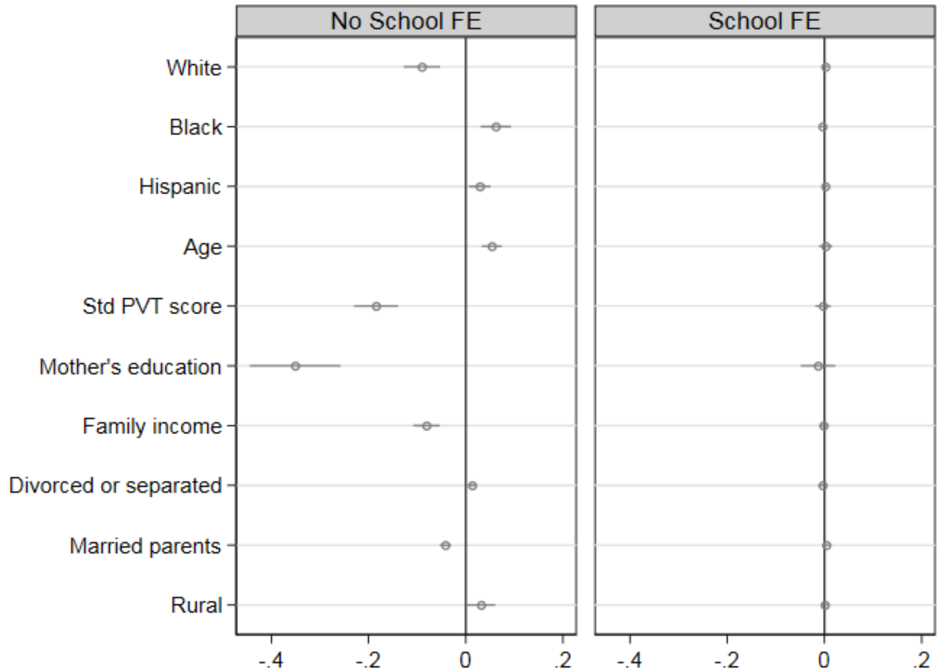
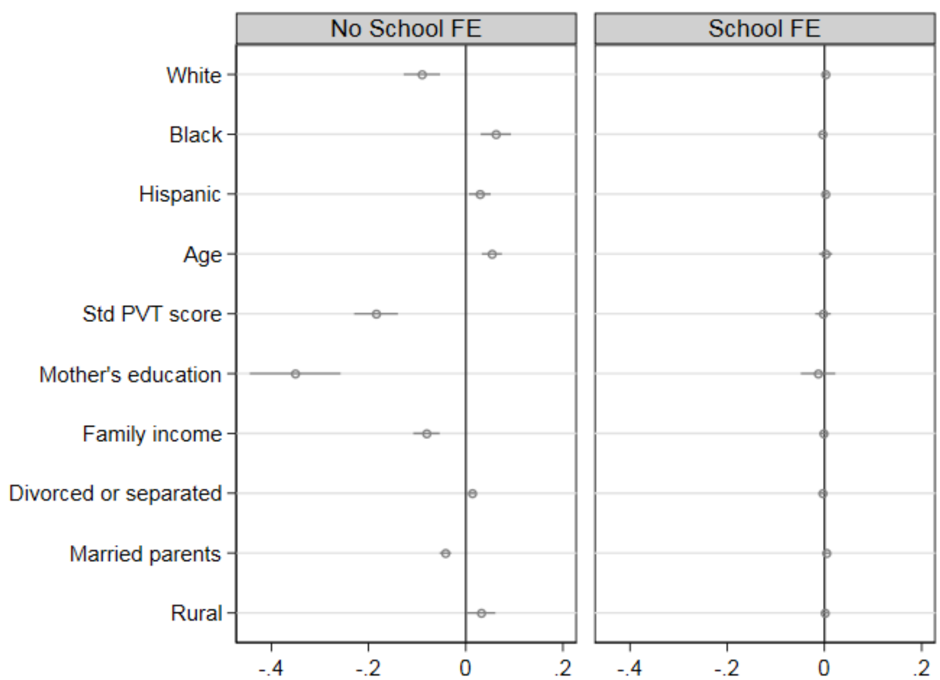


***Figure A2. Balancing tests for moments of school-cohort BMI distribution***

(A) Grade-level mean BMI




(B) Grade-level standard deviation BMI




*Note*: Each dot is the coefficient from a separate regression that includes a set of grade dummies. Robust standard errors are clustered at the school level. The spikes present 90% confidence intervals.

# Chapter 5. Implications and conclusion

## 1. Summary

This dissertation examines how school and peer contexts influence adolescents' health, social development and educational progress. Most studies in this tradition document the importance of having "good peers" or attending "good schools", in social stratification processes involving educational attainment, health accumulation and occupational position. Yet we know relatively little about stratification processes *within* schools. In this dissertation, I study these processes by investigating how relative (or rank) position in school-based local hierarchies affects adolescent health and educational outcomes. Using a quasi-experimental design, this dissertation uncovers consistent causal evidence for what I refer to as the *local-ladder* effect: conditional on attending a given school, a student's relative position within his or her school cohort significantly affects adolescent psychological health, social development, and educational achievement. This dissertation enhances our understanding of an overlooked aspect of stratification, the social-psychological process by which social hierarchies in the peer world of high school shape students' health and educational trajectories.

In this dissertation, I argue that in addition to conventional sources of status hierarchy in adolescence (e.g., family SES and ability) (Chapters 2 and 3), relative standing in terms of other salient youth characteristics like body weight also contributes to creating a local hierarchy which has an impact on adolescent outcomes (Chapter 4). These findings lend support to the argument that in adolescence as well as adulthood social position is multidimensional in nature and individuals belong to multiple social hierarchies (e.g., Sweeting et al. 2011).

Relatedly, this dissertation provides evidence that there seems to be gender differences in whether and how different local hierarchies influence adolescent outcomes. For example, while relative BMI has an impact on health and educational attainment only among female adolescents (Chapter 4), the effects of ability rank on psychological health are driven largely by male adolescents (Chapter 3). In Chapter 4, for males, relative body mass does matter for self-perception on weight status, but the effects of relative BMI are not found on psychological health and educational attainment. Perhaps, weight effects for male adolescents may work in a different direction (e.g., sports success, physical ability, or something related to masculinity). In Chapter 3, the finding that the relationship between ability rank and adolescent depression is relevant only for male adolescents may be attributable to gender differences in the way in which an adolescent gains status: boys attain their status and popularity through competition and dominance in status hierarchies within the larger group while girls gain social worth through increased closeness and intimacy with close friendship groups. In general, these findings are consistent with a large body of literature suggesting that there are clear gender differences in social experiences and peer relationships including status attainment process and social integration patterns (Crosnoe 2000; Foels and Tomcho 2009; Giordano 2003; Giordano, Cernkovich, and Pugh 1986; Guimond et al. 2006; Lindenlaub and Prummer 2013; Maccoby 1990).

This dissertation sheds light on mechanisms through which social positions in adolescence affect health, social, and educational outcomes. As proposed by the social comparison theory and reflected self-appraisal (or looking-glass self) perspective, the prior literature on relative social position and population health has relied largely on psychological process as the most likely mechanism—i.e., perception of own lower social position and subsequent feelings of anger and frustration (Marmot and Wilkinson 2001; De Vogli 2004; Wilkinson 1997). First, this dissertation extends the existing literature by exploring other dimensions of psychological resources that are likely to be affected by relative social position and to affect health outcomes. This dissertation argues that the relative position of individuals may have further impact on *future expectations and aspirations*. For example, relative deprivation may lead to stress and anger not only because the person feels relatively deprived of current access to material resources, but also they feel deprived of the opportunities for fulfill their potential and to control life circumstances (Blau and Blau 1982; Runciman 1966) (Chapter 2).

Second, drawing on the sociological tradition of social psychology explicitly focusing on the process of social stigmatization and discrimination (Link and Phelan 2001; Major and O'Brien 2005; Schafer and Ferraro 2011), this dissertation suggests that relative social position may affect adolescent outcomes through *social* mechanisms, independent of concurrent psychological distress led by invidious social comparison. This social pathway pays more attention to the roles of social exclusion and discrimination exerted by others in the reference group (especially those with higher social status) in contributing to poor psychological health outcomes among adolescents with lower social status.

Looking at an expanded set of potential mechanisms, this dissertation finds that the underlying mechanisms linking relative position to adolescent outcomes differ by different status characteristics. For example, the positive link between relative deprivation of parental income and adolescent psychological health is explained by a combination of concurrent psychological distress, future expectations, as well as social relationships, while future expectations account for the largest portion of the effect of relative deprivation (Chapter 2). Similarly, a component of social relationship as well as psychological factors (self-perception on weight status) contribute to explaining the effects of relative BMI on psychological health (Chapter 4). In contrast, among several potential mechanisms, the effects of ability rank are partly attenuated only by social relationships in the school settings—i.e., school attachment and relationship with other students (Chapter 3).

This dissertation provides some guidance and recommendations for future research in this area. The finding of this dissertation that multiple social hierarchies have an independent effect on adolescent outcomes presents a promising direction for future research to examine the potential effects of "status inconsistency," which is defined as having inconsistent hierarchical positions in different stratification systems (House and Harkins 1975; Peter, Gassler, and Geyer 2007; Stryker and Macke 1978): students may be subject to conflicting expectations within multiple hierarchies, which themselves may lead to psychological distress. For example, students with higher relative position in terms of parental SES in a peer group, but a lower ability rank in the same peer group may have worse psychological health. Relatedly, future research may examine whether "goal-striving"—i.e., incongruity between one's actual status and status aspirations (such as academic efforts and weight-loss behaviors)—is related to adolescent psychological well-being.

In addition, drawing on a life course approach, future work should aim to understand how being in a lower status group during adolescence, a critical psychosocial stressor, affects long-term consequences on health. Social stigma, discrimination and psychological distress associated with belonging to lower status groups during adolescence may leave a lasting imprint on bodies and minds. In other words, adolescents with lower social rank in a local peer group may receive little peer and teacher support, experience physical and emotional abuse, and suffer from chronic stress, all of which can impede physiological, social, and psychological development which is consequential for health and SES trajectories. Using cutting-edge biomarkers of physiological well-being (i.e., inflammatory, cardiovascular and metabolic function biomarkers), future research should examine how these negative social experiences during adolescence "get under the skin" of young people and shape their subsequent health trajectories. Finally, future research is needed to identify potential factors that may inhibit (enhance) the effects of relative social position on adolescent outcomes. For example, parental involvement and peer (close friendship) and teacher support may play a protective role against negative effects of lower social status in the school settings.

**2. Theoretical and empirical implications**

The idea that social status or position is important for population health is not new. Although this topic is examined and discussed widely across many disciplines outside sociology (e.g., epidemiology, public health, and social work), much of the theoretical framework used to link social status to health in modern society centers around the sociological concept that one's relative position to the reference group is the essential aspect of social hierarchy, which is known to play a critical role in production of health inequalities. However, a major challenge in this line of research has been to define and identify appropriate reference groups to which individuals compare themselves (Mangyo and Park 2011). While the vast majority of prior studies has defined reference groups based on demographic similarity (e.g., age, gender, and race/ethnicity) or geographic proximity (Singer 1981), the definition of reference group still remains contentious in the literature (Adjaye-Gbewonyo and Kawachi 2012; Lhila and Simon 2010; Mangyo and Park 2011).

This dissertation argues that adolescents' frame of reference is more clearly defined than adults' reference group. Schools (or classrooms), as a bounded social institution that brings together students for long periods of time, may serve as an important venue for social comparison as well as stigmatization. For example, a large body of empirical evidence on peer effects in adolescent research documents important roles of the normative context of a wider peer group in setting, maintain, and enforcing group norms to influence adolescents' attitudes and behavior (Coleman 1961; Giordano 2003; Kim and Fletcher 2018; Mangyo and Park 2011; Sacerdote 2014). Interestingly, the results of this dissertation lend support to the existing literature, by showing that students use classmate as a comparison point against which they assess themselves: students' position on a certain attribute (i.e., ability and BMI) relative to their classmates strongly predicts self-perception of their own position with respect to a reference group (Chapter 3 and Chapter 4). Therefore, fellow students attending the same school or school cohort appear to serve as a reasonable reference group for adolescents.

Relatedly, this dissertation adds to existing literature suggesting the significant role of a wider group of peers in influencing adolescent outcomes (see Kim and Fletcher 2018). Although peer groups based on nominations of best friends (i.e., close friendship) may serve as an alternative primary reference group, a wider group of peers such as classmates and schoolmates may be more relevant for the examination of relative position or social status among adolescents. A clear advantage of a wider peer group over close friendship is that the members of a wider peer network such as schoolmates and classmates tend to remain more stable (Schneider and Stevenson 1999; Urberg et al. 1995), providing a more consistent comparison point against which adolescents compare themselves. In contrast, a close friendship group appears to be too unstable to serve as a workable reference group. Adolescents' friendship network is known to be considerably unsteady and fluid: adolescents aged between 11 and 15 maintain less than 65% of their friendships across a school year and tend to lose more old friends than they form new ones (Berndt and Hoyle 1985; Chan and Poulin 2007; Neckerman 1996; Poulin and Chan 2010).

Despite relatively clear definition of reference groups among adolescents, selection into reference groups may pose a major empirical challenge in the analysis of relative position and adolescent outcomes. Leveraging a quasi-experimental research design, this dissertation overcomes non-random assignment of peer composition or distribution that determines students' relative position. Specifically, this research design relies on idiosyncratic variation in cohort composition within the same school to generate quasi-exogenous variation in peer characteristics. The core assumption of this approach to generate quasi-experimental variation is that parents and children only sort across schools based on the characteristics of the school, but not those of the child's cohort. Using a unique panel dataset, this dissertation provides strong empirical evidence in support of this assumption. In addition, to provide the most stringent test of the causal effects of relative position, throughout the chapters, this dissertation estimates family fixed effects model exploiting exogenous variation provided by the assignment of siblings who attend different grade cohorts within the same school.

Lastly, this dissertation offers important implications for intergenerational transmission of social disadvantages. The findings of this dissertation suggest that social inequality and stratification in our society may have an implication extended to population health in the next generation through socioeconomic stratification within schools (Chapter 2). Among adolescents, emerging school-based social hierarchies and ranking systems exacerbate relative deprivation, which in turn, deteriorates physical and mental health especially among those at the lower end of the SES distribution and thus contributes to health inequalities. In addition, the finding that relative deprivation is linked with declines in future expectations, particularly about educational attainment, also supports the claim that relative deprivation contributes to hampering social mobility. Students who are relatively deprived may see their future more negatively and reduce personal investment in education and training (Nguyen et al. 2012), while interpreting their relative deprivation as a major obstacle to better future (e.g., educational attainment, health, longevity, etc.). Therefore, in the longer-term, relative deprivation in the school settings may serve as a mechanism for intergenerational transmission of social disadvantages (Haas 2006).

**3. Policy implications**

The findings of this dissertation have implications for policies and other practical efforts to improve adolescent health. First, the findings provide useful insight on identification of at-risk population. The fact that the effects of social status depend on a social context suggests that using some absolute threshold to determine a target population (e.g., adolescents with obesity status, adolescents from families living under the poverty line, etc.) should miss adolescents at risk who do not meet the threshold of concern, but have *relatively* disadvantaged compared to members of their social group. Therefore, monitoring relative position, rather than mere absolute levels, may help schools identify at-risk adolescents and take effective measures to improve their health. In addition, as this dissertation focuses on classmates and schoolmates as the most sensible reference group for adolescents and they are often subject to direct policy influence (e.g., Billings, Deming, and Rockoff 2014; Cook and Ludwig 2006), *school-based* interventions could be especially useful and effective.

Furthermore, evidence on detailed mechanisms underlying the link between relative position and adolescent outcomes help develop interventions. In Chapter 2, since a student's psychological distress is found to mediate the effects of relative deprivation on adolescent health, a direct solution may be to reduce negative feelings of being at relatively lower status through psychological support and counseling services. In addition, it is important for teachers to help impoverished adolescents (who are relative deprived) feel hopeful about their future, in particular their educational attainment. Since, in general, the results of this dissertation emphasize the importance of social relationships, school-based programs to promote the social integration of low-status students and their families may be useful. As a more distant but fundamental solution, efforts to narrow socioeconomic gaps among students in the school setting (e.g., redistributive policies) can further help reduce psychological and social disadvantages of having a higher level of relative deprivation.

Deficits in social support from friends (or social isolation and exclusion from friends) have long been considered as a risk factor for adolescent depression. For instance, lack of support from friends may generate a feeling or perception that one is rejected or not valued in interpersonal relationships (Nangle et al. 2003; Respress et al. 2013). The results found in Chapter 3 thus adds to this line of research by providing strong evidence that ability rank is a critical source of peer hierarchies and social integration among adolescents. Moreover, the policy implications may crucially depend on evidence of this study that the rank effects are rather nonlinear and concentrated among male adolescents. It is therefore important that schools understand how students respond to ability rank of their own and others so that they can design effective policies for adolescents' psychological health that take into account the implicit penalties generated by school-based local hierarchies.

Along these lines, the findings of Chapter 4 that stigmatization appears to originate from fellow students in general (e.g., classmates) rather than teachers and close friends suggest that school-based programs focused on the promotion of social integration of the students at the school level may be more effective than interventions such as providing psychological counseling and services tailored for adolescents who are obese.

Last but not least, this dissertation provides broader implications of parental school choice and social mix policies. Documenting the potential trade-off between school quality and rank position—i.e., a student in a better-quality school should be ranked lower, this dissertation suggests that the rank of a child is another (often neglected) factor to consider when choosing a school for their children. Therefore, moving to a wealthier neighborhood or smarter school may have differential health consequences for different students depending on their SES and/or ability levels. Since the net effects for an individual student depends on the extent to which benefits of attending schools with higher SES or smarter peer composition (e.g., average peer quality, teacher quality, and school resources) are offset by drawbacks of having lower relative position (in terms of family income and ability). Therefore, more research is required to analyze and quantify the trade-off between rank effects and contextual effects.

**4. Conclusion**

I maintain that stratification processes prevail within the school. This stratification process is rather an overlooked aspect of stratification because a large body of prior literature have focused on broader processes of social stratification during adolescence: for example, how parental SES affects neighborhood or school choices, and in turn, how that leads to child's socioeconomic attainment. This dissertation, however, suggests that even after sorting into neighborhood or school, adolescents still face a whole new set of stratification processes within a given school. This dissertation suggests that there are a range of gender-specific attributes with particular salience for young people, contributing to school-based local hierarchies and these school-based local hierarchies shape adolescent health and educational trajectories. A deeper consideration of social hierarchies during adolescence has the potential to make substantial contributions to our efforts to understand and address social stratification and health inequalities.

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