Family Background, Cultural Capital, Obesity, and Academic Achievement in Childhood

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In the dissertation, I attempt to show how and why students' cultural knowledge and body shape are intertwined, which serve as an underlying mechanism of social and cultural reproduction in childhood. The dissertation consists of two main topics. For the first topic (second chapter), I investigate whether cultural capital matters for childhood obesity. While prior cultural capital studies have primarily focused on students' affective and cognitive orientations to schooling, I focus on the possible link between cultural capital and obesity as an alternative explanation for reduced educational success among minority students. This study is the first to investigate the longitudinal effects of cultural capital on student body mass index with large scale data. For the second topic (third chapter), I attempt to identify the mediating mechanism in the relationship between childhood obesity and academic achievement. Despite the growing concern about weight stigmatization and discrimination in the US, no empirical studies have investigated possible mediating roles of teacher evaluation on obese children's academic performance among marginalized subpopulations and have quantified the influence. To do so, I employ the newly released Early Childhood Longitudinal Study kindergarten cohort (ECLS-K: 2011), which is a nationally representative sample of American children who entered kindergarten in 2010-2011. In answering the proposed research questions, I attempt to exploit the advantages of structural equation modeling with a combination of econometric and quasi-experimental methods. The results of this study demonstrate that student cultural activity does reduce the risk of being obese in elementary schooling and that the negative influence of weight stigmatization might be

comparable to racial discrimination or even more pronounced for minority girls. Taken together, this study shows us the nuanced ways in which educational and health inequalities are perpetuated or exacerbated in childhood.

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Preface

I would like to thank my academic mentor and colleague, Dr. Sean Kelly, for all the support and advice he gave throughout my PhD studies. He has always encouraged me to develop my own academic interests and perspectives and provided me endless support. I was often wondering whether I can do the same things for my future advisee. I am greatly indebted to him for all he has done for me.

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1.0 Chapter 1: Introduction

School and society could be considered sites of symbolic violence where certain forms of knowledge, culture, attitudes, and skills are differentiated (Bourdieu, 1984). Not only is students' educational success determined by economic or social capital, it is also affected by cultural identity or *habitus*, which represents a distinctive set of cultural knowledge, practices, and dispositions (or perhaps, "thinking tools"). The term cultural capital, which broadly refers to widely shared high-status cultural practices and knowledge used for social and cultural exclusion, is originally derived from the work of French sociologist Pierre Bourdieu.[1] Although his analysis was based on French survey data, a substantial body of evidence supports that parental or student cultural capital has significant but modest effects on children's educational achievement and attainment (e.g., Dumais & Ward, 2010; Farkas, 2018; Jæger & Breen, 2016).

The term habitus, in particular, provides an important conceptual tool to understand the mechanisms of cultural capital effects; it shows us how individuals with different levels/types of cultural capital are differently positioned (or differently positioning themselves) in their fields. Lareau (2011), for instance, shows that students from affluent family backgrounds tend to have a sense of entitlement, which allows them to communicate easily with authoritative figures in schools. Lizardo (2006) also suggests that highbrow culture tastes (e.g., listening to classical

[1] It is worthwhile to mention that although the concept of cultural capital originated from Bourdieu, DiMaggio and his colleagues' early works (e.g., "from region to class, the changing locus of country music" in 1975 or "social class and arts consumption" in 1978) also provided important theoretical and empirical implications.

music) can contribute to shaping strong-tie density among students. In contrast, working-class boys who believe that they have limited educational opportunities and resources at their families and schools tend to invest in the classic macho mode of masculinity and related creation of anti-school cultures (see Devine, 2004; Willis, 1977 or Kelly, 2009). From Bourdieu's perspective, the practices of students from the working and upper classes are the consequence of their habitus due to different childrearing and early cultural experiences between social classes. Importantly, habitus is constructed during early childhood in perhaps largely unconscious processes, and cultural capital provides a cumulative advantage that increases over time. Christensen (2012), for example, shows that early socialization of arts is crucial in shaping student cultural participation in later stages. Although Bourdieu's perspective is generally considered as deterministic structuralism and thus criticized (though he attempted to overcome such critiques),[2] his theories of cultural capital and habitus have been widely used with respect to family and schooling or labor market outcomes (see also Farkas, 2018).

Beyond the specific frame of cultural capital, several sociologists and economists of education, have also paid attention to the importance of health-related social behaviors and norms (i.e. non-academic traits) as key mechanisms of social and cultural reproduction. Rothstein (2004), for instance, argues that too much emphasis has been placed on schooling, and that stronger families and simple health policies can overcome weak schools. In this view, education cannot be the sole solution for all manner of social ills. Likewise, schools must become more highly attuned

[2] Previous cultural capital studies in the US have also pointed out that distinctive class cultures that Bourdieu emphasizes are less likely to have clear symbolic boundaries in the highly pluralistic and democratized US culture and thus are relatively unimportant (see Kingston, 2001).

to addressing seemingly "non-academic" problems that become academic problems in the social world of schools. Crosnoe, for instance, has shown how students' health outcomes are unevenly distributed across social groups and regions, which are in turn significantly related to educational and economic outcomes. In particular, Crosnoe (2007) reveals that obese girls are less likely to enter college even after controlling for numerous demographic and school factors, and larger body sizes are also negatively related to adolescents' friendships in high schools (see Crosnoe et al., 2008). That is, obesity is a real academic risk factor, and educational researchers need to also consider the "social side of schooling" in mitigating social and educational inequalities. Indeed recent studies also show how factors not directly related to content coverage such as breakfast consumption (Basch, 2011) and student/teacher trust (Dewulf et al., 2017; Romero, 2015) are significantly related to students' educational outcomes.

*Cultural Capital and Health Outcomes***.** Can cultural experiences or knowledge, however, also be linked with health outcomes? In this dissertation, I will show how and why students' *cultural knowledge* and *body shape* are intertwined, which serve as an underlying mechanism of social and cultural reproduction in childhood. Previous studies suggest that the highly democratized and pluralized US society might mitigate the influence of "highbrow" cultural capital on student educational outcomes (e.g., Farkas, 2018; Kingston, 2001). From my perspective, however, the question should be revisited especially for health outcomes. Eating habits and practices are socially organized and reproduced, and even young children may adopt a specific food culture that often aligns with social class. For instance, Oncini (2019) points that although all children seem to have basic knowledge in nutrition and health, children from affluent families tend to have more specific knowledge of nutrition (i.e. food literacy). As such, cultural capital, including the habitus developed in artistic/cultural activities, may influence students' body image, eating behavior, and health, reducing the risk of being obese, even at a very young age.

In this particular topic, Bourdieu (1984) argues that the upper class distinguishes themselves from the working class not only by economic or social capital, but also by a preference for light and delicate foods and body images. Baumann et al. (2017) also show how the upper class rejects the aesthetic food tastes (e.g., corporate brands or familiar ethnic foods) of lower-class families, articulating symbolic and social boundaries. Importantly, Bourdieu (1984) argues that there are different *fields* in a society, and different types of capital carry different weights in each field. Put another way, the function of cultural capital can differ by contexts and dependent variables. For instance, it is difficult to imagine that simply visiting a theatre or museum can contribute to develop "pro-health habitus" among children. It is also questionable whether such common cultural activities can be a meaningful marker for social and cultural exclusion or a symbol of a social status at schools these days or if treating them as an equivalent form of cultural capital is appropriate. That said, educational researchers should revisit the roles of highbrow cultural capital (or heterogeneity in cultural capital) in relation to health outcomes. Nonetheless, previous cultural capital studies in the US have simply assumed the homogeneity of each cultural activity. The dissertation will contribute to expand our current understanding of cultural capital effects and its underlying assumptions.

*Why Childhood Obesity Matters**?*** There are numerous health measures, and different types of health problems carry different weights by age, sex, or race/ethnicity. Importantly, since there are limited resources in schools and districts, it is necessary to target identifiable and amenable risk factors for children. This dissertation particularly focuses on childhood obesity, which has drawn increasing attention in recent years as a key risk factor for academic achievement among

K-12 students (Joe et al., 2009). Specifically, the US has the highest rate of obesity among OECD countries; in 2016 18.4% of school-aged children were obese (OECD, 2017). Although there are some critics of obesity/overweight criteria and its negative influences such as over-concern with being overweight or stigmatization of obesity based on an arbitrary cut-off (e.g., Evans & Colls, 2009), a substantial body of evidence has accumulated over the past decade documenting the links between obesity and education, health, and economic outcomes (Kumar & Kelly, 2017; Tremmel et al., 2017). For instance, previous studies suggest that overweight children tend to have lower math and reading test scores (e.g., Datar et al., 2004) and higher levels of emotional distress/depression (e.g., Shaw et al., 2015); Hammond and Levine (2010) identify direct medical, productivity, transportation, and human capital costs as the economic cost of obesity in the US.

Why then might being obese matter for student academic performance? A common explanation for the observed negative relationships is that since obesity is generally associated with negative stigmas (e.g., being lazy, ugly, or unintelligent), it may affect student self-esteem/efficacy, emotional depression, or internalizing behaviors which in turn affects their academic outcomes (Shaw et al., 2015). Previous studies, for instance, suggest that even teachers, who are trained to be fair, are likely to have lower expectations for obese children (Friedman, 2008), and also perceive obese children as being emotional, unmotivated, and non-compliant (Russell-Mayhew et al., 2015). Mahoney et al. (2005) also find that teacher-rated popularity for children is significantly lower for obese children, even after accounting for student and family characteristics. Indeed several studies show that childhood obesity has negative associations with educational attainments (e.g., Shaw et al., 2015) and health outcomes (e.g., Caird et al., 2014), which in turn raise the cost of obesity. Consequently, childhood obesity has become an urgent public health concern in the US and among many developed nations.

A variety of ways to tackle childhood obesity have been proposed, both in and out of schools. In the second chapter of the dissertation, however I argue that cultural capital affects obesity trajectories (changes in student body mass index) and that this relationship can be empirically modeled with appropriate data. Further I question whether artistic cultural capital (i.e. participation in art or music class) is, in particular, beneficial for reducing the risk of being obese in early childhood. The results of this chapter will expand our current understanding of cultural capital effects, which emphasize aspirations, orientations to school, and other affective and cognitive mechanisms, to include physical health outcomes that in turn influence elementary school learning. In the following section, I discuss the importance of reducing weight discrimination against minority children for their educational success.

Is Weight Bias the Real Social Problem? In the US, weight discrimination has increased by 66% over the past decade and is also comparable to the prevalence of racial discrimination (Puhl & Heuer, 2009), which would be striking given the pervasive concerns of racial bias in American society. Hebl et al. (2019) also identify weight discrimination as one of a few distinctly modern forms of discrimination against e.g., LGBTQ individuals and older adults. Importantly, children are vulnerable to weight discrimination and stigmatization from peers and teachers (Puhl & Peterson, 2012); as can be seen from the popular novel “One fat summer” written by Robert Lipsyte (1977), weight related discrimination is a long-standing concern in the US culture. Moreover, how teachers perceive students affects student academic performance via teacher-student interactions in daily class (Kelly & Carbonaro, 2012). Although teachers in general intend to be fair in their teaching practices, they sometimes set their expectations based on students’ prior academic performance or race/ethnicity congruence (McKown & Weinstein, 2008). Previous studies, for instance, suggest that while teachers tend to provide more feedback and challenging instruction for high-expectation students (Rubie-Davies, 2007), they often perceive low-track students as more withdrawn and place an excessive emphasis on discipline and order (Kelly & Carbonaro, 2012). Indeed several studies also show that teachers are likely to have lower expectations or negative attitudes toward obese/overweight children (e.g., less competent or non-compliant) (Puhl & Peterson, 2012).

Compared to the general public reaction to racial and gender discrimination in the US, however, weight-related discrimination has been often rationalized and justified in many public areas. A recent news article, for instance, highlights that although female overweight candidates are more likely to be judged harshly in a job market, federal anti-discrimination laws provide little or no protection for overweight employees (Martin, 2017). What underlying mechanisms might explain the phenomenon? A prevailing societal perception in the US is that since BMI is modifiable, obese people are to blame for being overweight; people also feel less sympathy for those with more controllable conditions (Hebl et al., 2019). The perception may be further strengthened by US cultural beliefs that emphasize meritocratic values (e.g., people get what they deserve) (Puhl & Peterson, 2012). Moreover, individuals are often exposed to gendered and racialized cultural stereotypes about their physical appearance by schooling and media (e.g., Western beauty ideals). Previous studies, for instance, show that females (Barry & Grilo, 2002) or White females (Wang et al., 2009) are more concerned about eating and body image disturbances. Yet, the cost of weight stigmatization and discrimination is not trivial and have a serious impact on health and labor market outcomes (Puhl et al., 2010); weight bias among educators may also affect obese or overweight students' academic performance, though empirical evidence is lacking (Caird et al., 2014). Taken together, the research on the health and economic effects of obesity, along with research on discrimination and bias, imply that obesity itself is a real social problem, and weight discrimination must be addressed by educational leaders and teachers.

Obesity, Social Marginalization, and Intersectionality. Importantly, despite the growing concerns about weight stigmatization of minority students, to my knowledge, no empirical studies have investigated the possible mediation process between kindergarten obesity and academic achievement at the *intersection* of race, sex, and body size (e.g., Black and Hispanic girls with obesity). Student identities are socially constructed in ways that are contingent upon context and culture; their identities are affected by how others perceive and evaluate them. For instance, the experiences of Black or Hispanic female students might be substantially different from other racial/ethnic groups (Cho et al., 2013). The weight discrimination that students face may be formed substantially at the intersection of their social identities rather than a singular identity that lacks any connection. Indeed previous studies suggest that negative effects of stigmatization and discrimination of obesity by peers or teachers might be more salient for minority groups (Crosnoe 2007; Puhl et al., 2008). Weight discrimination and stigmatization would be double disadvantages for marginalized students who are already at higher risk for poor health/psychological outcomes and experience multiple stigmatized statuses.

In the third chapter of the dissertation, I thus investigate the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement among marginalized subpopulations. The results of this chapter will provide longitudinal empirical evidence on the mediating roles of teacher evaluation on obese children's academic performance and offer critical information about the influence of weight discrimination and stigmatization in elementary schooling. It will draw attention towards the importance of reducing weight discrimination against minority children for their educational success, as an issue of social justice.

The Early Childhood Longitudinal Study. In sum, two main research questions have been proposed in the dissertation: 1) What is the longitudinal relationship between cultural capital and body mass index in childhood; 2) What is the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement? Those research questions are further explored within the intersectionality framework.

What data then might provide the most insight and information in exploring the research questions? To answer the research questions, I rely on the newly released Early Childhood Longitudinal Study 2011 5th grade follow-up (ECLS-K: 2011), which is a nationally representative sample of American children who entered kindergarten in 2010-2011. The ECLS-K study follows the kindergarten cohort of 2010-2011 through the 2015-2016 school year, providing a comprehensive picture of children's academic development until secondary school. The study also includes a wide range of data on the children, their home, and school environments. Importantly, the ECLS-K provides a set of reliable measures of children's cognitive and non-cognitive skills, cultural activities, and body mass index that are widely used in previous studies (e.g., Dumais, 2006; Liu, 2019). The provided longitudinal measures are unusually rich compared to other representative data such as PISA and Add Health data; PISA is a cross-sectional international data and Add Health now targets adult population with no test-based measures of achievement.

Analytic Plan. In answering the research questions, and throughout the dissertation, I attempt to exploit the advantages of structural equation modeling (SEM). Econometric models can also be implemented in SEM framework relaxing various model assumptions (see also Bollen & Brand, 2010). Researchers, for instance, can freely estimate time-invariant coefficients or unit effect; the presumed fixed characteristics such as race/ethnicity and school/district effects may also vary over time. Many educational researchers often include a lagged dependent variable in their equations to account for the association between initial status and growth (for overview see also Kelly & Ye, 2017). Economists, however, have criticized this approach arguing that Y_{it-1} is likely to be correlated with the error term resulting in biased estimates, since Y_{it-1} is a direct function of U_i. In SEM, however, researchers can directly build the relationship between Y_{it-1} and U_i in addition to serial error correlation which often presents in longitudinal data. Model fit comparison and missing data analysis are additional advantages of SEM. I attempt to apply econometric and quasi-experimental methods within the SEM framework. The proposed analytic models are as follows.

In the second chapter of the dissertation, I investigate the longitudinal relationship between cultural capital and body mass index in elementary schooling. In cultural capital studies, it is of importance to address the cumulative nature of cultural capital and unobserved heterogeneity in cultural participation. I thus apply the recently developed dynamic panel model with ML (or ML-SEM) (Allison et al., 2017) with a difference-in-differences specification. In the third chapter of the dissertation, I investigate the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement. In this mediation study, it is of necessity to address confounding effects of unobserved heterogeneity among obese/overweight children at kindergarten. When other things were functionally equal, would teachers' negative evaluation of obese/overweight children be considered as weight bias. In addition, elementary school or teacher characteristics (e.g., school climate and teacher qualification) may also confound the relationship between teacher evaluation and student academic performance (i.e. mediator-outcome confounder). To address these likely confounding effects, I apply the recently developed covariate balancing generalized propensity scores (Fong et al., 2018) in a parallel process latent growth model framework with school and teacher fixed-effects models.

Overall, the dissertation will expand our current understanding of cultural capital and obesity effects in childhood. It will contribute to deeper understanding of growing inequalities in childhood health and educational outcomes by providing the missing links between early cultural experience, obesity, and academic achievement at the intersection of race, sex, and body size.

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2.0 Chapter 2: Does Cultural Capital Matter for Childhood Obesity?

Abstract

This study expands previous research on cultural capital which has primarily emphasized students' aspirations, orientations to school, and other affective and cognitive outcomes. I argue that cultural capital may contribute to shaping a student's body image, eating habits, or physical activities, reducing the risk of being overweight. Using the newly released Early Childhood Longitudinal Study 2011 5th grade follow-up (ECLS-K: 2011), I apply panel data econometrics including dynamic panel model using ML and difference-in-differences. The results of this study demonstrate that student cultural activity does reduce the risk of being obese in elementary schooling. Overall, given the recent trend of declining arts education in schools, my findings provide important policy implications.

Keywords: *cultural capital, arts education, childhood obesity, social stratification of health*

2.1 Introduction

Educational researchers have long been concerned that cultural capital provides middle- and upper-class families with educational advantages. However, while prior research has primarily focused on students' affective and cognitive orientations to schooling, this study focuses on the possible link between cultural capital and obesity as an explanation for reduced educational success. The United States has the highest rate of obesity among OECD countries. By 2030, about 47% of the US population is expected to be obese (OECD, 2017). In particular, the percent of children and adolescents (2-19 years) with obesity in the US increased from 13.9% in 2000 to 18.5% in 2016, and 18.4% of school-aged children (6-11 years) had obesity in 2016.

Previous studies also reveal differences in the prevalence of obesity by social class, race/ethnicity, and sex. For example, in 2016 the prevalence of obesity among Hispanic (26%) and Black (22%) children and adolescents was almost twice that of Whites (14%) and Asians (11%) (Hales et al., 2017). Not only is obesity related to serious health conditions (e.g., diabetes and cardiovascular disease), it also affects educational and labor market outcomes, reinforcing existing social inequalities. In elementary education, childhood obesity may contribute to a cycle of cumulative disadvantage in academic achievement, especially for minority students (Joe et al., 2009). Moreover, childhood obesity is a strong predictor of adulthood obesity. As such, childhood obesity has become one of the most pressing public health concerns in the US (Kumar & Kelly, 2017).

A variety of ways to tackle childhood obesity have been proposed, both in and out of schools (see Wang et al., 2015). In this study I focus on an overarching dimension of family background affecting diverse aspects of the school experience, students' cultural capital. Cultural capital is not often raised in scientific discussions of obesity, perhaps because highly proximate issues surrounding nutrition, exercise, and sedentary lifestyles are themselves not fully understood. Yet, access to arts education is especially uneven across social groups, and the extent to which schools provide art lessons in early grades has declined both in the US (Kisida et al., 2018) and the UK (Hickmore, 2019). In the present study, I propose that cultural capital affects obesity trajectories (changes in student body mass index) and that this relationship can be empirically modeled with appropriate data. Further I question whether artistic/highbrow cultural capital (i.e. participation in art or music class) is, in particular, beneficial for reducing the risk of being obese in early childhood. To my knowledge, this study is the first to investigate the longitudinal effects of cultural capital on student BMI with large scale data. The results of this study will expand our current understanding of cultural capital effects, which emphasize aspirations, orientations to school, and other affective and cognitive mechanisms, to include physical health outcomes that in turn influence elementary school learning.

2.2 Literature Review

2.2.1 Definition of Cultural Capital

Cultural capital, in general, refers to “widely shared high status cultural signals (attitudes, preferences, formal knowledge, behaviors, goods and credentials) used for social and cultural exclusion” (Lamont & Lareau, 1988, p.156) or “prestigious tastes, objects, or styles validated by centers of cultural authority, which maintain and disseminated societal standards of value and serve collectively to clarify and periodically revise the cultural currency” (Mohr & DiMaggio, 1995, p.168). Teachers, for instance, are likely to favor those students with higher cultural capital, providing more attention and feedback (Dumais, 2002). Cultural knowledge and formal language skills are generally valued by teachers who are oriented to the middle class. Although many teachers have working-class family origins in the US, in general, teachers were themselves quite successful in school and graduated from college (making their present status, by definition, middle class). Indeed there is a substantial body of evidence that parental and student cultural capital (e.g., participation in museums or musical performances) has statistically significant but modest effects on children's educational achievement and attainment (e.g., Aschaffenburg & Mass, 1997; DiMaggio & Mohr,1985; Dumais, 2002; Jæger & Breen, 2016).

The term "cultural capital" is originally derived from the work of French sociologist Pierre Bourdieu (1973, 1986). According to Bourdieu (1986), capitals refers to "accumulated labor (in its materialized form or its 'incorporated,' embodied form) which, when appropriated on a private, i.e., exclusive, basis by agents or groups of agents, enables them to appropriate social energy in the form of reified or living labor" (p. 241). Importantly, capital can exist in various forms such as economic, social, cultural, and symbolic capitals, and it can also be converted from one to another (e.g., transformation of economic capital into cultural or social capitals). In particular, Bourdieu (1977) defines cultural capital as "instruments for the appropriation of symbolic wealth socially designated as worthy of being sought and possessed" or "a symbolically and materially active, effective capital insofar as it is appropriated by agents and implemented." It should be, however, noted that Bourdieu's definition of cultural capital is not clear (Jæger & Breen, 2016).

From Bourdieu's perspective, social class is not only determined by economic or social capital but also by cultural identity (e.g., stylization of life) or habitus, which represents a structuring/structured structure which organizes practices and the perception of practices (Bourdieu, 1984) or a distinctive set of cultural knowledge, practices, and dispositions (Schwartz, 1997). DiMaggio (1982) and DiMaggio and Mohr (1985), for instance, show that status culture participation such as art events or having a cultivated self-image (e.g., I am a cultured person) has positive associations with educational and martial outcomes for both men and women. In a similar vein, Aschaffenburg and Mass (1997) find that both students' and parents' participation in cultural activities (e.g., music, visual arts, or painting) has significant positive relationships with school success (e.g., transition to high school or college). Lizardo (2006) also shows that highbrow culture tastes (e.g., read a poem or listening to classical music) has a significant effect on strong-tie density among students. Not all previous studies, however, find the positive relationships between cultural capital and student educational outcomes. Some studies, for instance, provide no compelling evidence for cultural capital effects (e.g., Byun & Pong, 2016; Katsillis & Rubinson, 1990; Plewis & Bartley, 2014) or rather report a negative association with student academic achievement (e.g., Byun et al., 2012), partly due to different measures of cultural capital or variations in national/cultural contexts.

According to Bourdieu, there are three types of cultural capital. First, embodied cultural capital refers to attitudes, dispositions, tastes, and behaviors for appreciating and understanding cultural goods, which exist in a hierarchical form. From his perspective, due to different childrearing and early cultural experiences between social classes, the dominant habitus is already embodied in privileged children. Second, objectified cultural capital refers to possessed cultural goods such as paintings, books, and sculptures. Third, institutionalized cultural capital refers to educational credentials or credentialing systems (Bodovski et al., 2017).[3]

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[3] Most prior empirical studies did not differentiate the three types of cultural capital, often due to the limited availability of indicators in their data. Since it is difficult to directly measure

2.2.2 Mechanisms of Cultural Reproduction via Cultural Capital

Before discussing how cultural capital might influence student BMI, it is important to describe the general mechanism of cultural capital effects on educational outcomes proposed in the literature. First, according to signaling theory, possession of cultural capital can function as a positive signal of class membership to teachers (or employers) who are middle-class oriented and value traditional cultural knowledge and skills. Second, according to the similarity-attraction hypothesis, cultural similarities yield attraction (Rivera, 2012). Put another way, those students who have similar cultural characteristics with school staff might be more favored. These two explanations emphasize that observed cultural capital effects are, in essence, misconceptions of cultural capital as academic brilliance by teachers and others. Jæger and Breen (2016) argue, thus, that although its consequences are real, cultural capital has no intrinsic use value.

Another compelling explanation, however, is that possession of certain types of cultural capital may enhance students' self-efficacy and confidence (since cultural capital is widely recognized and honored), which may in turn affect their educational achievement (Dumais, 2002). Wildhagen (2009) explains this process as a "self-selection" process, since students from middle- and upper-class family background develop a "sense of what they are entitled to." This mechanism can be better understood using Bourdieu's concept of *habitus*, which represents a distinctive set of cultural knowledge, practices, and dispositions (Schwartz, 1997). For instance, as can be seen from Willis (1977)' ethnographic study, working-class boys who believe that they have limited

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students' embodied cultural capital (or habitus), previous empirical studies tended to utilize participation in cultural activities such as visiting a museum, art gallery, or classical music concert as embodied cultural capital (e.g., Yamamoto & Brinton, 2010).

educational opportunities (e.g., limited economic and social capitals) may invest in the classic macho mode of masculinity or creation of anti-school cultures. In contrast, students from affluent family backgrounds tend to have a sense of entitlement, which allows them to communicate easily with authoritative figures in schools (Lareau, 2011). From Bourdieu's perspective, those working- and upper-class students' practices are the consequence of their habitus and limited capital in a given field (Dumais, 2002). Importantly, habitus is constructed during early childhood in an unconscious process, with cultural capital providing *cumulative* advantages that increase over time (for a general overview of the relationship between social class and social identity, see Warikoo and Carter 2009 or Kelly 2009).

Moreover, the initial advantage of acquiring the dominant habitus among privileged students are further strengthened by formal schooling. Meier (2002), for instance, argues that even in kindergarten, while the dominant habitus which privileged students "eagerly" bought from home is confirmed and honored increasing their self-confidence, "many other students never found a replacement for a school and teacher who didn't recognize their genius, who responded with a shrug or a look of incomprehension as they offered their equally eager home truths. They too soon learned that in school all they could show off was their ignorance. Better to be bad, or uninterested, or to just silently withdraw." (p. 15). These arguments suggest the importance of cultural capital especially for early childhood.

2.2.3 Cultural Capital and Health Outcomes

Unfortunately, previous studies on cultural capital have mainly focused on students' cognitive (or sometimes non-cognitive) outcomes. There are, however, several reasons to hypothesize that the acquisition of cultural capital can lead to better health outcomes, even for young children. Most fundamentally, cultural sociologists find that individuals may adopt healthy behaviors for cultural reasons as opposed to other more intrinsic reasons (e.g., to remediate health problems or because of enjoyment of specific activities). In particular, eating habits are socially organized and reproduced (Warde, 2016). Indeed, Oncini and Guetto (2017) show that measured cultural capital may better predict adult's health behaviors than social class itself.

Returning to early theories of cultural capital, Bourdieu (1984) argues that the upper class *distinguishes* themselves from the working class not only by economic capital, but also by a preference for light and delicate foods and body images/styles (i.e. symbolic values associated with food and dietary concerns). Baumann et al. (2017) show how the upper class rejects the aesthetic food tastes (i.e. abundance, corporate brands, and familiar ethnic foods) of lower-class families, articulating symbolic boundaries (for a more general overview of social stratification of eating and feeding, see also Oncini 2019b). Important to the present analysis, even young children can recognize cultural dimensions and differences (Pugh, 2014). In general, children at a very young age begin to develop a number of socio-emotional competencies (Harter, 1999), and more specifically, young children are active actors or agents in performing class-based identities (Streib, 2011) and adopt a specific food culture that often aligns with social class (Oncini, 2019a).

Abel (2008), in a theoretical synthesis of social class effects on health, identifies cultural capital as a key mechanism associated with health inequality. Building on Abel (2008) and Bourdieu's work Distinction (1984), I propose several theoretical explanations for the possible relationship between cultural capital and health disparities. First, there are culture-based resources that are acting in favor of health and well-being. In particular, objectified cultural capital (e.g., health books or sporting goods) and institutionalized cultural capital (e.g., health related degrees or licenses) can promote healthy and active lifestyles. Family lifestyle and culture also include sporting activities that are likely to lead to healthy and active lifestyles (Wheeler, 2012). Second, socially recognized cultural capital can enhance one' self-efficacy/esteem or sense of belonging related to psychological well-being (e.g., Khawaja & Mowafi, 2006). Artistic cultural activities can also provide children with opportunities to release emotion (Gara et al., 2018), and Brown et al. (2017), based on an RCT design, further show that arts activities (i.e. music, dance, and visual arts) reduce cortisol levels. Third, according to Bourdieu (1984) knowledge of arts and taste for "high-brow" culture are essential components of cultural capital. In particular, acquiring artistic cultural capital entails cultivating one's disposition and taste for appreciating arts and beauty, what society deems as desirable or attractive. Thus, it is plausible to predict that students with higher levels of artistic cultural capital, sometimes denoted "high-brow," may have a more desirable body image and lifestyles (or food choices) through adoption of aesthetic principles favoring graceful and restrained styles or health. Finally, the participation in exclusive cultural activities can expand one' social capital with upper-class social groups that generally favor healthy and socially rewarding lifestyles (e.g., acquisition of "pro-health" habitus or informal access to health information; see also Alvarez et al., 2017). In the result section, I illustrate how cultural activities, especially for arts and music lessons, are unevenly distributed between family backgrounds (see also Gara et al., 2018). Note also that the third and fourth mechanisms are particularly related to embodied cultural capital. Figure 1 summarizes the mechanism of cultural capital effects on health outcomes.

[Figure 1 about here]

In sum, I propose that cultural capital orients students to healthy and socially desirable lifestyles, which in turn affect their body mass index. Given the function of exclusive forms of cultural activities especially for health outcomes, I further suggest that "high-brow" artistic cultural capital (i.e. participation in art or music class) might be beneficial for reducing the risk of being obese in early childhood. I believe that a focus on artistic cultural capital may also provide important implications for school policy in the recent declining trend of arts education in schools. To test my hypotheses, I utilize two types of cultural capital: 1) *global* cultural capital that is employed in previous studies in the ECLS-K; 2) *artistic/highbrow* cultural capital that represents an exclusive embodied form of cultural capital.

2.2.4 Limitations of Previous Cultural Capital Studies on Health

Unfortunately, while a substantial body of research has investigated the role of cultural capital on students' educational outcomes, the longitudinal effects of early participation in cultural activities on student health are not well documented with large scale data. In particular, despite the importance of childhood obesity in public health, to my knowledge, no studies have attempted to investigate the effects of early participation in cultural activities on student body mass index.

Using Canada's General Social Survey 1986 and 2005 McLaren et al. (2009), for instance, show that adults with higher education spend more time in physical activity and reading, and this different time-use pattern is significantly associated with their social gradient in body weight. In a similar vein, using the Danish Survey 2011 Christensen (2011) also argues that parents with higher cultural capital tend to have low-weight children. Yet, even these a few early pioneering empirical studies have substantial limitations.

First, most of the research on the health-related aspects of cultural capital are based on cross-sectional correlational analyses focusing on adults and institutionalized cultural capital (e.g., education level). Specifically, from previous studies, it is difficult to disentangle the effects of cultural capital from unobserved individual abilities, family SES, and school or neighbor characteristics. Moreover, the nature of a cross-sectional data analysis does not provide cumulative or longitudinal evidence on cultural capital. Second, while several studies investigated gendered cultural capital effects or how cultural capital effects differ by social class (e.g., Oncini & Guetto, 2018), no empirical studies have investigated how the effect of cultural capital on health differs at the *intersection* of sex and race/ethnicity. Intersectionality is, however, important, since multiple social categories (e.g., Black women) reflect distinctive experiences of multiple social marginalization (Cho et al., 2013). The prevalence of obesity in early childhood is also more pronounced for minority groups (Hales et al., 2017).

Consequently, the main research questions of this study are: 1) Are there any disparities in childhood cultural activities between sex, race/ethnicity, family SES, and regions? 2) What is the longitudinal relationship between student cultural capital and body mass index in elementary schooling? 3) Can early participation in cultural activities at kindergarten provide significant returns in reducing the risk of being obese? If so, do cultural capital effects differ by sex, race/ethnicity, or at the intersection of sex and race/ethnicity?

2.3 Methodology

2.3.1 Data and Sample

To achieve the aim of this study, I employ the newly released Early Childhood Longitudinal Study kindergarten cohort (ECLS-K: 2011), which is a nationally representative sample of American children who entered kindergarten in 2010-2011. The ECLS-K study follows the kindergarten cohort of 2010-2011 through the 2015-2016 school year, providing a comprehensive picture of children's academic development until secondary school. The study also includes a wide range of data on the children, their homes, and school environments based on a three-step sampling design (for more information on the ECLS-K, see Tourangeau et al., 2015). Approximately 18,170 kindergarteners from 1,310 schools were sampled in the baseline year. This study employs the data from kindergarten to fifth grade. The final analytic sample is 15,820. Sample sizes are rounded to be nearest 10 in accordance with NCES secure data.

2.3.2 Measures

Student body mass index. This study employs the standard definition of BMI ($weight/height^2$) raw score (Burns et al., 2020; Von Hippel et al., 2007). Cole et al. (2005) also argue that the most appropriate measure of adiposity change in growing children is the change in BMI raw score. In addition, since this study focuses on the comparison of multiple groups, I prefer a liner specification for interpretation (see also Karlson et al., 2012). I use the composite BMI calculated by composite weight and height in the ECLS-K (Hsu et al., 2019). To obtain accurate measurements, each child's height and weight were measured twice in each data collection using a Shorr board and a digital scale. Composite BMI was computed based on the composite height and weight measures, which were constructed from two measurements (see more in Tourangeau et al., 2015).

Global cultural capital. I begin the analysis by investigating Dumais' (2006) cultural capital specification used in the ECLS-K Class of 1998-99. I create a continuous cultural capital variable measuring student cultural experiences in families and outside of school hours: visiting a library/bookstore, play/concert/other live show, art/museum/historical site, zoo/aquarium/farm, or a sporting event; participating in music lessons, drama lessons, art lessons, or a performing arts program. These variables are only available at kindergarten, second, and fifth grades, which are originally coded "yes=1" "no=0." Global cultural capital, then, represents the total number of cultural activities ranging from 0 to 9.

Artistic/highbrow cultural capital. In ECLS-K: 2011, after school participation in music, art, drama, and performing arts classes was measured more frequently than other indicators of cultural capital, annually beginning in kindergarten. These are exclusive activities in that participation rates are about 10%, while family cultural activities are not necessarily exclusive (participation rates range from 35% to 60%); Figure 4 also shows that there are considerable gaps in cultural participation between low- and high-SES families especially for art and music lesson. However, among these indicators, drama lessons have an extremely low frequency of participation among students of this age (2.18%). Additionally, performing arts programs may differ substantively from music and art lessons in that they often entail substantial physical activities (such that any effects on BMI may stem from a more direct set of mechanisms). Thus, I control for rare participation in these activities rather than include them in the artistic cultural capital measure. In contrast, music and art lessons show similar and higher participation rates (10%) and the highest Tetrachoric correlation (.4) among the original four classes of after school activities enumerated in ECLS-K. I thus focus on students' participation in art (e.g., painting or drawing) and music (e.g., piano or instrumental music) lessons outside of school hours and create a 0-2 scale of cultural capital (none to participation in both).

Confounders. Since ML-SEM and DID models can effectively address unobserved time-invariant confounders (see more in the analytic section), I identify observed potential time-varying confounders: family income, students' math, science, reading IRT scores, family size, and single parent. Fixed characteristics which were measured at kindergarten are additionally controlled for a linear growth model. These include child sex, age, race/ethnicity, birth weight, attendance of prekindergarten programs (e.g., preschool or Head Start), parental reports of overall child health, parent's educational level and educational expectations for children, home language (English or not), and residential area.

2.3.3 Analytic Strategy

In this longitudinal analysis, I first report the results for global cultural capital from ML-SEM. However, given the infrequency of these measures and their irregular spacing, I primarily focus on artistic cultural capital where the internal validity of the inference is improved (see further discussion in the results section).

To investigate the longitudinal relationship between cultural capital and BMI, I employ a dynamic panel model. Let me first begin with a basic panel model as follows:

$$Y_{it} = \partial + X_{it}\beta + U_i + \varepsilon_{it}, \tag{1}$$

where X_{it} is cultural capital that changes across t but not i; U_i represents unobserved stable factors in unit i (i.e. individual specific or unit effects); ε_{it} refers to idiosyncratic error term that varies across units and time (i.e. idiosyncratic disturbance). One of key issues in causal inference is whether U_i is correlated with observed predictors (X_{it}). In observational studies, however, it is likely that variables of interest (here is cultural capital) are correlated with unobserved stable confounders (i.e. $\mathrm{Cov}(X_{it}, U_i) \neq 0$). One option to reduce the omitted variable bias is to look at the effect of variables of interest within each unit, removing between-group variation. I do not use between-group variation to estimate the regression coefficient, since this variation may reflect an omitted variable bias. In this cultural capital study, removing between-group variation is of importance, since students in affluent families and schools may have more opportunities to participate in artistic cultural activities.

The fixed-effect approach, however, is based on the identifying assumption that unobserved confounders are time-invariant, in addition to no measurement error and no simultaneity (or no reverse causality). Additional cost is that I cannot estimate effects of time-constant variables (e.g., sex or race/ethnicity), and that under the presence of a variable with a low within variation, FE estimator provides imprecise coefficients (Cameron & Trivedi, 2009; Joachim, 2016).[4]

Bollen and Brand (2010) propose a way to overcome the several limitations of FE model with a structural equation model (SEM) approach. Figure 2 is a path diagram of equation 1. Cultural capital varies over time with BMI, and importantly there is a latent U term, which is the set of stable unobservables. This diagram clearly provides a better sense of the properties of FE model. In FE model, I assume that the effect of cultural capital on BMI is constant ($\beta 1$) across time, and residuals are uncorrelated with each other. Moreover, there is no autoregressive parameter of Y_{it}, reverse effect of Y_{it-1} on X_{it}, and importantly U_i effects are time-invariant assuming no measurement errors of variables.

[Figure 2 about here]

[4] Hybrid model expands the traditional RE model with the idea of FE model. That is, by including a group-mean (or person-mean) centered variable $(X_{it} - \bar{X}_i)$ along with its group-mean variable $(\bar{X}_i)$, we can both estimate the effect of a within-group change on Y_{it} and the effect of a between-group change on Y_{it} (Bell & Jones, 2015).

The advantage of structural equation model approach is that I can relax the fixed parameters in different waves including stable unit effect. Thus, I can test the sensitivity of models from time-varying effects of time-invariant confounding (Finkel, 2008). Additionally, structural equation model provides a model fit for comparison (e.g., RMSEA or TLI), and missing data can be easily handled by full maximum likelihood estimator. The autocorrelation issue in longitudinal studies can also be directly tested by allowing covariances between residuals. Finally, if student BMI or cultural capital is measured by multiple items, I can directly model measurement errors of each latent construct. In sum, FE-SEM has advantages in addressing the bias from measurement errors, unobserved time-varying unit effects, and missing data.

Strictly speaking, however, in FE model I assume that after accounting for stable unit effects, there is no effect of previous Y on X (i.e. reverse causality) and the underlying time trajectories of Y are the same across values of X (Morgan & Winship, 2007). However, in cultural capital studies it may be that the previous value of BMI affects the current cultural activities (i.e. predetermined). Obese children, for instance, are more encouraged to participate in physical activities to reduce their weights rather than artistic cultural activities (e.g., music and art classes). Moreover, given the dynamic and cumulative nature of cultural capital (Jæger & Breen, 2016), it is plausible to predict that previous levels of cultural capital affect current levels of BMI, and the previous levels of BMI will also determine current levels of BMI (Ng et al., 2012). The lagged specification is of importance since it determines the direction of causality (Allison, 2009). I can then rewrite the previous equation as follows, which is called as a dynamic panel model:

$$Y_{it} = \alpha + \beta_1 X_{it-1} + \beta_2 Y_{it-1} + U_i + \varepsilon_{it}, \quad (2)$$

where X_{it-1} and Y_{it-1} represent lagged cultural capital and BMI respectively that change across t but not i; U_i represents unobserved stable factors in unit i (i.e. individual specific or unit effects); ε_{it} refers to idiosyncratic error term that varies across units and time. Economists, however, have criticized this approach arguing that the lagged Y is likely to be correlated with independent variables and the error term, since Y_{it-1} is a direct function of U_i. Moreover, in observational studies students in affluent families and schools may have more opportunities to participate in cultural activities, leading to selection bias in β_1. That is, I cannot estimate β_1 without bias in the equation (2).

Several approaches such as Anderson-Hsiao (AH) or Arellano-Bond Generalized Method of Moments (AB-GMM) estimators have been adopted to address such issues in a dynamic panel model.[5] Recently, Allison et al. (2017) propose a maximum likelihood structural equation modeling (ML-SEM) method (or dynamic panel modeling using ML) arguing that it provides several advantages over the AB-GMM estimator under the assumption of sequential exogeneity (for s ≤ t, $E(X_{is},\ \varepsilon_{it})$=0). Figure 3 illustrates the ML-SEM approach, which is equivalent to the equation (2).

[5] According to Anderson-Hsiao (1981), after adopting the first difference model (i.e. difference out the U_i in the equation), we can use either twice lagged difference term ($Y_{it-2} - Y_{it-3}$) or the level variable Y_{it-2} as an instrument for the lagged difference term ($Y_{it-1} - Y_{it-2}$). This is because they are not correlated with the error term (ε_{it}-ε_{it-1}), under the assumption that ε_{it} is independent and identically distributed. If so, we can rewrite as $E(\triangle\ \varepsilon_{it+2} | Y_{it}, Y_{it-1}, \ldots Y_{io}) = 0$. Based on this assumption, it is possible to pick up as many as instruments in longer panel data. AB-GMM method expands this approach constructing instruments for X_{it} from the lags of X, either in the form of lagged levels or differences (Arellano & Bond, 1991).

[Figure 3 about here]

In this dynamic panel model with ML, I only have the endogenous BMI variables and predetermined cultural capital variable. However, it is also possible to include both observed time-varying and time-invariant covariates in this model unlike a traditional FE Model. Specifically, current BMI is determined by the previous values of cultural capital and BMI, which are both correlated with U_i, so that I can account for unobserved stable unit characteristics. Importantly, since the ML-SEM builds the relationship between Y_{it-1} and U_i, I can avoid the bias from including a lagged dependent variable in the equation (2).

In this model, sequential exogeneity means that current levels of cultural capital are independent of future and current values of ε after accounting for the stable unit effect (U_i), but may be correlated with past values of ε. The allowed relationship with past residuals (i.e. dashed lines in Figure 3) implies that previous values of BMI affect current cultural activities (i.e. predetermined). Obese children, for instance, are more encouraged to participate in physical activities to reduce their weights rather than artistic cultural activities. ML-SEM can effectively address the reverse causality.

ML-SEM can control for unobserved familial and demographic variables (e.g., family climate, parenting behaviors, and school/district characteristics) as long as the effects of those variables do not change over time. Yet, there might be time-varying omitted confounders (e.g., sports activities) in this proposed model. To address such potential bias, I also control for important time-varying confounders (e.g., family income and academic achievement) and conduct several sensitivity analyses for the baseline estimates from ML-SEM. Note also that since I control for previous levels of BMI in the equation (2), I can further block back doors from changes in BMI_{it-1}

(e.g., being obese -> sports participation -> cultural/arts activities and BMI_{it}). To answer Research Question 2, I thus apply ML-SEM with maximum likelihood with robust standard errors which is robust to non-normality.

I then investigate the consequence of early participation in artistic cultural activities (at kindergarten) on BMI (at 1st and 5th grade) based on school-fixed difference-in-differences specification as follows:

$$Y_{it} = \alpha + \alpha' S_i + \beta_1 C_i^1 + \beta_2 C_i^2 + \theta T_t + \delta_1 (C_i^1 \times T_t) + \delta_2 (C_i^2 \times T_t) + \beta' X_{it} + U_i + \varepsilon_{it}, \quad (3)$$

where Y_{it} represents student BMI, C_i^1 (=1) and C_i^2 (=2) are the number of early participation in artistic cultural activities (ref=0), T_t is a time-fixed effect which denotes 1st or 5th grade (ref=kindergarten), X_{it} is a vector of observed time-varying confounders, and S_i represents the schools in this sample. Thus, the α' coefficients capture differences between the means of each school and the omitted school. In this double-treatments setup, I am particularly interested in the interaction effects of δ_1 and δ_2; the returns of artistic cultural capital. The interaction terms are identical to estimates calculating the average difference in BMI separately for participants and non-participants over periods (first difference) and then taking the difference between the average changes in BMI for the two groups (second difference). Based on cultural capital theory, I posit that the effects of early arts participation will be realized in a later stage in elementary schooling.

Although DID model can effectively address time-invariant unobserved heterogeneity and different mean initial status between treatment groups, it basically assumes that the trends of changes in BMI are parallel between treatment groups in the absence of treatment (Angrist &

Pischke, 2009).[6] Since the ECLS-K provides the baseline BMI, it is also possible to control for a pre-trend of BMI as a robustness check (see Raudenbush, 2001). I expand the equation (3) with the following equation with an additional time point.

$$Z_t + \delta_3(C_i^1 \times Z_t) + \delta_4(C_i^2 \times Z_t) \qquad (4)$$

Here Z_t is a dummy variable taking on a value of 1 at the third time point (i.e. 1st or 5th grade) and 0 otherwise. Thus, δ_3 and δ_4 are the *deflection* experienced by student i between times 2 and 3, after accounting for different pretreatment growth rates between treatment groups; the difference between these nonlinear deflections allow us to capture the presumptive treatment effect. As an alternative specification, I also provide results from a linear growth model. Finally, the heterogeneous returns to cultural capital are examined with interaction models investigating Research Questions 2 and 3. Missing cases are imputed with full information maximum likelihood (FIML) for ML-SEM and multiple imputation (MI) for DID generating 10 data sets. Both FIML and MI provide equivalent results (Graham, 2009). Given the nested structure of the ECLS-K data, standard errors are adjusted with a cluster option. Mplus and Stata are employed to conduct the proposed methods.

The ECLS-K provides several sampling weights. Recent studies, however, argue that the aim of sampling weights is to adjust the descriptive statistics of the sample to resemble the population, and that the use of sampling weights may not be appropriate in understanding the

[6] I also plot student BMI across years between treatment groups (see Appendix C). The trends in BMI between treatment groups are parallel during kindergarten, which implies that treatment effects occurred in elementary schooling are not mainly due to the fluctuation of the pre-trend in BMI.

impacts of variables (i.e. weighted estimates are less precise) (Schudde, 2018; Solon et al., 2015). This study only employs the sampling weights to generate descriptive statistics. Yet, I confirm that main models show similar results with or without sampling weights in the ECLS-K.

2.4 Results

2.4.1 Disparities in Cultural Activities between Family Background, Race/Ethnicity, and Sex.

Figure 4 illustrates the participation rates in global cultural activities (i.e. participation rate of all cultural activities) and art or music lessons (i.e. proportion of participation) by family SES and sex at kindergarten. I use the composite family SES variable in the ECLS-K and generate high- and low-SES families based on a 20 percentile specification. There are considerable gaps in cultural participation between low- and high-SES families especially for art and music lesson; children from high-SES families are about 5 and 10 times more likely to participate in art and music classes, respectively. Even for global cultural activities, while high-SES students show a 38% participation rate in all types of cultural activities, students from low-SES families show a 24% of the participation rate.

[Figure 4 about here]

Figure 5 depicts the cultural participation gaps between race/ethnicity and sex. Compared to other racial/ethnic groups, Hispanic and Black children show low cultural participation rates both in the global and artistic cultural activities. Yet, the participation gaps are larger in arts activities. In particular, although the participation rates of Hispanic and Black children are below average, the observed participation gaps between races/ethnicities (except for Asians in arts activities) are not as considerable as SES differences, as shown in Figure 4. Interestingly, Asian students are about 3 times more likely to participate in arts activities than the average student (10%). In terms of sex, Figure 5 reveals that the high rates of arts participation among Asians is mainly due to female students' participation (about 40%).

[Figure 5 about here]

Regional gaps in cultural participation are illustrated in Figure 6. It shows broadly similar patterns for global and artistic cultural capital. Specifically, children living in the South and Midwest are less likely to participate in cultural activities compared to those in the West and Northeast; the observed gaps (relative risk calculations) range from 8% to 39%. Those children attending schools in towns (i.e. smaller, non-metropolitan towns) also have considerable disadvantages for after-school arts/cultural education. Specifically, the participation rates in music (5%) and art (4%) classes are, in general, 2 times lower than children from other school locations. Yuksek et al.'s (2019) recent study shows that the influence of social class on highbrow arts participation (e.g., visiting an art museum or attending an opera) has decreased among US adults. With respect to childhood arts activities (which also affect adult arts participation or arts preferences), however, my findings demonstrate that considerable gaps still remain between family backgrounds and even entire regions.

[Figure 6 about here]

2.4.2 The Longitudinal Relationship between Global/Artistic Cultural Activities and Body Mass Index

Global cultural capital. The right columns of Table 1 present results from global cultural capital models using ML-SEM methods. Although ML-SEM can effectively identify lagged effects of cultural capital after accounting for reverse causality in a fixed-effect model framework, I conduct several sensitivity analyses for the baseline specification, M1. Specifically, in M2 I allow time-invariant unobserved heterogeneity (U_i) to vary over time. By doing so, the time-varying parameter U_i may capture the influence of unobserved time-varying effects of time-invariant confounders or the remaining partial portion of time-varying confounders, after controlling for observed time-varying characteristics (e.g., family income and academic achievement) in this model.[7] I do not report model fit indices for the global cultural capital specification, since the model with two-wave lags is a just-identified model.

[Table 1 about here]

In M1, I do observe significant returns to global cultural capital on BMI, especially for females and White females. Specifically, the observed return for those girls who participated in two-thirds of all cultural activities is about 22% ((–.07*6)*2/3.90) of a SD of BMI.[8] In M2,

[7] The ECLS-K does not annually measure students' sport participation. Yet, even if I control for the available time-varying sport participation, the results are almost identical. In Appendix D, I provide a brief simulation result for the performance of time-varying latent U_i in the presence of unobserved time-varying confounding.

[8] In this study, I present effects standardized at the student level (see Kraft, 2020).

however, the returns to cultural capital are substantially reduced, and the observed effect for White girls is no longer statistically significant (–.02). Recall that this model includes students' academic transition from kindergarten to elementary school, which is likely to reflect unobserved time-varying confounding (e.g., changes in school climate or peer effects). Since the time-varying parameter U_i partially captures influences of time-varying confounding, it may explain the reduced effects of global cultural capital on BMI.

Yet, there are some additional factors that comprise the internal validity of my findings here. First, in this dynamic panel model with three waves, I only have two lagged cultural capital variables (at kindergarten and 2nd grade). As such, the data may not be sufficient for capturing the cumulative nature of cultural capital effects. There is also a possibility that the irregularly spaced time points for the global cultural capital variable may introduce bias (Millimet & McDonough, 2017). Second, in this global cultural capital specification, I basically treat all cultural activities as an equivalent form of cultural capital (i.e. linearity). Yet, one might question whether simply visiting a library or a museum promotes a pro-health habitus for children or if treating them as forms of cultural capital equivalent to intensive cultural experiences is appropriate, especially for *health* outcomes. Indeed, while student participation rates in art and music lessons are about 10%, family cultural activities are not necessarily exclusive (participation rates range from 35% to 60%). Moreover, measures of some cultural capital change from "ever participation" to "in the past year" as children move to elementary schools. Due to limitations of the data structure that affect the scale of global cultural capital, for the remainder of the analyses I thus concentrate on artistic cultural capital.

Artistic/highbrow cultural capital. The lefts columns of Table 1 illustrate the results for the relationship between artistic cultural capital and BMI from grade 1 to 5. The model fits for artistic cultural capital specification are excellent in terms of CFI, TLI, and RMSEA, implying that the proposed models are reasonably consistent with the ECLS-K data. It is recommended that CFI and TLI should be higher than .90 and RMSEA should be lower than .08 (Hooper et al., 2008). Since I now have more than three waves, in M3 I further allow cultural capital variables to covary with not only past residuals but also contemporaneous residuals to address potential bias from common causes including a wrong lag specification (Zyphur et al., 2019).

The estimates from M1 show that those children who participated in at least one artistic cultural activity tend to have lower BMI with an annual average decline of .08 points. Thus, for those children who participated in both art and music lessons, the expected decrease of BMI for 4 years is about 16% of a SD of BMI ((–.08*2)*4/4.11), which is small but still robust to multiple specifications; M3 shows that the baseline estimate (M1) might be conservative. Interestingly, the observed returns to cultural capital are more pronounced for male (–.09) and Hispanic male students (–.17). Specifically, for those Hispanic male students who participated in both cultural activities, the expected return to cultural capital over four years is about 29% of a SD of BMI ((–.17*2)*4/4.66). Yet, the results become marginally significant at $p<.10$ in M2 and M3 specifications. Thus, more emphasis should be placed on the estimates for all students.[9]

In Table 1, however, I basically assume that cultural capital effects are constant over time, as in a traditional regression model. By exploiting advantages of ML-SEM over the AB-GMM estimator, I relax this assumption and illustrate how cultural capital effects vary over time in Figure 7, showing 95% CIs. The results show us that in general the influences of artistic cultural capital

[9] I also extend the model to include an additional wave from kindergarten, which however provides a similar estimate (–.10*) as in M3.

on BMI become stronger (except for Hispanic and Black male children), as students move to higher grades. In the following section, I investigate the consequence of early arts participation on BMI.

[Figure 7 about here]

2.4.3 The Consequence of Early Participation in Artistic Cultural Activities at Kindergarten

Table 2 illustrates results from the difference-in-differences specification. Note that the DID estimates are total effects of early arts participation on BMI. This specification generates the difference in gain scores between treatment groups after accounting for initial differences and unobserved time-invariant heterogeneity as well as observed time-varying controls in this study (e.g., academic achievement and family income).

[Table 2 about here]

Table 2 shows that apart from female (–.20) and White female children (–.22), there are no observed significant returns to artistic cultural activities at kindergarten for 1st graders, which are similar findings from the ML-SEM models for global cultural capital (see M1 in Table 1). Yet, after accounting for different pretreatment growth rates, the significant effects disappear; there are no immediate returns to early arts participation. After five years, however, significant returns are observed. Specifically, the observed return for those children who participated in both art and music classes at kindergarten is about 16% (–.66/4.11) of a SD of BMI, which is identical with the finding from the ML-SEM specification. Interestingly, the effects of early arts participation are more pronounced for female and White children. Observed significant effect sizes between sex and race/ethnicity range from 7% (–.28/4.14) to 32% (–1.22/3.83) from the models controlling for a pre-trend of BMI. According to cultural mobility hypothesis (DiMaggio & Mohr, 1985), cultural capital may be able to function as a path of social mobility for minority students (see also Dumais, 2006). With respect to student BMI, my findings are mixed.

As a supplemental analysis, I also conduct a linear growth model (see Appendix A). The growth model provides a useful portrait of initial differences in BMI and average annual returns to arts participation at kindergarten across treatment groups. It provides broadly similar results with the DID specification. Generally speaking, children who participated in arts activities tend to have slightly higher body mass indices at the outset (the gaps are bigger in school fixed-effects model). As children move to higher grades, however, those children with early arts experiences begin to lose weight, which essentially cancels out the initial differences in BMI and provides a further weight loss after 5 years. The marginal effects of cultural capital over time for female and White female children, who received the most benefits from early arts participation, are illustrated in Appendix B. In sum, my findings from multiple specifications demonstrate that artistic cultural capital does contribute to reducing the risk of being obese in elementary schooling.

2.5 Discussion

In the present study, I hypothesize that cultural capital may contribute to shaping a student's body image, eating habits, or physical activities, thereby reducing the risk of being overweight. I first investigate the possible link between a global form of cultural capital and BMI. The results show that there are significant returns to global cultural capital, especially for girls and White girls, which are consistent findings from the DID specification targeting early arts participation. Yet, the results are sensitive to time-varying confounding, and the available three time points may not be sufficient for capturing the cumulative nature of cultural capital effects. I thus put more emphasis on findings from models of artistic/highbrow cultural capital. I believe that the focus on artistic cultural capital also provides important policy implications related to the recent declining trend of arts education in schools among developed nations including the US and UK.

Returning to the main analyses, my findings demonstrate that arts participation in elementary schooling does reduce the risk of being overweight; the effect size is between 12% and 23% of a SD of BMI for all students (from M1 to M3 in Table 1), and the influence of arts participation is stronger in later grades, as cultural capital theory posits. I also observe that arts participation at kindergarten has significant impacts on changes in BMI in elementary schooling. In particular, the effects of early arts participation are more pronounced for female and White female students (about 22% and 32% of a SD of BMI respectively from the DID specification). The observed longitudinal returns for early arts participation are slightly larger than the reported small effect sizes (.25 weighted mean differences of BMI) of school- and home-based obesity prevention programs (following participants at least 1 year) found in a meta-analysis (Wang et al., 2015).

2.5.1 Limitations

Before discussing implications of this study, it is worthwhile to mention several limitations of my analyses here. First, in the present study I particularly focus on the relationship between student participation in art and music lessons (i.e. “high-brow” embodied cultural capital) and their body mass index. Arts activities or knowledge are widely used to measure students’ cultural capital in national data (e.g., Jaeger, 2009). However, it may be that other forms of cultural capital also affect various health outcomes (e.g., psychological well-being or risk behaviors). Although I also find significant relationships between global cultural capital and BMI, there are some limitations of the data structure and scale of global cultural capital that make it difficult to generalize my findings. I thus call for future studies to investigate the relationship between various forms of cultural capital and health outcomes with more appropriate longitudinal data.

Yet, I am somewhat skeptical of study approaches that investigate the sum of, or generate factor scores of, multiple cultural activities (e.g., participation/visits to concerts, libraries, bookstores, museums, theaters, or historical sites), especially for student health outcomes. In particular, Lareau and Weininger (2003) argue the necessity of the expansion of cultural capital focusing on high status cultural signals. According to them, technical skills including academic skills, for instance, should also be considered as cultural capital. However, it does not necessarily mean that academic skills and music or painting skills should be treated as the same cultural capital. In particular, Bourdieu (1984) argues that there are different *fields* in a society, and different types of capital carry different weights in each field. Put another way, the function of cultural capital can differ by contexts and dependent variables. I question whether visiting a museum or theater can be a meaningful marker for social exclusion or confer social status (related to self-efficacy/esteem or social capital networks) at schools these days or if treating them as forms of cultural capital equivalent to more intensive cultural experiences is appropriate in explaining cultural capital effects on health outcomes. There may also be important cross-national variation in the relative importance of each cultural activity.

Additionally, although this study focuses on available family and out of school cultural activities, it would be also worthwhile to examine the relationship between school cultural activities and students' diverse health outcomes to better understand school-to-school variation in educational attainment or health disparities. Finally, while I attempted to provide several theoretical explanations for the possible link between cultural capital and health, the mechanisms of cultural capital effects on BMI, which would provide further support for a causal claim, remain untested.

2.5.2 Conclusion and Implications

This study expands previous research on cultural capital which has primarily emphasized students' aspirations, orientations to school, and other affective and cognitive outcomes. My findings reveal a significant new pathway of social reproduction via the accumulation of cultural capital and subsequent changes in BMI in childhood. Previous studies show that being overweight not only leads to serious health problems, but also affects student academic performance due to associated negative stigmas (e.g., being lazy or physically unattractive) (Shaw et al., 2015) or impaired neurocognitive functioning such as attention and motor skills (Liang et al., 2014). My findings, in particular, suggest the possibility of cumulative advantages of participating in artistic cultural activities (see also Figure 7 and Appendix B), as cultural capital theory posits. High-SES children may have enjoyed an unexpected benefit of losing weight (or maintaining healthy weight) from early cultural/arts experiences.

Beyond BMI, considered here, I further suggest that educational researchers consider not only cognitive/non-cognitive outcomes, but also diverse health outcomes to better understand the growing inequalities in academic achievement gaps between high- and low-income students (Reardon & Portilla, 2015). Indeed, descriptive analyses show that the disparities in students' cultural/arts participation are much larger among high- and low-SES families than racial/ethnic groups (see Figure 4 and 5). Considering the link between cultural capital and health in childhood will show us the nuanced ways in which educational inequalities are perpetuated or exacerbated.

My findings also highlight the necessity of revisiting the roles of "high-brow" or exclusive cultural activities. Previous cultural capital studies show that elite cultural activities, at least in the US, are not particularly central to the academic success of middle-class children (Farkas, 2018). With respect to health outcomes, however, there are several reasons to hypothesize that class-based cultural activities may lead to better health outcomes (e.g., increased self-efficacy/esteem, shared similar values or preferences favoring healthy lifestyles, or informal access to health information). Since children's health status is an important predictor of future academic performance (Joe et al., 2009), high-brow or legitimate cultural capital may affect students' future academic success via various health channels.

Unfortunately, in the US, the amount that schools provide little or no arts education has increased in the early grades, especially as the No Child Left Behind (NCLB) era unfolded, and the non-participation rate is largest for children from low-SES families (Gara et al., 2018). The decline trend of arts education is also observed in other nations (Aróstegui, 2016; Hickmore, 2019). This study suggests that student cultural experiences are of importance in reducing the risk of being overweight, contributing to literature that challenges school policies that overly emphasize preparation for standardized assessments in early grades. Early arts participation is an important predictor of adult arts participation (Dumais, 2019; Rabkin & Hedberg, 2011), and it also has significant relationships with early childhood development such as academic skills and emotional outcomes (Holochwost et al., 2017; Kisida et al., 2018). As schools provide less arts education, however, participation in artistic cultural activities will be heavily determined by family SES and parental involvement in children's education. From a policy perspective then, my findings suggest that schools do need to play an important role in providing students with early arts experiences. Not only does having arts education in early grades provide more equality of educational opportunity in the arts itself, it may also help reduce the cost of obesity. Indeed the model-based estimates show that early arts participation may generate positive returns comparable to school- and home-based obesity prevention programs. Yet, further empirical research is needed to expand the proposed research model to include more diverse cultural capital and health outcomes. In sum, this study contributes to a deeper understating of growing inequalities in childhood health and educational outcomes, in addition to expanding our current understanding of cultural capital effects.

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Table 1. Results from Maximum Likelihood Structural Equation Modeling

Sample	Model fit	Artistic cultural capital			Global cultural capital	
		M1	M2	M3	M1	M2
		ML-SEM	ML-SEM (time-varying U_i)	ML-SEM (endogenous)	ML-SEM	ML-SEM (time-varying U_i)
Total (15,820)	CFI=.98; TLI=.97; RMSEA=.03	–.08** (.03)	–.06** (.02)	–.12* (.05)	–.04 (.03)	-.01 (.01)
Male (8,070)	CFI=.98; TLI=.97; RMSEA=.03	–.09* (.04)	–.08* (.03)	–.14 (.07)	.02 (.04)	.00 (.01)
Female (7,730)	CFI=.98; TLI=.97; RMSEA=.03	–.06 (.03)	–.07 (.04)	–.09 (.06)	–.07* (.03)	–.02* (.01)
Black male (1,000)	CFI=.97; TLI=.95; RMSEA=.04	–.11 (.12)	–.04 (.09)	–.27 (.25)	.01 (.12)	.01 (.03)
Black female (930)	CFI=.97; TLI=.96; RMSEA=.03	–.05 (.12)	–.08 (.12)	–.05 (.19)	.06 (.09)	.01 (.04)
Hispanic male (2,110)	CFI=.97; TLI=.97; RMSEA=.03	–.17* (.09)	–.15 (.08)	–.30 (.17)	.10 (.08)	.02 (.03)
Hispanic female (2,040)	CFI=.98; TLI=.98; RMSEA=.02	–.03 (.07)	–.10 (.08)	–.02 (.13)	–.07 (.07)	–.03 (.02)
White male (3,830)	CFI=.98; TLI=.97; RMSEA=.03	–.08 (.06)	–.03 (.04)	–.14 (.12)	.00 (.04)	.01 (.02)
White female (3,570)	CFI=.97; TLI=.97; RMSEA=.03	–.09 (.05)	–.06 (.04)	–.18 (.12)	–.10* (.05)	–.02 (.02)
Asian male (640)	CFI=.97; TLI=.95; RMSEA=.04	–.11 (.08)	–.13 (N/A)	–.14 (.14)	.15 (.12)	–.03 (.05)
Asian female (730)	CFI=.98; TLI=.97; RMSEA=.03	.06 (.09)	.02 (.07)	–.01 (.14)	–.06 (.09)	–.01 (N/A)

***p<.001 **p<.01 *p<.05. Note: Standard errors are adjusted with cluster option. MLR estimator and subpopulation option are employed. MLR is robust to non-normality. N/A denotes a non-convergence issue.

Table 2. Difference-in-differences Model for BMI

Treatment level	Total	Total		White		Black		Hispanic		Asian	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Kindergarten vs. 1st grade											
T1	–.03	–.03	–.03	–.10	–.03	–.16	.10	.12	–.05	.10	.09
	(.03)	(.05)	(.04)	(.06)	(.05)	(.19)	(.14)	(.13)	(.09)	(.16)	(.14)
T2	–.10	.02	–.20*	–.03	–.22*	.44	–.46	.19	–.10	–.17	.11
	(.07)	(.11)	(.08)	(.11)	(.10)	(.26)	(.59)	(.22)	(.22)	(.42)	(.18)
Kindergarten vs. 1st grade (pre-trend)											
T1	–.04	–.05	–.03	–.14	–.08	–.28	.21	.20	.09	–.04	–.08
	(.04)	(.07)	(.06)	(.08)	(.08)	(.33)	(.18)	(.17)	(.12)	(.21)	(.20)
T2	–.09	–.02	–.16	–.14	–.23	.52	–.04	.03	–.16	–.05	.03
	(.10)	(.15)	(.12)	(.16)	(.13)	(.32)	(1.05)	(.28)	(.29)	(.64)	(.25)
Kindergarten vs. 5th grade											
T1	–.28***	–.27*	–.31**	–.36*	–.27*	–.39	–.30	.38	–.14	.02	.07
	(.08)	(.12)	(.10)	(.16)	(.13)	(.39)	(.38)	(.30)	(.25)	(.34)	(.27)
T2	–.66***	–.36	–.90***	–.50	–1.17**	.43	–.45	–.17	–.19	–.34	–.28
	(.17)	(.26)	(.22)	(.41)	(.34)	(.76)	(.90)	(.57)	(.64)	(.59)	(.34)
Kindergarten vs. 5th grade (pre-trend)											
T1	–.29***	–.28*	–.31**	–.39*	–.33*	–.46	–.17	.47	–.03	–.13	–.10
	(.08)	(.39)	(.11)	(.16)	(.14)	(.43)	(.38)	(.30)	(.26)	(.35)	(.29)
T2	–.66***	–.39	–.89***	–.58	–1.22***	.59	–.02	–.30	–.31	–.25	–.35
	(.18)	(.27)	(.23)	(.43)	(.33)	(.63)	(1.27)	(.54)	(.65)	(.77)	(.39)

***p<.001 **p<.01 *p<.05. Note: Standard errors are adjusted with cluster option. Results are similar with the models based on the logarithm of BMI.

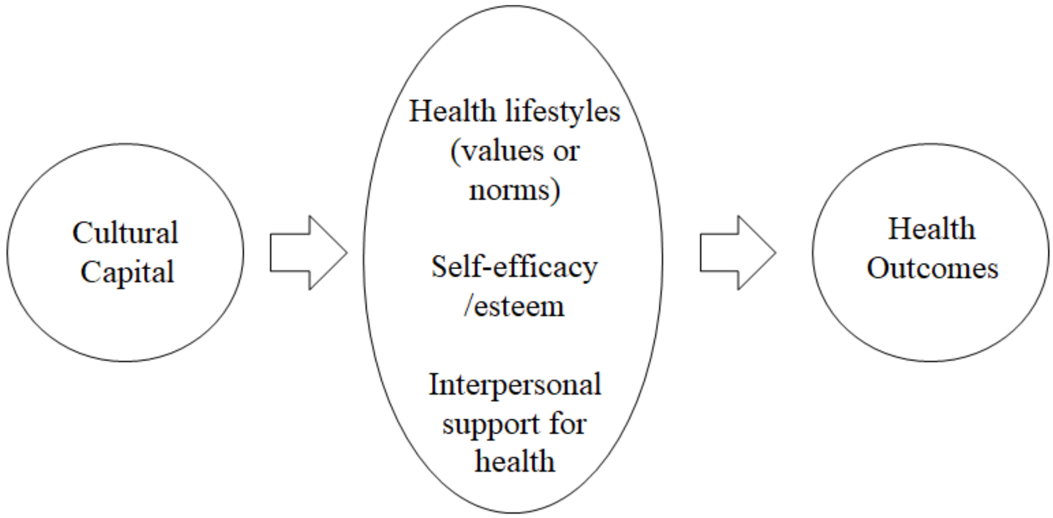


Figure 1. Mechanism of Cultural Capital Effects on Health Outcomes

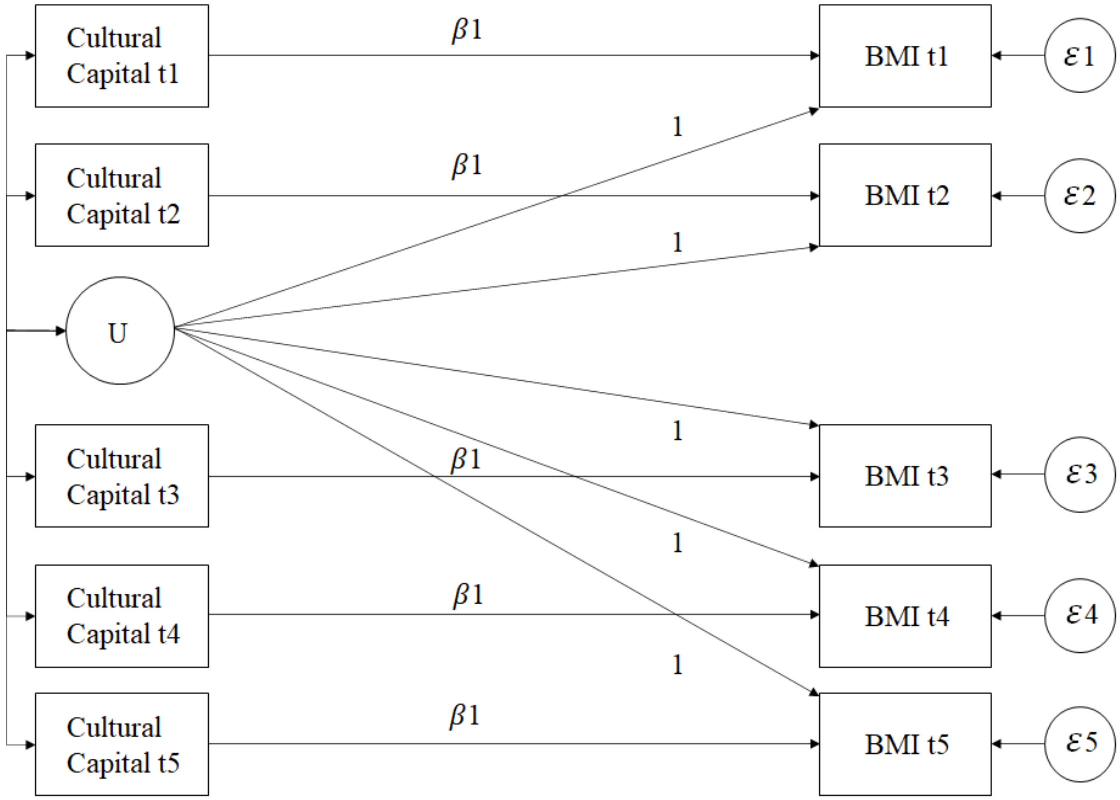


Figure 2. FE-SEM Framework (source: Bollen & Brand, 2010)

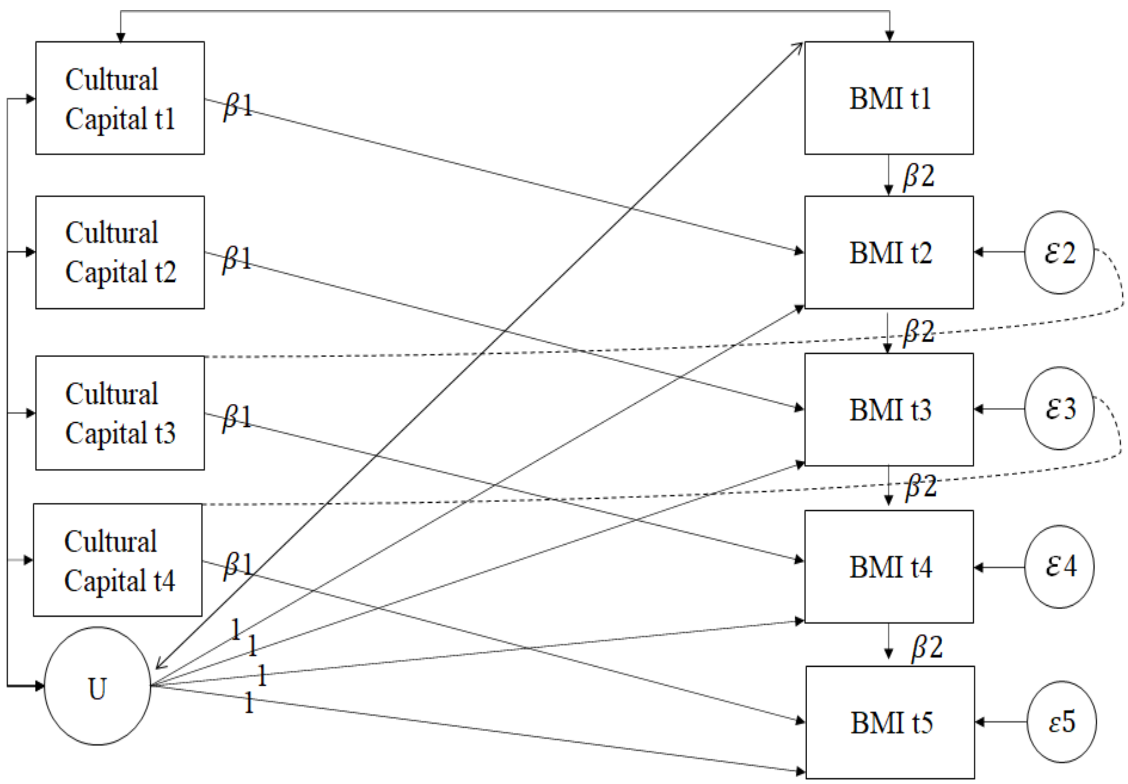


Figure 3. Path Diagram for 5-period Dynamic Panel Model with ML (source: Allison et al., 2017)

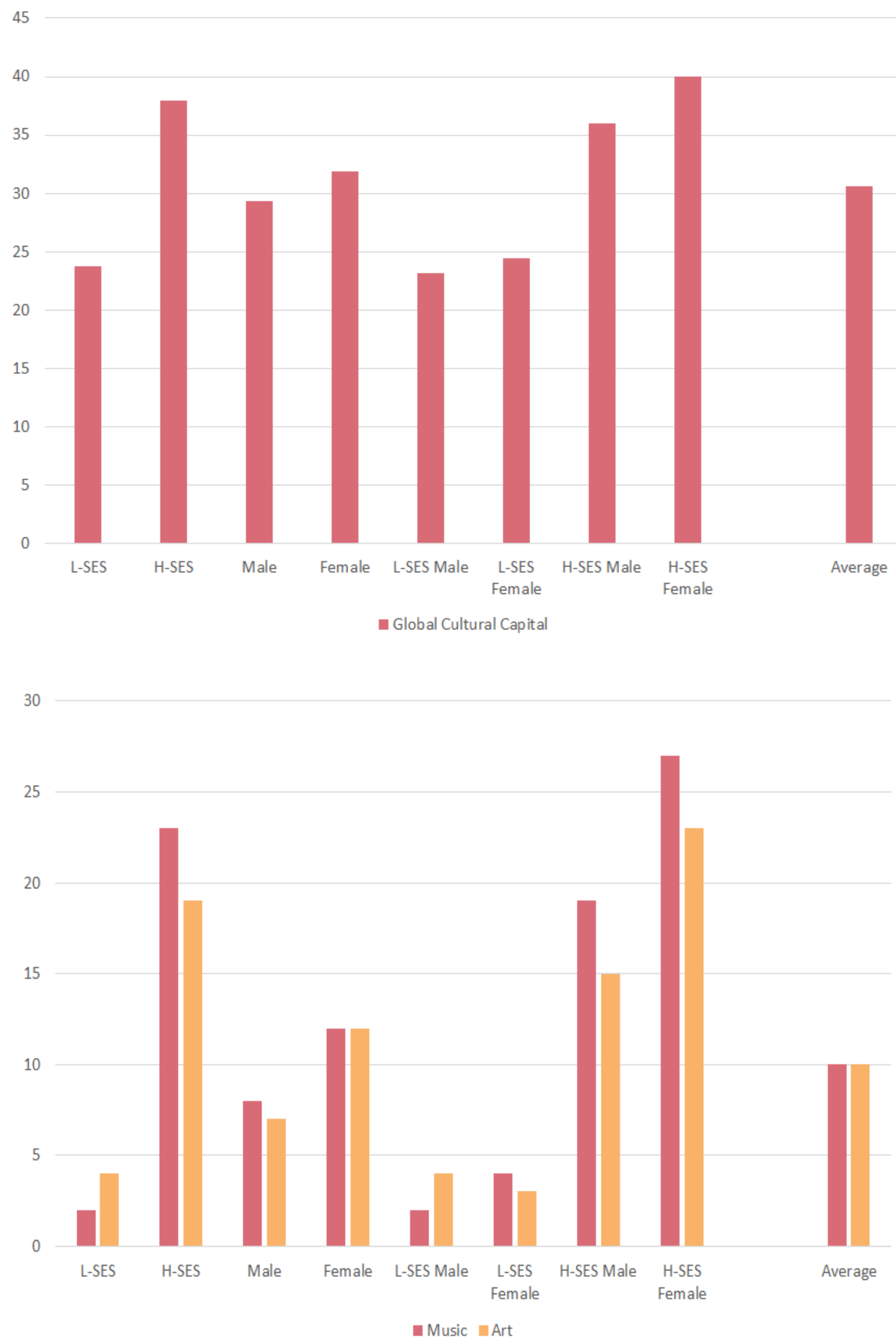
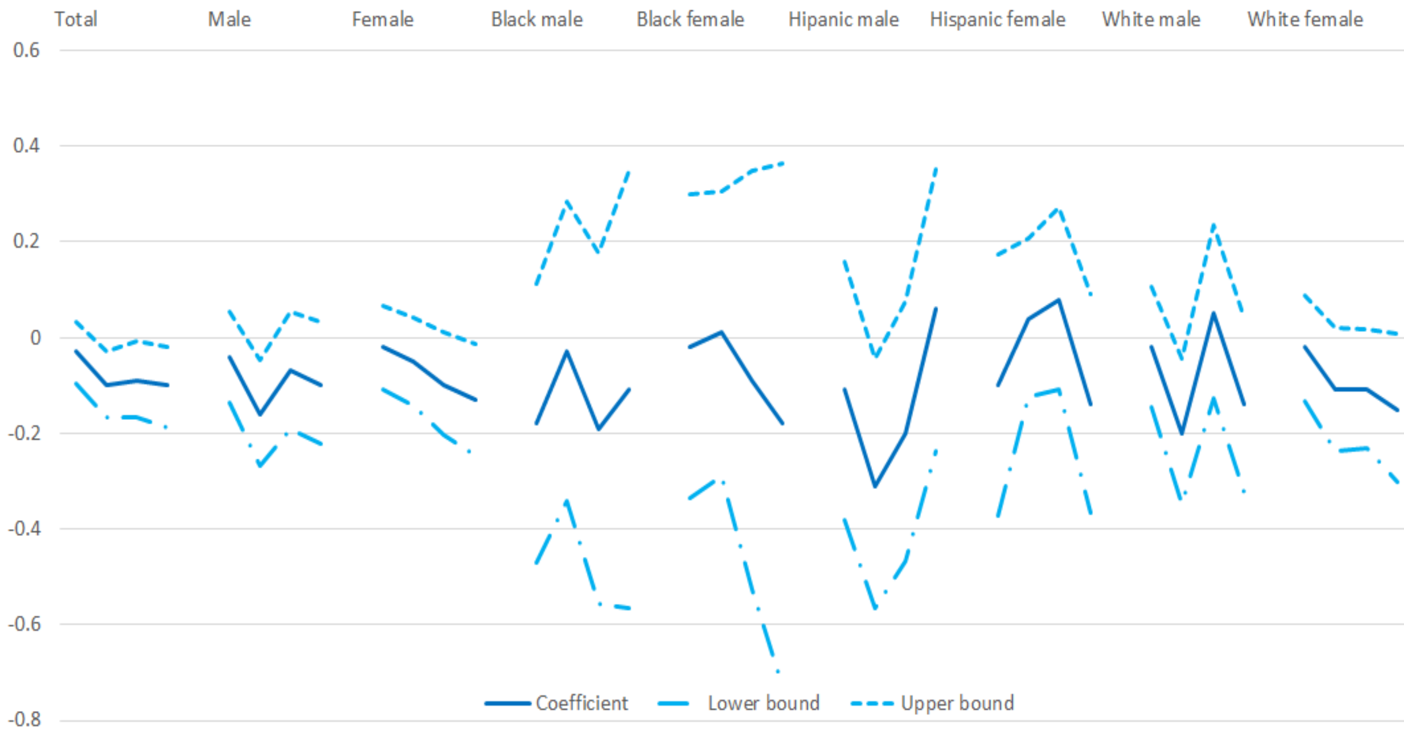


Figure 4. Disparities in Cultural Activities (participation rate) by Family Background and Sex

Figure 5. Disparities in Cultural Activities (participation rate) by Race/Ethnicity and Sex

Figure 6. Disparities in Cultural Activities (participation rate) by Regions



Note: Asian children are omitted. There was a model convergence issue due to the small sample and model complexity in the specification.

Figure 7. Time-variant Cultural Capital Effects

Appendix A Linear Growth Model for BMI

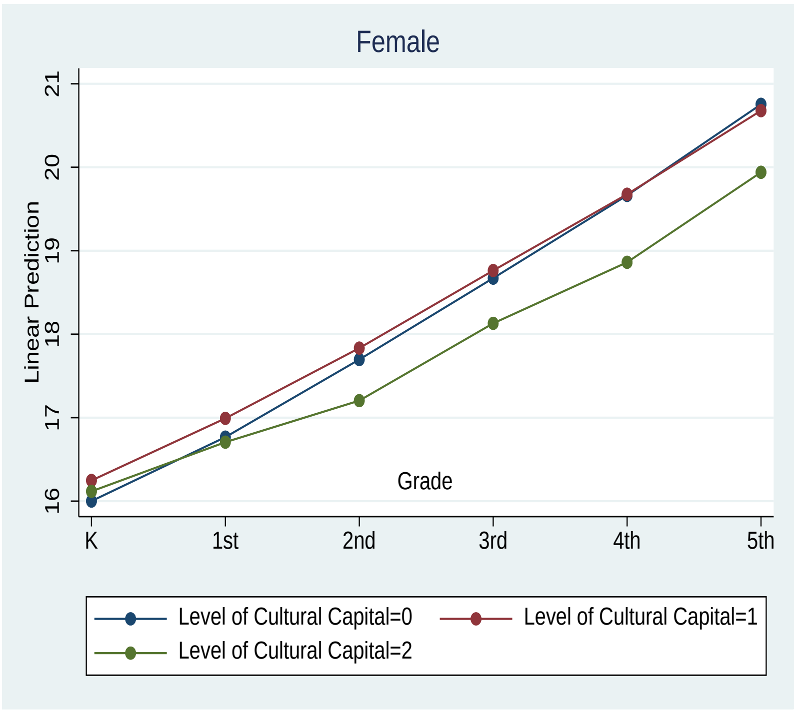
Treatment level	Total	Total		White		Black		Hispanic		Asian	
		Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
<u>Intercept</u>											
T1	.23***	.26**	.22**	.23*	.16	–.09	.01	.33	.30	.20	.02
	(.06)	(.09)	(.08)	(.11)	(.11)	(.30)	(.31)	(.22)	(.17)	(.20)	(.17)
T2	.23	.32	.19	.56	.12	.05	.31	.31	.10	–.14	–.20
	(.12)	(.18)	(.15)	(.31)	(.22)	(.45)	(.67)	(.49)	(.41)	(.32)	(.22)
<u>Slope</u>											
T1	–.06***	–.06**	–.06**	–.08**	–.05	–.08	–.07	.07	–.03	.01	.02
	(.01)	(.02)	(.02)	(.03)	(.03)	(.07)	(.07)	(.05)	(.05)	(.06)	(.04)
T2	–.15***	–.10*	–.20***	–.14	–.23**	.08	–.06	–.09	–.04	–.04	–.09
	(.03)	(.05)	(.04)	(.08)	(.07)	(.13)	(.14)	(.11)	(.11)	(.09)	(.06)
<u>Intercept (school-fixed)</u>											
T1	.32***	.34**	.28**	.30*	.23	.30	–.14	.56	.34	–.02	.29
	(.06)	(.10)	(.09)	(.14)	(.13)	(.49)	(.45)	(.31)	(.27)	(.27)	(.25)
T2	.29*	.51*	.08	.78*	.23	.44	–.19	.33	–.39	–.21	–.10
	(.13)	(.22)	(.18)	(.39)	(.28)	(.73)	(1.15)	(.79)	(.55)	(.50)	(.35)

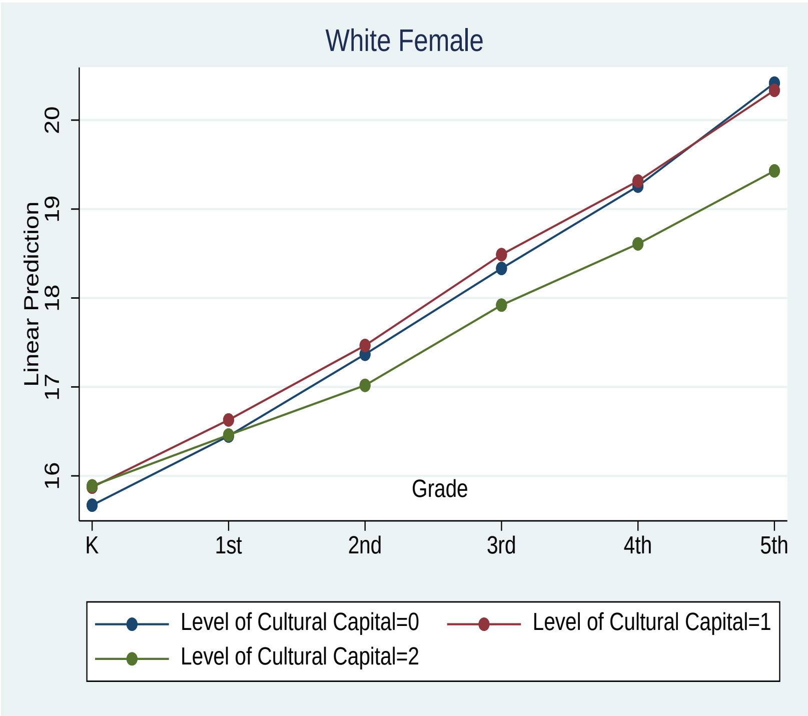
Slope (school-fixed)

T1	–.06***	–.06**	–.07**	–.08*	–.05	–.07	–.07	.06	–.03	.02	.01
	(.02)	(.02)	(.02)	(.03)	(.03)	(.07)	(.07)	(.06)	(.05)	(.06)	(.05)
T2	–.16***	–.10*	–.20***	–.14	–.23**	.09	–.06	–.09	–.04	–.06	–.09
	(.03)	(.05)	(.04)	(.08)	(.07)	(.13)	(.14)	(.11)	(.11)	(.10)	(.06)

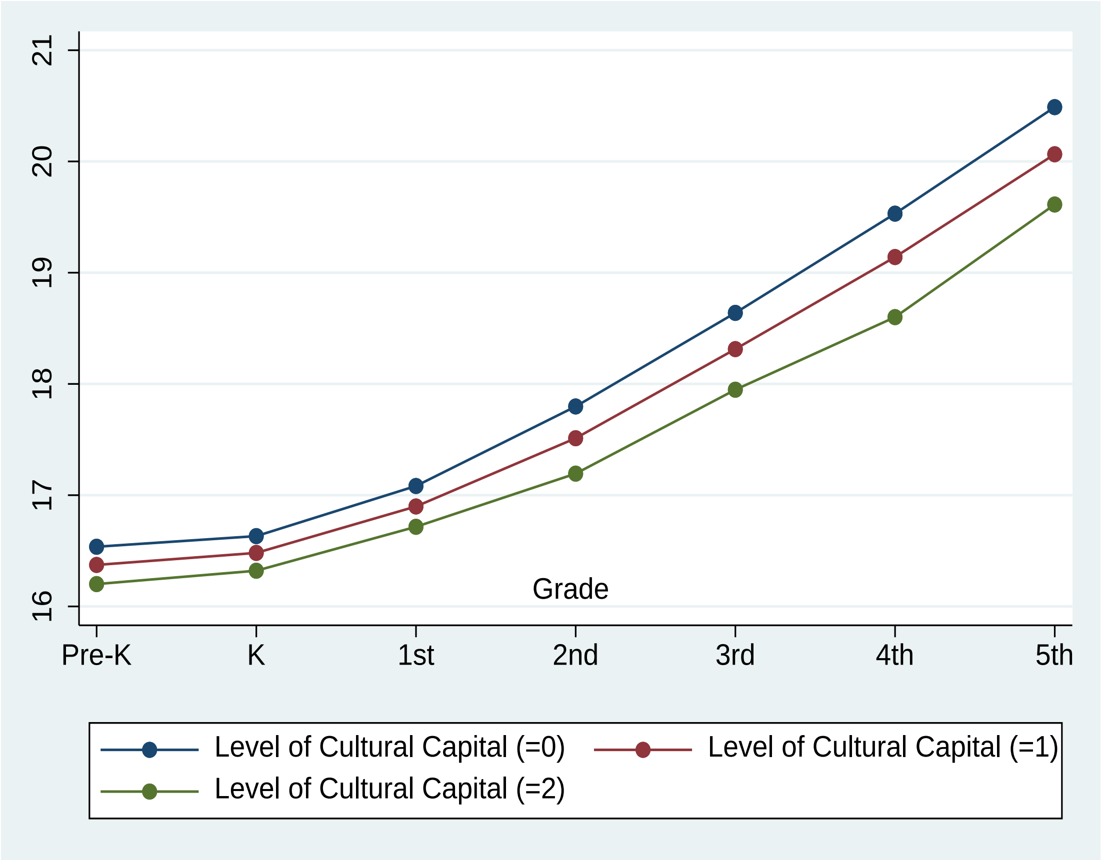
***p<.001 **p<.01 *p<.05. Note: controls are child sex, age, race/ethnicity, birth weight, math/reading/science IRT scores, attendance of prekindergarten programs (preschool or Head Start), parental reports of overall child health, family income, family size, parent's educational level and educational expectations for children, single parent status, home language (English or not), other forms of cultural activities (e.g., visiting museums or theaters), and residential area. Standard errors are adjusted with cluster option.

Appendix B Marginal Effects of Early Arts Participation (from a school-fixed linear growth model)





Appendix C Trends in BMI between Treatment Groups



Appendix D Simulation Study

A simple example is used to test the performance of the proposed approach. I build the data by following Allison et al. (2018). Let me first consider two random variables X and Y, which have a causal relationship in addition to time-invariant variable U_i that has constant effects on both X and Y. I first generate two random variables (X_{i0} and Y_{io}) and add normally distributed error terms. I then generate time-varying variable Z_{it} that has time-varying effects on both X and Y. I build the data based on the following equation:

$$Y_{it} = \partial_t + X_{it}\beta_1 + U_i\beta_2 + Z_{it}\beta_3 + \varepsilon_{yit}.$$

For this descriptive simulation, initial parameter values are set to be as follows: Where β_1 (.4) is the constant effect of X on Y, which is of my interest; β_2 is the time-invariant effect of unit-specific variable on X and Y (or Z), which represents unobserved heterogeneity (.5). Z_{it} is the unobserved time-varying confounder (corr(Z_{i0}, Z_{i1}) =.5) that has effects on X (.25; .50; .75) and Y (.25; .50; .75; 1.00) for time 0, and that has effects on X (.50; .75) and Y (.75; 1.00; 1.25; -.25) for time 1. Based on the specification, I create two types of unobserved time-varying confounding: 1) time-varying effects of time-invariant U_i; 2) time-varying effects of time-varying Z_{it}. The covariance between Z_{it} and U_i set to .5. I examine three models: 1) naïve SEM (no controls); 2) FE-SEM; 3) FE-SEM with time-varying latent U_i. I generate the data using Stata (n=500, t=2, and 500 iteration) and run the models using Mplus with ML estimator.

Table 1 illustrates how the three models response to the presence of time-varying effects of U_i in the absence of Z_{it}. First two rows show how the estimates of each model change when there are incremental effects (.25) of U_i on X and Y. The third row illustrates the case that the direction of association of U_i with X (-) and Y (+) is opposite. The last row shows the extreme case with 200% changes in U_i effects over two periods. In this scenario, while naïve SEM produces erroneous estimates of X_{it}, FE-SEM cannot also recover the true estimate. Yet, M3 tends to provide precise estimates in modest conditions. In observational studies, however, unit effects U_i will present along with $Z_{it.}$ I thus also vary the effects of time-varying Z_{it} and summarize the result in Table 2. When unobserved time-varying effects of time-varying confounder ($Z_{it.}$) present with unobserved heterogeneity ($U_i = .5$), M3 also shows some limitations. Yet, it tends to provide less biased estimates compared to naïve SEM and traditional FE-SEM.

Appendix Table 1. Simulation Results for Time-varying Effects of U_i

Values	True	M1 Naïve SEM	M2 FE-SEM	M3 FE-SEM (time-varying U_i)
$\text{Corr}(U_i, X_{i0}) = .25$ $\text{Corr}(U_i, Y_{i0}) = .50$ $\text{Corr}(U_i, X_{i1}) = .50$ $\text{Corr}(U_i, Y_{i1}) = .75$	X->Y (.40)	.58 (.03)	.43 (.04)	.40 (.05)
$\text{Corr}(U_i, X_{i0}) = .50$ $\text{Corr}(U_i, Y_{i0}) = .75$ $\text{Corr}(U_i, X_{i1}) = .75$ $\text{Corr}(U_i, Y_{i1}) = 1.00$	X->Y (.40)	.71 (.04)	.43 (.04)	.40 (.05)
$\text{Corr}(U_i, X_{i0}) = .75$ $\text{Corr}(U_i, Y_{i0}) = 1.00$ $\text{Corr}(U_i, X_{i1}) = .50$ $\text{Corr}(U_i, Y_{i1}) = 1.25$	X->Y (.40)	.71 (.04)	.37 (.04)	.40 (.05)
$\text{Corr}(U_i, X_{i0}) = .25$ $\text{Corr}(U_i, Y_{i0}) = .25$ $\text{Corr}(U_i, X_{i1}) = .75$ $\text{Corr}(U_i, Y_{i1}) = -.25$	X->Y (.40)	.36 (.03)	.29 (.04)	.32 (.06)

Note: $Z_{it} = 0$

Appendix Table 2. Simulation Results for Time-varying Effects of Z_{it}

Values	True	M1 Naïve SEM	M2 FE-SEM	M3 FE-SEM (time-varying U_i)
$\text{Corr}(Z_{i0}, X_{i0}) = .25$ $\text{Corr}(Z_{i0}, Y_{i0}) = .50$ $\text{Corr}(Z_{i1}, X_{i1}) = .50$ $\text{Corr}(Z_{i1}, Y_{i1}) = .75$	X->Y (.40)	.91 (.03)	.60 (.05)	.52 (.05)
$\text{Corr}(Z_{i0}, X_{i0}) = .50$ $\text{Corr}(Z_{i0}, Y_{i0}) = .75$ $\text{Corr}(Z_{i1}, X_{i1}) = .75$ $\text{Corr}(Z_{i1}, Y_{i1}) = 1.00$	X->Y (.40)	1.07 (.03)	.74 (.05)	.65 (.05)
$\text{Corr}(Z_{i0}, X_{i0}) = .75$ $\text{Corr}(Z_{i0}, Y_{i0}) = 1.00$ $\text{Corr}(Z_{i1}, X_{i1}) = .50$ $\text{Corr}(Z_{i1}, Y_{i1}) = 1.25$	X->Y (.40)	1.18 (.04)	.73 (.05)	.76 (.05)
$\text{Corr}(Z_{i0}, X_{i0}) = .25$ $\text{Corr}(Z_{i0}, Y_{i0}) = .25$ $\text{Corr}(Z_{i1}, X_{i1}) = .75$ $\text{Corr}(Z_{i1}, Y_{i1}) = -.25$	X->Y (.40)	.52 (.03)	.27 (.04)	.31 (.04)

Note: $U_i = .5$; $corr(U_i,\ Z_{it}) = .5$; $corr(Z_{i0}, Z_{i1}) = .5$

3.0 Chapter 3: Kindergarten Obesity, Weight Bias, and Academic Achievement: Stratification at the Intersection of Race, Sex, and Body Size

Abstract

This study draws the attention towards the importance of reducing weight discrimination against minority children for their educational success, as an issue of social justice. I investigate the consequences of early-onset obesity identifying the mediating mechanisms in the relationship between childhood obesity and academic achievement among marginalized subpopulations. To do so, I employ the newly released Early Childhood Longitudinal Study kindergarten cohort (ECLS-K: 2011) and apply covariate balancing generalized propensity scores in a parallel process latent growth model framework. The results of this study suggest that the negative influence of weight stigmatization and discrimination among teachers might be comparable to racial discrimination or even more pronounced for minority girls.

Keywords: *childhood obesity, weight bias and stigma, teacher expectation, intersectionality*

3.1 Introduction

Early-onset obesity can be a significant predictor of student future academic success. Previous studies show that childhood obesity is significantly associated with an individual's emotional distress/depression (Shaw et al., 2015), internalizing problem behaviors (Datar et al., 2004), resiliency (Shore et al., 2008), and with physical/cognitive impairments (Pacheco et al., 2017), which in turn affect educational outcomes (Caird et al., 2014). Importantly, the reported negative consequence of childhood obesity might stem from *weight bias* from peers, teachers, or even families (Branigan, 2017; Puhl & Latner, 2007). Previous studies, for instance, suggest negative effects of social marginalization and stigmatization of obesity by peers or teachers, especially for girls (Martin et al., 2017; Nutter et al., 2016) or minority groups (Crosnoe 2007; Puhl et al., 2008).

Although teachers in general intend to be fair in their teaching practices, they sometimes set their expectations based on students' previous academic performance, family backgrounds, sex, or race/ethnicity (Kelly, 2008; Kelly & Carbonaro, 2012; McKown & Weinstein, 2008). In particular, some studies suggest that teachers may perceive obese children to be overly emotional, disordered/untidy, or unattractive (Russell-Mayhew et al., 2015; Washington, 2011). That is, teachers can serve as a significant source of weight bias (Puhl & Latner, 2007). Indeed previous studies suggest that stigmatization or isolation from social interaction may function as a possible mediator between childhood obesity and academic performance (Caird et al., 2014). As children with obesity are already at higher risk for poor health outcomes, the weight-related discrimination/stigmatization in schools or other public areas has been widely criticized (Friedman, 2008). Some studies further argue that weight discrimination is comparable to the prevalence of racial discrimination in the US (e.g., Puhl et al., 2008), which would be striking given the pervasive concerns of racial bias in American society.

Despite the widespread belief, few studies have empirically investigated mediating or moderating mechanisms between childhood obesity and educational outcomes (e.g., Gable et al., 2012; Kranjac, 2015, see also Santana et al., 2017). In particular, no empirical studies have investigated possible mediating roles of teacher evaluation on obese children's academic performance among marginalizes subpopulations and have quantified the influence. Previous studies tend to focus on correlational direct relationships between obesity status and teacher reports of student social skills (e.g., Gable et al., 2009; Judge & Jahns, 2007), academic achievement (e.g., Datar & Sturm, 2006; Kenney et al., 2015), or the relationships between weight gain and health outcomes (see Pacheco et al., 2017).

Importantly, while several previous studies show how influences of childhood obesity differ by sex category (e.g., Gable et al., 2012), few studies have explored how the observed relationships` differ at the *intersection* of sex and race/ethnicity (see also Branigan, 2017; Puhl et al., 2008). Student identities are socially constructed in ways that are contingent upon context and culture; their identities are affected by how others perceive and evaluate them. For instance, the experiences of Black or Hispanic female students might be substantially different from other racial/ethnic groups (Cho et al., 2013), and the prevalence of obesity in childhood is more pronounced among many minority groups (Hales et al., 2017). Weight discrimination would be double disadvantages for minority students who are already at higher risk for poor health/psychological outcomes and are also exposed to other forms of discrimination.

This chapter seeks to contribute to previous studies by providing robust empirical evidence on the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement growth at the intersection of race, sex, and body size. It draws the attention towards the importance of reducing weight stigma and discrimination among minority children for their educational success, as an issue of social justice. In this longitudinal study, however, it is important to address confounding effects of unobserved heterogeneity among obese/overweight children at kindergarten. Indeed, from previous correlational cross-sectional studies, it is unclear whether teachers do perceive obese students' non-cognitive skills negatively, even after accounting for initial differences in children, families, and school characteristics. To address these likely selection mechanisms, I begin by calculating covariate balancing generalized propensity scores (Fong et al., 2018) based on important confounders measured at kindergarten including birth weights, academic achievements, health conditions, and family/school SES. Based on the calculated CBPS weights then, I apply a parallel process latent growth model (PP-LGM) to investigate the longitudinal relationships between kindergarten obesity, teacher evaluation, and academic achievement growth in elementary schooling.

3.2 Literature Review

3.2.1 Childhood Obesity and Educational Outcomes

Why might being overweight or obese matter for student academic performance? A compelling explanation is that since obesity is generally associated with negative stigma or discrimination (e.g., claims of innuendo of being lazy, unintelligent, or dishonest), it may affect student self-esteem/efficacy or mental health, which in turn affects their academic outcomes (Puhl et al., 2007; Shaw et al., 2015). Previous studies suggest that even young children are strongly biased against peers with obesity (Latner & Stunkard, 2003). Indeed, several studies show that being obese/overweight affects an individual’s emotional distress/depression (Shaw et al., 2015), internalizing problem behaviors (Datar et al., 2004), resiliency (Shore et al., 2008), or even levels of the stress hormone cortisol (Schvey, 2014). All of these outcomes could potentially serve as mediators between childhood obesity and academic achievement.

Second, the observed negative effects of childhood obesity on academic performance might be attributable to physical or cognitive impairments (Sabia, 2007). For instance, previous studies show that there is a significant association between obesity and sleep disorders (Sharma et al., 2017), and sleep disorders and academic achievement (Galland et al., 2015). Thus, there is a possibility that obesity may affect student academic performance via impaired physical function (see also Caird et al., 2014). Additionally, there might be direct effects of obesity on neurocognitive functioning, which affects cognition and behaviors. In particular, after reviewing articles from 1976 to 2013, Liang et al. (2014) conclude that there is a negative association between obesity and neurocognitive functioning such as attention or motor skills among adolescents. Cottrell et al. (2007) further suggest that increased cardiovascular risks among obese children may lead to lower academic performance.

Indeed, based on the ECLS-K data (1988 to 1999), Datar et al. (2004) show that overweight children tend to have lower math and reading test scores. Using the same data set Capogrossi and You (2013) further show that negative effects of childhood BMI are more pronounced for lower achieving students. The observed significant relationships might be explained by changes in child interpersonal skills and internalizing behaviors due to obesity (Gable et al., 2012). Yet, Crosnoe and Muller (2004) argue that the observed difference in GPA between obese and non-obese children is small. In the studies of Leblanc et al. (2012) and Chen et al. (2012), they find no significant relationship between obesity and student academic achievement after controlling for family SES. In this regard, Santana et al. (2017) conclude that there is no compelling evidence for the significant direct impacts of obesity on academic performance among school age children; they suggest that more rigorous longitudinal research is needed.

Importantly, related to the analyses in this chapter, few studies have empirically investigated possible mediating mechanisms between childhood obesity and educational outcomes formally, even as the many persuasive mechanisms discussed above have been advanced (see Puhl & Latner, 2007; Puhl & Heuer, 2009; Santana et al., 2017). The lack of formal testing might be accounted for by a tendency among many educational researchers to rely first on simple “X -> Y tests” in determining a necessity of mediational analyses. However, a null effect of obesity on academic performance does *not* necessarily mean that there are no mediation effects. Since the total effect of X on Y is the sum of the direct and indirect effects, as an example, opposite signs may cancel each other out (see more discussion in Hayes, 2009 or Zhao et al., 2010). That said, educational researchers need to explore and test various mediational theories to better understand the relationships between childhood obesity and educational outcomes.

3.2.2 Teachers and Weight Bias

Weight bias in general refers to negative attitudes toward individuals because of obesity or overweight status (Puhl et al., 2014). There is growing evidence that stigmatization and discrimination towards overweight and obese children may be a major social problem (Puhl & Heuer, 2009). Although teachers in general intend to be fair in their teaching practices, and they are trained and socialized to be fair (Valenzuela, 2016), teachers often set their expectations based on students’ previous academic performance, family SES, or race/ethnicity and sex congruence

(McKown & Weinstein, 2008; Tenenbaum & Ruck, 2007). Teachers, for instance, often perceive low-track students as more inattentive, disruptive, and withdrawn and place an excessive emphasis on discipline (Kelly & Carbonaro, 2012). In contrast, teachers tend to provide more feedback, praise, and challenging instruction for high-expectation students (Cooper, 1979; Rubie-Davies, 2007). Importantly, even young children are able to identify teachers with different expectations (Peterson et al., 2016), and how teachers perceive students affects student academic performance via the many teacher-student interactions in daily class (Hattie, 2009; Rubie-Davies, 2007; Rubie-Davies et al., 2015). For instance, Rubie-Davies et al. (2015), based on an RCT, show that students in classrooms of teachers with high expectations tend to have higher math scores.

Previous studies also suggest that weight bias among educators may affect obese or overweight students' academic performance, though empirical evidence is limited (Caird et al., 2014; Puhl & Latner, 2007). In particular, specific studies have found that teachers are likely to have lower expectations for obese/overweight children (Friedman, 2008), and they also perceive obese children as being emotional, unmotivated, less competent, and non-compliant (Puhl & Peterson, 2012; Russell-Mayhew et al., 2015; Washington, 2011). Mahoney et al. (2005), for instance, show that even after accounting for differences in poverty status and race/ethnicity, teacher-rated popularity for children is significantly lower for obese children. Obese students are also found to experience discrimination or stigmatization from their teachers (e.g., Puhl & Brownell, 2006).

What underlying mechanisms might potentially explain weight discrimination or stigmatization among teachers? According to attribution theory, individuals tend to seek causes and make attributions (i.e. specific attributional tendencies of blame), when they encounter a person with stigmatized characteristics (Puhl & Peterson, 2012). A prevailing societal perception in the US is that since BMI is modifiable, obese people are to blame for being overweight (e.g., low self-discipline or impulsivity). The perception may be further strengthened by US cultural beliefs that emphasize meritocratic values (for more discussion of meritocracy see Bills, 2019 or Tannock, 2008). Moreover, individuals are often exposed to gendered and racialized cultural stereotypes about their physical appearance by schooling, media, and their families (e.g., Western ideals of thinness and beauty). Previous studies, for instance, show that females (Barry & Grilo, 2002) or White females (Wang et al., 2009) are more concerned about eating and body image disturbances.

Indeed, previous studies suggest that the negative effects of stigmatization and discrimination of obesity by peers or teachers might be more salient for girls (Martin et al., 2017; Tang-Péronard & Heitmann, 2008). For instance, Branigan (2017) shows that the negative association between obesity and teacher-assessed academic achievement is larger for White girls in English, which is a traditionally female-gendered subject. Datar and Sturm (2006) also find that the significant association between overweight status and school outcomes (e.g., test scores or approaches to learning) does not hold for boys. Regarding racial/ethnic groups, Puhl et al. (2008) suggest that weight discrimination might be more prevalent in minorities such as Black females. Crosnoe (2007) also points that the association between obesity and college enrollment is stronger for girls from racial/ethnic minority groups. Yet, the empirical studies on marginalized subpopulation who experiences multiple discrimination (e.g., ethnic/racial minorities or LGBTQ individuals) are still lacking.

3.2.3 The Current Study

The current study investigates the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement among marginalized subpopulations. Despite the observed or theorized negative relationships between childhood obesity and weight bias of teachers, however, in many school settings assigned teachers are likely to be relocated to other classes as students move to higher grades. Therefore, in practice it is less likely that obese children are exposed to continual or cumulative disadvantages from weight bias of teachers. Yet, from previous correlational cross-sectional studies, it is unclear whether teachers do perceive obese students' non-cognitive skills *negatively,* even after accounting for initial differences in children, families, and school characteristics. It is also questionable, even if childhood obesity may lead to teachers' negative perceptions, whether the teachers' evaluation can serve as a significant mediator between childhood obesity and academic performance; unobservable differences between teachers and schools may account for the observed relationships.

Importantly, despite the growing concerns about weight discrimination/stigmatization of minority students, no empirical studies have investigated the mediation process at the intersection of race, sex, and body size. Weight discrimination/stigmatization would be double disadvantages for minority children who are already at higher risk for poor health and mental outcomes. The ELCS-K provides annually measured children's cognitive and non-cognitive skills, which are unusually rich compared to other national data such as PISA and Add Health. If there is stigma associated with obesity, I expect that the stigma effect will be realized in direct teacher reports of non-cognitive skills (e.g., approaches to learning or internalizing/externalizing behaviors) rather than academic skills (i.e. reading and math IRT scores) that are measured by certified child assessors with two-stage adaptive tests (see more in Tourangeau et al., 2015).

Consequently, the main research questions of this study are: 1) Does being obese or overweight matter for teacher evaluation of children's non-cognitive skills, even after accounting for potential selection bias? If so, are there any differences between sex and racial/ethnic minorities? 2) Are there any mediating effects of teacher evaluation on obese children's academic achievement? Before answering those research questions, I first begin my analyses descriptively, reporting the disparities in kindergarten obesity/overweight status between family SES, sex, race/ethnicity, and regions in the ECLS-K. The findings of this chapter will provide robust empirical evidence on the links between kindergarten obesity, teacher evaluation, and academic achievement and offer critical information about the influence of weight discrimination and stigmatization.

3.3 Methodology

3.3.1 Data and Sample

To achieve the aim of this study, I employ the newly released Early Childhood Longitudinal Study kindergarten cohort (ECLS-K: 2011), which is a nationally representative sample of American children who entered kindergarten in 2010-2011. The ECLS-K study follows the kindergarten cohort of 2010-2011 through the 2015-2016 school year, providing a comprehensive picture of children's academic development until secondary school. The study also includes a wide range of data on the children, their homes, and school environments based on a three-step sampling design (for more information on the ECLS-K, see Tourangeau et al., 2015).

Approximately 18,170 kindergarteners from 1,310 schools were sampled in the baseline year. This study employs the data from kindergarten to fifth grade. The final analytic sample is 15,820.

3.3.2 Measures

Obesity and overweight status. I create obesity and overweight specifications at kindergarten based on the composite BMI calculated by composite weight and height in the ECLS-K (Hsu et al., 2019). To obtain accurate measurements, each child's height and weight were measured twice in each data collection using a Shorr board and a digital scale. Composite BMI was then computed based on the composite height and weight measures, which were constructed from two measurements (see more in Tourangeau et al., 2015). Overweight children are defined as being between the 85th and 95th percentiles of BMI, while obese children are above the 95th percentile of BMI (DeFrancesco et al., 2018; Staiano et al., 2013).

Non-cognitive skills. The ECLS-K provides a set of reliable measures of children's non-cognitive skills widely used in previous studies (e.g., Datar & Sturm, 2006; Liu, 2019). I use composite variables representing teacher perception of children's social skills and behavioral problems provided in the ECLS-K. Teachers reported how often their children exhibited certain social skills and behavioral problems using a scale ranging from "never" to "very often." These are teacher report of approaches to learning (e.g., eagerness to learn new things), self-control (e.g., controlling temper or accepting peer ideas), interpersonal skills (e.g., skills in forming and maintaining friendships), and externalizing (e.g., whether a child argues, fights, gets angry, acts impulsively) and internalizing problem behaviors (e.g., presence of anxiety, loneliness, low self-esteem, and sadness). Higher scores indicate that the child shows the behavior represented by the scale more often. *Academic achievement.* I use the reading and math IRT scores widely used in previous studies (e.g., Hair et al., 2006; Kranjac, 2015; Little, 2017). IRT scoring makes possible longitudinal measurement of gain in achievement, even though the assessments administered to a child are not identical (see more in Tourangeau et al., 2015). I use both reading and math IRT scores that were measured from grade 1 to 5 (Little, 2017).

Confounders. This study identifies student, family, and school-level potential confounders. These include child sex, age, race/ethnicity, birth weight, attendance of prekindergarten programs (e.g., preschool or Head Start), parental reports of overall child health, child's disability status, family income, family size, single parent, parent's educational level and educational expectations for children, home language (English or not), participation in cultural activities (e.g., visiting museums or theaters), children's math, science, reading IRT scores, residential area, school locale, school type (private vs. public), school SES, school size, and percentage of Black or Hispanic children at schools.

3.3.3 Analytic Strategy

To address unobserved heterogeneity among obese and overweight children, I first calculate covariate balancing generalized propensity score for subsequent analytic models. The key feature of the method is that it can be applied to a continuous or categorical treatment variable with the improvement of the robustness to model misspecification in matching and weighting by optimizing sample covariate balance (see more in Fong et al., 2018). Based on the covariates that were measured at kindergarten, I first set the treatment assignment (being overweight (=1) and obese (=2)) equation and calculate CBPS weights. For subgroup analyses, CBPS weights are calculated within each subgroup. The estimated CBPS weights can be employed in the standard regression setting. The covariate balance with CBPS weights between treatment groups is illustrated in Appendix E; covariate balances between treatment groups in this analysis are excellent in terms of standardized mean differences.

To investigate the consequence of being overweight/obese at kindergarten on teacher evaluation on children's non-cognitive skills, I employ a latent growth curve model (LGM). LGMs are capable of capturing individual differences in developmental trajectories across time. The basic model can be written as follows:

$$Y_{it} = \eta_{0i} + \eta_{1i}\lambda_t + \varepsilon_{it} \tag{5}$$

$$\eta_{0i} = \eta_0 + \gamma_{01}(obesity/overweight) + \zeta_{0i} \tag{6}$$

$$\eta_{1i} = \eta_1 + \gamma_{11}(obesity/overweight) + \gamma_{12}\eta_{0i} + \zeta_{1i}, \tag{7}$$

where Y_{it} is the individual i's observed outcome measured at time point t; η_{0i} and η_{1i} are two latent factors representing intercept and slop, respectively; λ_t is a time score (coded -1, 0, 1 so that intercept represents the first year of elementary school); ε_{it} refers to idiosyncratic error term that varies across units and time. Equation (6) and (7) are the between subject models that are of interest to this study. In particular, η_{0i} represents the overall mean level of the initial outcome, η_{1i} shows the average rate of outcome change over time. They are predicated by the obesity specification at kindergarten (obesity/overweight). Finally, ζ_{0i} and ζ_{1i} are error terms representing between subject variations. Note that I allow η_{0i} to predict η_{1i} to account for the association between initial status and growth (see also Von Soest & Hagtvet, 2011).[10] The equivalent form of the model is depicted in Figure 8. In the data analysis process, I first fit the baseline model with various time specifications (e.g., quadratic, cubic, and latent basis model) to find an appropriate growth model for the ECLS-K data.

[10] Estimated coefficients are generally larger and significant without the specification.

[Figure 8 about here]

To investigate possible mediating roles of teacher's evaluation between kindergarten obesity/overweight status and academic growth, I apply a parallel process latent growth model (PP-LGM). When both the dependent variable and mediating variable are measured repeatedly over time, the growths of dependent and mediating variables can be considered as two distinctive LGM processes (Cheong et al., 2003). Figure 9 illustrates a parallel process growth curve model (or bivariate latent growth model) where children's academic achievements and non-cognitive skills are measured over five time points with a linear specification. Note that while the LGM for student academic achievement is measured from grade 1 to 5 (intercept is grade 2), the LGM for teacher report of non-cognitive skills is measured from kindergarten to 4th grade (intercept is grade 1). The time specification is necessary to make an appropriate time sequence in the mediation process.

[Figure 9 about here]

The proposed mediation model can be written as follows:

$$\eta_{2i} = \eta_2 + \gamma_{21}(obesity/overweigth) + \gamma_{22}\eta_{0i} + \zeta_{2i} \tag{8}$$

$$\eta_{3i} = \eta_3 + \gamma_{31}(obesity/overweigth) + \gamma_{32}\eta_{0i} + \gamma_{33}\eta_{1i} + \gamma_{34}\eta_{2i} + \zeta_{3i} \tag{9}$$

$$\eta_{0i} = \eta_0 + \gamma_{01}(obesity/overweight) \ + \zeta_{0i} \tag{10}$$

$$\eta_{1i} = \eta_1 + \gamma_{11}(obesity/overweigth) + \gamma_{12}\eta_{0i} + \zeta_{1i}, \tag{11}$$

where η_{0i} represents the initial status for the mediation process (i.e. teacher report of non-cognitive outcomes); η_{1i} is the growth rate of the mediation process; η_{2i} is the initial status for the outcome variable (i.e. child academic achievement); η_{3i} is the growth rate of the outcome variable. While the growth rate of the outcome in equation (9) is predicated by both the initial status (η_{0i}) and growth (η_{1i}) of the mediation process, the initial status of the outcome (η_{2i}) is only predicated by the initial status of the mediation process (η_{0i}). In both LGMs, latent growth factors are predicted by latent intercepts to account for their associations. Note also that each latent factor, η_{ki}, is predicated by the treatment variable, kindergarten obesity/overweight status.

In the propose PP-LGM, I am particularly interested in the indirect effects of teacher evaluation between kindergarten obesity/overweight status and academic achievement growth. Since a higher order time specification for academic achievement growth yields a model convergence issue, I use a latent basis model for academic growth by freely estimating growth parameters (Grimm et al., 2011), which also exhibits excellent model fit indices (see more in the result section). Mediation analyses are conducted with a bias-corrected bootstrapping (Preacher & Hayes, 2008) with 2,000 replications, and I also conduct several sensitivity analyses for the baseline estimates using school and teacher fixed-effects models. Given the nested structure of the ECLS-K data, cluster option is employed to adjust standard errors with maximum likelihood with robust standard errors (MLR or Huber–White SEs) which is robust to non-normality. Missing cases are imputed with a multiple imputation generating 10 data sets. R and Mplus are employed to conduct the proposed methods.

3.4 Results

3.4.1 Disparities in Kindergarten Obesity between Family Background, Race/Ethnicity, Sex, and Regions

Figure 10 illustrates the proportions of obesity/overweight status by family SES and sex at kindergarten with the ECLS-K sampling weights. I use the composite family SES variable in the ECLS-K and generate high- and low-SES families based on a 20th percentile specification. Generally speaking, the proportions of children designated as overweight are about three times higher than that of obesity designations. There are also considerable gaps in obesity/overweight status between low- and high-SES families. Specifically, compared to high-SES children, those children from low-SES families are about 4.4 and 2.7 times more likely to be obese and overweight at kindergarten, respectively. The observed gaps in kindergarten obesity/overweight status between boys and girls are not substantial as observed in family SES differences.

[Figure 10 about here]

Figure 11 depicts the proportions of kindergarten students who are obese/overweight between race/ethnicity and sex. As found in the previous studies (e.g., Hales et al., 2017), while Black and Hispanic children have higher proportions of kindergarten weight problems than the average, White and Asian children have lower proportions of kindergarten obesity/overweight status. Specifically, Black girls and Hispanic boys have the highest rates of obesity/overweight status (about 9%/22%). In contrast, White girls (3%/12%) and Asian girls (2%/10%) have the lowest proportions of kindergarten weight problems. However, the observed gaps between races/ethnicities are not as considerable as SES differences, as shown in Figure 10.

[Figure 11 about here]

Regional gaps in kindergarten obesity/overweight status are illustrated in Figure 12. In general, the observed gaps are not considerable as shown in Figure 10 and 11. Yet, while children living in the South are more likely to be obese/overweight at kindergarten (6%/17%), children from the Northeast are less likely to have kindergarten weight problems (3%/14%). Those children attending schools in a city also have slightly larger proportions of kindergarten obesity/overweight status (6%/15%) than children from other school locations. In sum, these findings show that there are considerable disparities in kindergarten weight problems between family background, race/ethnicity, and sex.

[Figure 12 about here]

3.4.2 Effects of Kindergarten Obesity/Overweight Status on Non-cognitive Skills and Academic Achievement Growth

Before investigating total effects of kindergarten obesity/overweight status on students' non-cognitive skills and academic achievement growths using LGM, I first explore appropriate time specifications for each dependent variable. I consider linear, quadratic, cubic, and latent basis models as shown in Table 3. Since there are no considerable differences in the model fit indices, I prefer a parsimonious model, a linear specification, for teacher report of self-control.

In Table 4, the unconditional model (without any controls) shows that overweight/obesity status at kindergarten have significant effects only on the intercept (here for grade 1). However, after controlling for family characteristics (e.g., family income and parental education level) and adjusting CBPS weight, the observed total effects of kindergarten obesity/overweight status on self-control are substantially reduced. Specifically, the effect of kindergarten overweight status on self-control is reduced about 33%, and the previously statistically significant effect of kindergarten obesity (–.08) now disappears (–.03).

[Table 3 and 4 about here]

In Table 5 to Table 10, I further explore whether kindergarten obesity and overweight status have significant total effects on children's various non-cognitive and cognitive outcomes. The applied time specification for each dependent variable is illustrated in each parenthesis. Generally speaking, the observed significant negative effects of kindergarten weight problems are considerably reduced (or disappear) after accounting for family charateristics and CBPS weight. In particular, regarding reading and math achievement growths, the observed significant negative effects of kindergarten obesity/overweight status are primarily a function of initial differences in student, family, and school characteristics (see Table 9 and 10).[11]

[Table 5 and 10 about here]

Even after applying CBPS weight, however, I observe significant influences of kindergarten obesity/overweight status on teachers' perceptions of students' non-cognitive skills, especially for each intercept (see Table 4 to 8). The estimated effect sizes range from .06 to .11, which are small but still robust to CBPS weight. As I discussed, in school settings assigned class teachers are likely to change, as students move to higher grades. This may explain why I mainly find significant effects of kindergarten obesity/overweight status on the model intercepts. As a supplemental analysis, I re-estimate the models after changing the time specification for each

[11] The results are almost identical with lower order terms or a latent basis model.

intercept to represent grade 2, 3, 4, and 5, respectively. The results show broadly similar patterns implying that obese/overweight children are likely to begin their new semester with less positive teacher evaluations of their non-cognitive skills. Interestingly, there is a small but significant growth effect of obesity status on externalizing problem behaviors (–.01) in Table 8; those children with obesity at kindergarten are less likely to show externalizing behavior problems (e.g., the frequency at which the child argues, fights or gets angry) in elementary schooling. This is a similar finding from Datar and Strum (2006) using the ECLS-K: 1998. Yet, they report the significant negative relationship only for boys (–.07). I summarize the main findings from Table 4 to 10 in Table 11.

[Table 11 about here]

3.4.3 Heterogeneous Effects of Kindergarten Obesity/Overweight Status

The observed negative effects of childhood obesity on children's non-cognitive and cognitive outcomes may operate differently for different social or racial/ethnic groups (Caird et al., 2014). In particular, previous studies suggest that negative effects of stigmatization of obesity might be more salient for females (Martin et al., 2017; Tang-Péronard & Heitmann, 2008) or minority groups (Puhl et al., 2008). I thus explore whether the influences of kindergarten obesity/overweigh status differ by sex or at the intersection of race/ethnicity and sex (i.e. Black/ Hispanic/Asian girls).

Table 12 illustrates the results for male students. The applied time specification for each dependent variable is illustrated in the parentheses. Model fit indices are excellent in terms of RMSEA, CFI, and TLI, implying that the proposed models are reasonably consistent with the

ECLS-K data. As can be seen from Table 11 (for total students), the estimated coefficients from unconditional models are also substantially reduced in models with CBPS weight. In particular, the observed significant effects of kindergarten obesity/overweight status on math and reading scores disappear after applying CBPS weight. Apart from the insignificant effects of kindergarten obesity/overweight status on externalizing problem behaviors, the sizes and directions of estimated coefficients are very similar with the previous findings for all students; the observed effects are also limited to intercepts.

[Table 12 about here]

Table 13 illustrates the results for female students. Even after adjusting CBPS weight, teachers are likely to report lower levels of approaches to learning (–.08) and higher levels of internalizing problem behaviors (.08), especially for obese girls; the estimated coefficients are also much larger (effect sizes range from .10 to .16) for girls. Yet, the direct effects of kindergarten obesity/overweight status on self-control, interpersonal relationships, and reading and math scores are no longer significant after adjustment using CBPS weights for female students.

[Table 13 about here]

Given that weight stigmatization/discrimination is hypothesized to be more salient for minority groups (Puhl et al., 2008), I further explore how kindergarten weight problems are related to teacher reports of non-cognitive and cognitive skills, especially for Hispanic, Black, and Asian girls.[12] The results are illustrated in Table 14 and 15. Notably, regarding Black and Hispanic girls

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[12] I also re-estimate the model for White girls, which shows similar findings. Teachers are likely to report lower levels of approaches to learning (–.06) for obese girls and higher levels of internalizing behaviors (.05) for overweight girls at grade 1.

who have the highest rates of obesity/overweight status compared to other racial/ethnic groups (see also Figure 11), kindergarten obesity is significantly associated with teachers' negative evaluation on their internalizing problem behaviors. In particular, for Hispanic girls, teachers are likely to report .30 of a SD (.15/.50) higher levels of internalizing problem behaviors at 1^{st} grade (see middle column in Table 14). Moreover, there is a significant growth effect of kindergarten obesity on teacher reports of internalizing behaviors for Black girls; teachers are expected to have .29 of a SD ((.04*4)/.56) higher levels of internalizing problem behaviors for Black girls at the end of this study (5^{th} grade). Yet, there are no significant effects of kindergarten weight problems for Asian girls (see Table 15). In sum, these results demonstrate that there are significant disadvantages of early-onset obesity at kindergarten, especially for Black and Hispanic girls.

[Table 14 and 15 about here]

3.4.4 Mediation Effects of Teachers' Evaluation of Students' Non-cognitive Skills

Even if there are no statistically significant total effects of kindergarten obesity/overweight status on female students' math and reading scores, there is a possibility that kindergarten weight problems may affect students' reading and math achievements via teachers' evaluation of students' non-cognitive skills. I thus investigate possible mediation effects of teachers' perceptions of obese students' non-cognitive skills between kindergarten obesity/overweight status and academic achievement growth. To do so, I combine the LGM for the mediator process and the LGM for the outcome process into a single parallel process LGM as shown in Figure 9. Since the detrimental effects of kindergarten obesity/overweight status are more pronounced for minority female students, I further explore whether the mediation effects of teachers' evaluation are particularly harmful for Black and Hispanic girls. All mediation analyses are adjusted with CBPS weights.

The results of PP-LGM are illustrated in Table 16 to 19 with bias-corrected (BC) bootstrap 95% confidence intervals (Preacher & Hayes, 2008). I report both the results from MLR and ML with BC bootstrapping, which are robust to violation of multivariate normality; they provide generally equivalent results (Yuan & Hayashi, 2006). Teacher reports of multiple non-cognitive skills are averaged to represent an overall level of children's non-cognitive skills.[13] The model fit indices are excellent in terms of RMSEA, CFI, and TLI. Table 16 (for total students) shows that kindergarten obesity/overweight status affect students' reading and math achievement intercepts via teacher evaluation. Specifically, kindergarten obesity/overweight status are related to teachers' negative evaluation of students' non-cognitive skills at grade 1, which in turn affect the intercepts of reading/math scores (at grade 2). There are no significant indirect effects via growth factors. Yet, the estimated standardized coefficients are small in the model for all students (.04 to .05).

[Table 16 about here]

The significant mediation effects for males, female, and Hispanic female students are illustrated in Table 17 to 19. I do not report the null mediation effects for Black and Asian girls here. Notably, observed mediation effects are also pronounced for girls and Hispanic girls, and obesity status is more predictive than overweight status for female students. In particular, for Hispanic girls, reading/math scores at grade 2 decrease by .14 standard deviations for being obese

[13] Unfortunately, a latent variable approach was not feasible due to the model complexity of PP-LGM with CBPS weight. The overall Cronbach's alpha computed from the five items is .88, and the standardized factor loadings of the items in CFA are > .8.

via teacher evaluation (see Table 19). I observe the similar pattern both for reading and math subjects in this study.[14] Given the pooled effect size between perceived racial/ethnic discrimination experiences and academic outcomes among adolescents is about .10 (Benner et al., 2018), the observed mediation effects seem non-trivial.

[Table 17 and 19 about here]

3.4.5 Robustness Analyses

Disentangling weight bias. Weight bias refers to discriminatory or prejudicial attitudes towards individuals because of an individual's bodyweight itself. When other things were functionally equal, would teachers' negative evaluation of obese children be considered as actual weight bias. It is thus important to address heterogeneity among obese/overweight children (e.g., previous academic performance, health conditions, and family/school SES) to accurately evaluate consequences of weight discrimination/stigmatization among obese children. This study accounts for the observed initial differences between obese and non-obese kindergarteners using well-balanced CBPS weights. Yet, there is a possibility that kindergarten obesity/overweight status may affect teacher evaluations via concomitant changes in self-esteem/efficacy or difficulties in school adaptation among obese children (e.g., peer relationships). That is, the observed significant negative effects might be the sum of weight bias along with reactions to the potential detrimental

[14] As a supplemental analysis, I also conduct the mediation analysis for White girls, which shows a significant but small mediation effect (kindergarten overweight status -> teacher evaluation intercept -> reading/math intercepts: B= –.06, $p<.05$).

effects of kindergarten obesity on students' non-cognitive skills. Given that the observed significant effects of kindergarten obesity are mainly limited to intercepts (Spring 1st grade), however, it is less likely that children's social skills or problematic behaviors meaningfully change within a half semester during 1st grade due to unobserved factors. Yet, one possible way to disentangle weight bias from other sources is to further control for parent reports of children's social skills: self-control; social interactions; sad/lonely designations; impulsive/overactive designations, that are available at grade 1. I examine how the estimated coefficients for female students change after controlling for parent reports of social skills and illustrate the results in Table 20. The results are almost identical suggesting that the observed negative teacher evaluation of obese girls could be termed weight bias.[15]

[Table 20 about here]

Omitted variable bias. Although this study employs well-balanced CBPS weights between treatment groups using multiple covariates, it is worthwhile to reiterate that matching/weighting methods are based on the conditional independence assumption; there might also be unobserved time-varying confounding (Morgan & Winship, 2015). Yet, since the observed significant effects are mainly limited to intercepts of models, the estimated coefficients are likely to be robust to unobserved time-varying confounding. As a supplemental analysis, I further control for observed time-varying covariates such as family income and family structure; the main results are also very similar. In addition, in this longitudinal mediation model, elementary school or teacher characteristics (e.g., school climate, school SES, and teacher qualification) may also confound the

[15] The estimated coefficients are also similar even after further controlling for math and reading achievement at grade 1, which can serve as a potential mediator.

relationship between teacher evaluation and student academic performance (i.e. mediator-outcome confounder) (Keele, 2015). To address this concern, I apply school and teacher fixed-effects models controlling for the time-varying covariates in the PP-LGM models. Additionally, I also generate a phantom latent unobserved heterogeneity that has constant effects on mediator and outcome variables (Finkel, 2008). The results are illustrated in Table 21. Yet, one concern for the teacher fixed-effects model is that because of the small number of students in each teacher compared to the school level, the within-group estimates may not be reliable. I thus do not put much emphasis on the results from teacher fixed-effects models. The school fixed-effects models show broadly similar findings, providing confidence in the mediation results; the indirect effects for Hispanic girls are particularly robust to multiple specifications.

[Table 21 about here]

3.5 Discussion

In the US, weight discrimination has increased by 66% over the past decade and is also comparable to the prevalence of racial discrimination, especially for females or minority groups (Puhl et al., 2008; Puhl & Heuer, 2009). Importantly, children are vulnerable to weight discrimination and stigmatization (Puhl & Peterson, 2012), and how teachers perceive students affects student academic performance via teacher-student interactions in daily class (Kelly & Carbonaro, 2012; Rubie-Davies et al., 2015). Despite the widespread belief, however, few empirical studies have directly investigated whether and how teacher evaluation on obese children matters for student academic achievement in elementary schooling. Importantly, previous studies are limited to cross-sectional correlational studies (Santana et al., 2017) and have paid little attention to the intersection of race, sex, and body size. This study is among the first to investigate the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement growth among marginalized subpopulations with a more rigorous research design.

The results of this study demonstrate that the significant total effects of kindergarten obesity/overweight status on academic achievement growth in elementary schooling are primarily a function of observed child, family, and school characteristics. However, even after accounting for the selection mechanism into early-onset obesity/overweight status at kindergarten, teachers are likely to perceive obese children as having more problematic behaviors, especially for girls and Hispanic girls. Specifically, for Hispanic girls with obesity, teachers are likely to report .30 of a SD higher levels of internalizing behaviors. Yet, observed significant effects are mainly limited to intercepts (1^{st} grade).

I also investigate possible mediating roles of teacher evaluation between kindergarten obesity/overweight status and academic achievement growth. The results from PP-LGM with CBPS weight show significant mediating effects of teacher evaluation of obese/overweight children's non-cognitive skills, especially for girls. In particular, the mediation effects are more pronounced for Hispanic girls (–.14); reading/math scores decrease by –.14 standard deviations for kindergarten obesity via teacher evaluation, which are also robust to multiple specifications including teacher and school fixed-effects models. Given the pooled effect size between perceived racial/ethnic discrimination experiences and academic outcomes among adolescents, from a meta-analysis, is about .10 (Benner et al., 2018), the observed mediation effects suggest that negative influence of weight stigmatization or discrimination might be comparable to racial discrimination or even more pronounced for minority girls.

In sum, the results of this study suggest that teachers may serve as a significant source of weight bias, which in turn affects child academic performance. Although the observed negative mediation effects are not cumulative (i.e. no growth effects), it can be an additional disadvantage for minority girls who are already at higher risk for poor health/psychological outcomes and are also exposed to other forms of discrimination (e.g., racial/ethnic or gender). Importantly, since kindergarten obesity/overweight status are closely related to family background, kindergarten weight problems would be "double jeopardy" for minority students due to the lack of family resources. Indeed, Figure 10 shows that children from low-SES families are about 4.4 and 2.7 times more likely to be obese and overweight at kindergarten. That said, an emphasis should be shifted from attributing blame for individuals to an issue of social justice.

From a policy perspective then, my findings highlight the need to incorporate weight and health education into teacher professional development, so that teachers can serve as a preventive actor in reducing the negative influences of kindergarten obesity. According to attribution theory, for instance, individuals seek causes and make attributions for obese children (e.g., low self-discipline/control) due to the modifiable/controllable characteristics of BMI. Previous studies, however, also show us that obesity is not simply a matter of self-discipline or willpower; family SES and genetic factors do also matter (Barness et al., 2007). Replacing the widespread societal stereotypes, with greater tolerance for diverse body types and physical characteristics (Walker, 2014), could be one strategy to address weight stigma and discrimination in our schools and society. Fostering a positive and supportive school climate may also help obese children to avoid weight discrimination (Winter, 2009). Careful monitoring of children with early-onset obesity should also take place within families.

3.5.1 Limitations and Future studies

This study explores heterogeneous effects of kindergarten obesity/overweight status on children's cognitive and non-cognitive outcomes among marginalized children, who are at the intersection of race, sex, and boy size. Yet, it may be that the observed relationships can further vary by teacher or school characteristics. For instance, previous studies on teacher-student race/sex matching suggest that teachers may have different expectations based on the racial or sex congruence (e.g., Rasheed et al., 2019; Weathers, 2019), though Pigott and Cowen (2000) find no significant interactions between teacher and student race/ethnicity. Unfortunately, previous studies on the effects of teacher-student race/sex matching have primarily focused on students' educational outcomes. In addition, in schools where obesity is not the norm (e.g., high-SES private school), obese/overweight children may face multiple disadvantages (see also Crosnoe & Muller, 2004). It is also worthwhile to mention that the class level might be important as much as the school level, though there are only small number of students in each teacher compared to the school level in the ECLS-K, which makes it difficult to generalize findings. Yet, careful attention should be paid to the establishment of causality in multiple treatment variables in complex interaction models (see more in VanderWeele, 2015). Finally, although this study mainly focuses on child academic performance as a primary outcome of weight bias, previous studies also suggest that negative behaviors/attitudes of teachers toward students can affect students' identity formation (Weinstein, 2002), which are also associated with psychological well-being (Greenaway et al., 2016). Expanding the analytic model of this study to include heterogeneity of teacher and school characteristics with diverse health outcomes will enrich our current understanding of the relationships between childhood obesity and educational attainments.

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Table 3.Time Specification for Self-control

Self-control (Total=15,820)		Linear	Quadratic	Cubic	Latent basis
Model fit	RMSEA	.02	.01	.01	.02
	CFI	.99	.99	.99	.99
	TLI	.99	.99	.99	.99
Intercept	Overweight	–.06***	–.06***	–.06***	–.06***
		(.01)	(.01)	(.02)	(.01)
	Obesity	–.08***	–.09***	–.10***	–.09***
		(.02)	(.02)	(.02)	(.02)
Slope	Overweight	.00	.00	–.00	.00
		(.00)	(.01)	(.01)	(.00)
	Obesity	.01	–.00	–.01	.01
		(.01)	(.01)	(.01)	(.01)
Quadratic	Overweight		.00	.00	
			(.00)	(.01)	
	Obesity		.00	.02	
			(.00)	(.01)	
Cubic	Overweight			.00	
				(.00)	
	Obesity			–.00	
				(.00)	

Table 4. LGM for Self-control (linear)

Self-control (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.02	.01	.01
	CFI	.99	.99	.99
	TLI	.99	.99	.99
Intercept	Overweight	–.06***	–.04**	–.04**
		(.01)	(.01)	(.01)
	Obesity	–.08***	–.02	–.03
		(.02)	(.02)	(.02)
Slope	Overweight	.00	.00	.00
		(.00)	(.00)	(.00)
	Obesity	.01	.01	.01
		(.01)	(.01)	(.01)

Table 5. LGM for Approaches to Learning (linear)

Approach to learning (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.03	.02	.02
	CFI	.99	.99	.99
	TLI	.99	.99	.98
Intercept	Overweight	–.07***	–.04**	–.05**
		(.02)	(.01)	(.02)
	Obesity	–.15***	–.06**	–.06*
		(.02)	(.02)	(.03)
Slope	Overweight	–.00	.00	.00
		(.00)	(.00)	(.00)
	Obesity	.00	.01	.01
		(.01)	(.01)	(.01)

Table 6. LGM for Interpersonal Relationship (quadratic)

Interpersonal Relationship (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.01	.01	.00
	CFI	.99	.99	.99
	TLI	.99	.99	.99
Intercept	Overweight	–.06***	–.04**	–.05**
		(.02)	(.01)	(.02)
	Obesity	–.09***	–.03	–.03
		(.02)	(.02)	(.03)
Slope	Overweight	–.01	–.01	–.00
		(.01)	(.01)	(.01)
	Obesity	–.02	–.01	–.01
		(.01)	(.01)	(.01)
Quadratic	Overweight	.00	.00	.00
		(.00)	(.00)	(.00)
	Obesity	.01*	.01	.01
		(.00)	(.00)	(.00)

Table 7. LGM for Internalizing Behaviors (linear)

Internal problem (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.03	.01	.02
	CFI	.97	.97	.97
	TLI	.97	.96	.97
Intercept	Overweight	.03**	.02*	.03*
		(.01)	(.01)	(.01)
	Obesity	.09***	.06***	.06***
		(.01)	(.01)	(.02)
Slope	Overweight	.01*	.01*	.01
		(.00)	(.00)	(.00)
	Obesity	.00	.00	.00
		(.01)	(.01)	(.01)

Table 8. LGM for Externalizing Behaviors (linear)

External problem (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.05	.02	.02
	CFI	.98	.97	.97
	TLI	.97	.97	.97
Intercept	Overweight	.04**	.04*	.04*
		(.02)	(.02)	(.02)
	Obesity	.06**	.03	.03
		(.02)	(.03)	(.03)
Slope	Overweight	–.00	–.00	–.00
		(.00)	(.00)	(.00)
	Obesity	–.01*	–.01*	–.01*
		(.00)	(.01)	(.01)

Table 9. LGM for Reading (cubic)

External problem (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.08	N/A	.03
	CFI	.99	N/A	.99
	TLI	.98	N/A	.97
Intercept	Overweight	–1.41**	N/A	.20
		(.44)		(.46)
	Obesity	–4.78***	N/A	–.43
		(.59)		(.75)
Slope	Overweight	–.11	N/A	.07
		(.15)		(.16)
	Obesity	.14	N/A	.32
		(.19)		(.25)
Quadratic	Overweight	–.03	N/A	–.05
		(.11)		(.11)
	Obesity	–.25	N/A	–.18
		(.14)		(.19)
Cubic	Overweight	.02	N/A	.01
		(.02)		(.02)
	Obesity	.06*	N/A	.04
		(.03)		(.04)

Note: N/A denotes a model that did not converge.

Table 10. LGM for Math (quadratic)

External problem (Total=15,820)		Unconditional	Family controls	CBPS weight
Model fit	RMSEA	.07	.03	.03
	CFI	.99	.99	.99
	TLI	.99	.99	.98
Intercept	Overweight	–1.77***	–.40	–.26
		(.38)	(.27)	(.40)
	Obesity	–5.03***	–1.42***	–1.21
		(.52)	(.36)	(.69)
Slope	Overweight	–.18	–.01	–.07
		(.12)	(.11)	(.13)
	Obesity	–.05	.19	.01
		(.16)	(.15)	(.21)
Quadratic	Overweight	.06*	.05	.06*
		(.03)	(.03)	(.03)
	Obesity	.08	.07	.08
		(.05)	(.04)	(.06)

Table 11. LGM for Child Cognitive and Non-cognitive Skills for Total Students

Total (n=15,820)		Self-control (linear)	Interpersonal Relationship (quad)	Approaches to learning (linear)	Internalizing behaviors (linear)	Externalizing behaviors (linear)	Reading (cubic)	Math (quad)
Model Fit		RMSEA:.02 CFI: .99 TLI:.99	RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.03 CFI:.99 TLI:.99	RMSEA:.03 CFI:.97 TLI:.97	RMSEA:.05 CFI:.98 TLI:.97	RMSEA:.08 CFI:.99 TLI:.98	RMSEA:.07 CFI:.99 TLI:.99
Unconditional								
Intercept	Overweight	–.06*** (.01)	–.06*** (.02)	–.07*** (.02)	.03** (.01)	.04** (.02)	–1.41** (.44)	–1.77*** (.38)
	Obesity	–.08*** (.02)	–.09*** (.02)	–.15*** (.02)	.09*** (.01)	.06** (.02)	–4.78*** (.59)	–5.03*** (.52)
Slope	Overweight	.00 (.00)	–.01 (.01)	–.00 (.00)	.01* (.00)	–.00 (.00)	–.11 (.15)	–.18 (.12)
	Obesity	.01 (.01)	–.02 (.01)	.00 (.01)	.00 (.01)	–.01* (.00)	.14 (.19)	–.05 (.16)
Quad	Overweight		.00 (.00)				–.03 (.11)	.06* (.03)
	Obesity		.01* (.00)				–.25 (.14)	.08 (.05)
Cubic	Overweight						.02 (.02)	
	Obesity						.06* (.03)	
CBPS weight								
Model Fit		RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.00 CFI:.99 TLI:.99	RMSEA:.02 CFI:.99 TLI:.98	RMSEA:.02 CFI:.97 TLI:.97	RMSEA:.02 CFI:.97 TLI:.97	RMSEA:.03 CFI:.99 TLI:.97	RMSEA:.03 CFI:.99 TLI:.98
Intercept	Overweight	–.04** (.01)	–.05** (.02)	–.05** (.02)	.03* (.01)	.04* (.02)	.20 (.46)	–.26 (.40)
	Obesity	–.03 (.02)	–.03 (.03)	–.06* (.03)	.06*** (.02)	.03 (.03)	–.43 (.75)	–1.21 (.69)
Slope	Overweight	.00 (.00)	–.00 (.01)	.00 (.00)	.01 (.00)	–.00 (.00)	.07 (.16)	–.07 (.13)
	Obesity	.01 (.01)	–.01 (.01)	.01 (.01)	.00 (.01)	–.01*(.01)	.32 (.25)	.01 (.21)
Quad	Overweight		.00 (.00)				–.05 (.11)	.06* (.03)
	Obesity		.01 (.00)				–.18 (.19)	.08 (.06)
Cubic	Overweight						.01 (.02)	
	Obesity						.04 (.04)	

Table 12. LGM for Child Cognitive and Non-cognitive Skills for Males

Male (n=8,070)		Self-control (linear)	Interpersonal Relationship (linear)	Approaches to learning (linear)	Internalizing behaviors (linear)	Externalizing behaviors (linear)	Reading (cubic)	Math (quad)
Model Fit		RMSEA:.02 CFI: .99 TLI:.99	RMSEA:.02 CFI:.99 TLI:.99	RMSEA:.04 CFI:.99 TLI:.99	RMSEA:.04 CFI:.96 TLI:.96	RMSEA:.05 CFI:.97 TLI:.97	RMSEA:.09 CFI:.99 TLI:.99	RMSEA:.07 CFI:.99 TLI:.99
Unconditional								
Intercept	Overweight	–.06*** (.02)	–.06** (.02)	–.07** (.02)	.01 (.02)	.04 (.02)	–1.18 (.65)	–2.06*** (.57)
	Obesity	–.02 (.03)	–.02 (.03)	–.10*** (.03)	.07** (.02)	–.00 (.03)	–4.55*** (.79)	–4.90*** (.72)
Slope	Overweight	.00 (.01)	.00 (.01)	–.00 (.01)	.01* (.01)	.00 (.01)	–.16 (.21)	–.01 (.17)
	Obesity	.01 (.01)	.01 (.01)	.01 (.01)	.00 (.01)	–.02* (.01)	.19 (.26)	–.17 (.24)
Quad	Overweight						.04 (.15)	.06 (.04)
	Obesity						–.36 (.20)	.12* (.06)
Cubic	Overweight						.00 (.03)	
	Obesity						.08* (.04)	
CBPS weight								
Model Fit		RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.08 CFI:.99 TLI:.99	RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.02 CFI:.97 TLI:.96	RMSEA:.02 CFI:.98 TLI:.97	RMSEA:.04 CFI:.99 TLI:.97	RMSEA:.03 CFI:.99 TLI:.98
Intercept	Overweight	–.05* (.02)	–.04* (.02)	–.05* (.02)	–.00 (.02)	.04 (.02)	.64 (.71)	–.10 (.63)
	Obesity	.02 (.04)	.04 (.04)	–.03 (.04)	.05* (.03)	.00 (.04)	–.22 (1.07)	–1.00 (1.09)
Slope	Overweight	.00 (.01)	.00 (.01)	.00 (.01)	.01 (.01)	–.00 (.01)	.07 (.22)	.08 (.19)
	Obesity	.00 (.01)	.00 (.01)	.01 (.01)	–.01 (.01)	–.01 (.01)	.17 (.38)	–.01 (.34)
Quad	Overweight						–.04 (.16)	.05 (.05)
	Obesity						–.20 (.27)	.08 (.08)
Cubic	Overweight						.02 (.03)	
	Obesity						.05 (.06)	

Table 13. LGM for Child Cognitive and Non-cognitive Skills for Females

Female (n=7,730)		Self-control (linear)	Interpersonal Relationship (linear)	Approaches to learning (linear)	Internalizing behaviors (linear)	Externalizing behaviors (linear)	Reading (cubic)	Math (quad)
Unconditional								
Model Fit		RMSEA:.02 CFI: .99 TLI:.99	RMSEA:.02 CFI:.99 TLI:.99	RMSEA:.04 CFI:.99 TLI:.98	RMSEA:.02 CFI:.98 TLI:.98	RMSEA:.05 CFI:.97 TLI:.96	RMSEA:.08 CFI: .99 TLI:.98	RMSEA:.08 CFI: .99 TLI:.98
Intercept	Overweight	–.06** (.02)	–.05** (.02)	–.06** (.02)	.06*** (.01)	.05* (.02)	–1.72** (.59)	–1.53** (.53)
	Obesity	–.15*** (.03)	–.15*** (.03)	–.19*** (.03)	.12*** (.02)	.11*** (.03)	–4.75*** (.84)	–5.14*** (.71)
Slope	Overweight	–.00 (.01)	–.01 (.01)	–.00 (.01)	.01 (.00)	–.00 (.00)	–.03 (.20)	–.27 (.17)
	Obesity	.01 (.01)	.00 (.01)	–.00 (.01)	.01 (.01)	–.01 (.01)	.06 (.30)	.00 (.24)
Quad	Overweight						–.11 (.14)	.07 (.04)
	Obesity						–.10 (.19)	.06 (.07)
Cubic	Overweight						.03 (.03)	
	Obesity						.03 (.04)	
CBPS weight								
Model Fit		RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.02 CFI:.98 TLI:.98	RMSEA:.01 CFI:.96 TLI:.96	RMSEA:.02 CFI:.96 TLI:.96	RMSEA:.03 CFI:.99 TLI:.98	RMSEA:.04 CFI:.98 TLI:.97
Intercept	Overweight	–.04 (.02)	–.04 (.02)	–.04 (.02)	.05** (.02)	.03 (.02)	.32 (.71)	–.18 (.56)
	Obesity	–.06 (.03)	–.06 (.03)	–.08* (.04)	.08** (.03)	.04 (.04)	–.98 (1.08)	–1.50 (.85)
Slope	Overweight	–.00 (.01)	–.01 (.01)	.00 (.01)	.01 (.01)	–.00 (.01)	.08 (.26)	–.20 (.18)
	Obesity	.02 (.01)	.01 (.01)	.01 (.01)	.01 (.01)	–.02 (.01)	.31 (.32)	.05 (.28)
Quad	Overweight						–.08 (.18)	.08 (.04)
	Obesity						–.15 (.24)	.07 (.08)
Cubic	Overweight						.01 (.04)	
	Obesity						.04 (.05)	

Table 14. LGM for Child Cognitive and Non-cognitive Skills for Black/Hispanic Females

Subgroups		Self-control (linear)	Interpersonal Relationship (linear)	Approaches to learning (linear)	Internalizing behaviors (linear)	Externalizing behaviors (linear)	Reading (cubic)	Math (quad)
CBPS weight (Black female, n=930)								
Model Fit		RMSEA:.03 CFI:.96 TLI:.96	RMSEA:.02 CFI:.95 TLI:.95	RMSEA:.02 CFI:.98 TLI:.97	RMSEA:.03 CFI:.91 TLI:.89	RMSEA:.03 CFI:.95 TLI:.94	RMSEA:.03 CFI:.99 TLI:.97	RMSEA:.03 CFI:.98 TLI:.97
Intercept	Overweight	–.01 (.07)	–.08 (.08)	–.07 (.09)	.09 (.07)	–.04 (.07)	–2.60 (2.37)	–.53 (2.31)
	Obesity	–.14 (.09)	–.10 (.10)	–.17 (.11)	.03 (.06)	.11 (.09)	2.29 (2.75)	–1.71 (1.58)
Slope	Overweight	.01 (.02)	.00 (.02)	.01 (.02)	.02 (.02)	.00 (.02)	.85 (.75)	.54 (.78)
	Obesity	.01 (.02)	–.01 (.02)	–.04 (.02)	.04* (.02)	.00 (.02)	–.24 (.87)	–.81 (.74)
Quad	Overweight						.31 (.52)	–.14 (.19)
	Obesity						–.60 (.61)	.40* (.17)
Cubic	Overweight						–.12 (.12)	
	Obesity						.16 (.14)	
CBPS weight (Hispanic female, n=2,040)								
Model Fit		RMSEA:.02 CFI:.98 TLI:.97	RMSEA:.00 CFI:.99 TLI:.99	RMSEA:.01 CFI:.99 TLI:.99	RMSEA:.00 CFI:.99 TLI:.99	RMSEA:.02 CFI:.99 TLI:.98	RMSEA:.04 CFI:.99 TLI:.97	RMSEA:.02 CFI:.99 TLI:.99
Intercept	Overweight	–.03 (.04)	–.06 (.04)	–.05 (.05)	.05 (.03)	.02 (.04)	.06 (1.25)	1.16 (.97)
	Obesity	–.08 (.06)	–.10 (.06)	–.08 (.07)	.15** (.05)	.05 (.06)	–.78 (2.04)	–1.89 (1.61)
Slope	Overweight	–.01 (.01)	–.02 (.01)	–.01 (.01)	.01 (.01)	.00 (.01)	–.39 (.38)	–.23 (.37)
	Obesity	.01 (.02)	–.01 (.02)	.00 (.02)	.01 (.02)	–.01 (.01)	–.09 (.57)	–.03 (.45)
Quad	Overweight						.00 (.33)	.01 (.11)
	Obesity						–.05 (.33)	.04 (.13)
Cubic	Overweight						.03 (.07)	
	Obesity						.03 (.07)	

Table 15. LGM for Child Cognitive and Non-cognitive Skills for Asian Females

		Self-control (linear)	Interpersonal Relationship (linear)	Approaches to learning (linear)	Internalizing behaviors (linear)	Externalizing behaviors (linear)	Reading (cubic)	Math (quad)
CBPS weight (Asian female, n=730)								
Model Fit		RMSEA:.01 CFI:.98 TLI:.98	RMSEA:.02 CFI:.96 TLI:.96	RMSEA:.02 CFI:.96 TLI:.96	RMSEA:.02 CFI:.92 TLI:.93	RMSEA:.02 CFI:.96 TLI:.95	RMSEA:.05 CFI:.97 TLI:.93	RMSEA:.04 CFI:.97 TLI:.96
Intercept	Overweight	.03 (.08)	.12 (.08)	.16 (.09)	.03 (.07)	–.08 (.07)	2.99 (2.55)	3.02 (2.97)
	Obesity	.12 (.18)	.03 (.22)	–.01 (.16)	.06 (.11)	–.12 (.12)	.87 (3.83)	–.67 (2.57)
Slope	Overweight	–.01 (.02)	–.02 (.03)	–.03 (.02)	–.02 (.03)	.00 (.03)	.68 (.97)	.58 (1.05)
	Obesity	.01 (.03)	.02 (.04)	.03 (.04)	–.05 (.06)	–.03 (.03)	1.20 (2.36)	1.24 (1.29)
Quad	Overweight						–.69 (.85)	–.08 (.24)
	Obesity						–.15 (1.91)	–.16 (.33)
Cubic	Overweight						.14 (.18)	
	Obesity						.01 (.36)	

Table 16. PP-LGM Mediation Model for Total Students

Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.99	.99	b	B	BC bootstrap 95% CI
Mediation Process (reading)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–.68** (.21)	–.05** (.01)	(–1.07, –.29)
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–.71* (.34)	–.05* (.02)	(–1.49, –.21)
Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.98	.98	b	B	BC bootstrap 95% CI
Mediation Process (math)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–.65** (.20)	–.04** (.01)	(–1.01, –.27)
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–.68* (.33)	–.04* (.02)	(–1.42, –.20)

Note: time specification is based on a latent basis model. Standard errors are in parentheses. The significant p-values of unstandardized and standardized coefficients are obtained from MLR. BC bootstrap CI is obtained from the first imputed data.

Table 17. PP-LGM Mediation Model for Males

Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.99	.98	b	B	BC bootstrap 95% CI
Mediation Process (reading)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–.57* (.28)	–.02* (.01)	(–1.11, –.05)
Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.99	.98	b	B	BC bootstrap 95% CI
Mediation Process (math)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–.64* (.32)	–.04* (.02)	(–1.29, –.08)

Note: time specification is based on a latent basis model. Standard errors are in parentheses. The significant p-values of unstandardized and standardized coefficients are obtained from MLR. BC bootstrap CI is obtained from the first imputed data.

Table 18. PP-LGM Mediation Model for Females

Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.99	.99	b	B	BC bootstrap 95% CI
Mediation Process (reading)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–.82* (.34)	–.06* (.02)	(–1.53, –.17)
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–1.31* (.54)	–.09* (.04)	(–2.50, –.49)
Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.98	.98	b	B	BC bootstrap 95% CI
Mediation Process (math)						
Overweight (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–.84* (.35)	–.06* (.02)	(–1.56, –.17)
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–1.33* (.55)	–.09* (.04)	(–2.56, –.48)

Note: time specification is based on a latent basis model. Standard errors are in parentheses. The significant p-values of unstandardized and standardized coefficients are obtained from MLR. BC bootstrap CI is obtained from the first imputed data.

Table 19. PP-LGM Mediation Model for Hispanic Females

Model fit	RMSEA	CFI	TLI	Indirect effects		
	.02	.99	.98	b	B	BC bootstrap 95% CI
Mediation Process (reading)						
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Reading intercept (2nd)				–2.02* (1.00)	–.14* (.07)	(–3.92, –.17)
Model fit	RMSEA	CFI	TLI	Indirect effects		
	.01	.99	.99	b	B	BC bootstrap 95% CI
Mediation Process (math)						
Obesity (K) (-) -> Non-cog skills intercept (1st) (+) -> Math intercept (2nd)				–1.90* (.95)	–.14* (.07)	(–4.01, –.11)

Note: time specification is based on a latent basis model. Standard errors are in parentheses. The significant p-values of unstandardized and standardized coefficients are obtained from MLR. BC bootstrap CI is obtained from the first imputed data.

Table 20. Sensitivity Analysis for Teacher Evaluation of Females

		Approaches to learning (female)	Internalizing behaviors (female)	Internalizing behaviors (Black female)	Internalizing behaviors (Hispanic female)
CBPS weight					
Model Fit		RMSEA:.02 CFI:.98 TLI:.98	RMSEA:.01 CFI:.96 TLI:.96	RMSEA:.03 CFI:.91 TLI:.89	RMSEA:.00 CFI:.99 TLI:.99
Intercept	Overweight	–.04 (.02)	.05** (.02)	.09 (.07)	.05 (.03)
	Obesity	–.08* (.04)	.08** (.03)	.03 (.06)	.15** (.05)
Slope	Overweight	.00 (.01)	.01 (.01)	.02 (.02)	.01 (.01)
	Obesity	.01 (.01)	.01 (.01)	.04* (.02)	.01 (.02)
CBPS weight (parent report controlled)					
Model Fit		RMSEA:.01 CFI:.98 TLI:.98	RMSEA:.01 CFI:.95 TLI:.94	RMSEA:.03 CFI:.88 TLI:.85	RMSEA:.00 CFI:.99 TLI:.99
Intercept	Overweight	–.03 (.02)	.04** (.02)	.08 (.07)	.05 (.03)
	Obesity	–.09* (.04)	.08*** (.03)	.02 (.06)	.16*** (.04)
Slope	Overweight	.00 (.01)	.00 (.01)	.02 (.02)	.01 (.01)
	Obesity	.01 (.01)	.01 (.01)	.04* (.02)	.01 (.02)

Table 21. Sensitivity Analysis for Mediational Analyses for Females

Mediation paths	PP-LGM	School fixed	Teacher fixed	Latent U_i
Female				
Overweight -> Non-cog skills intercept -> Reading intercept	–.82* (.34)	–.78* (.32)	–.50 (.39)	–.60* (.30)
Obesity -> Non-cog skills intercept -> Reading intercept	–1.31* (.54)	–1.68** (.57)	–1.31 (.85)	–1.40** (.48)
Overweight -> Non-cog skills intercept -> Math intercept	–.84* (.35)	–.79* (.33)	–.51 (.40)	–.71* (.29)
Obesity -> Non-cog skills intercept -> Math intercept	–1.33* (.55)	–1.71** (.58)	–1.35 (.86)	–1.12* (.49)
Hispanic female				
Obesity -> Non-cog skills intercept -> Reading intercept	–2.02* (1.00)	–2.58* (1.10)	–2.64* (1.21)	–1.69* (.85)
Obesity -> Non-cog skills intercept -> Math intercept	–1.90* (.95)	–2.41* (1.02)	–2.46* (1.12)	–1.58* (.79)

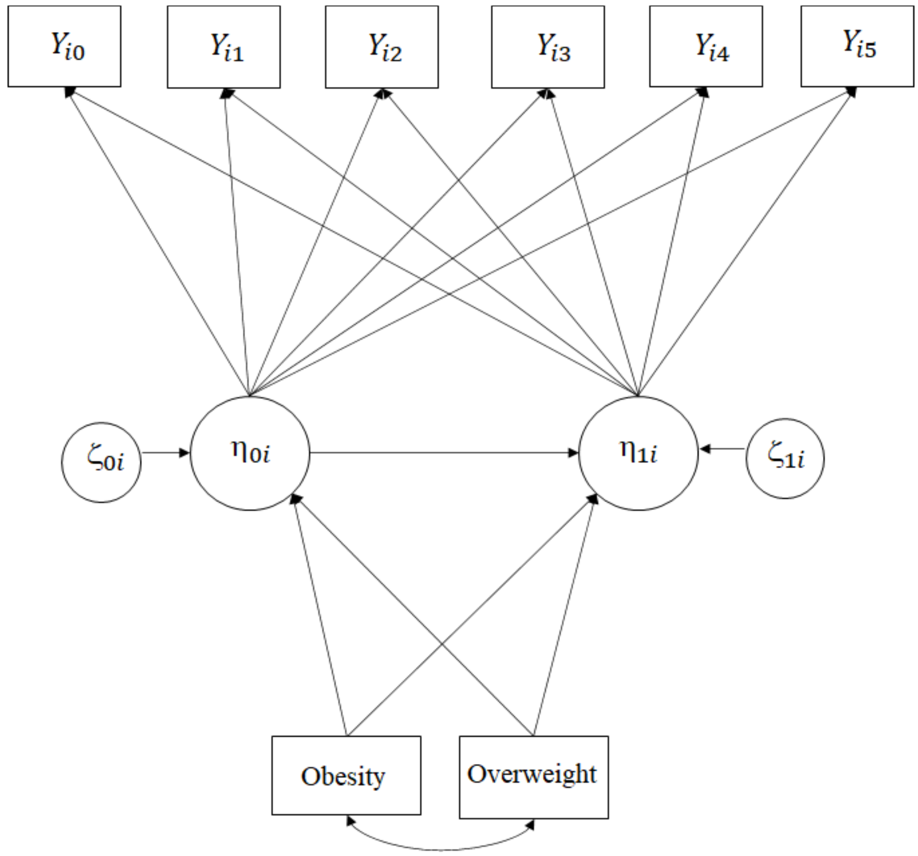


Figure 8. Baseline LGM

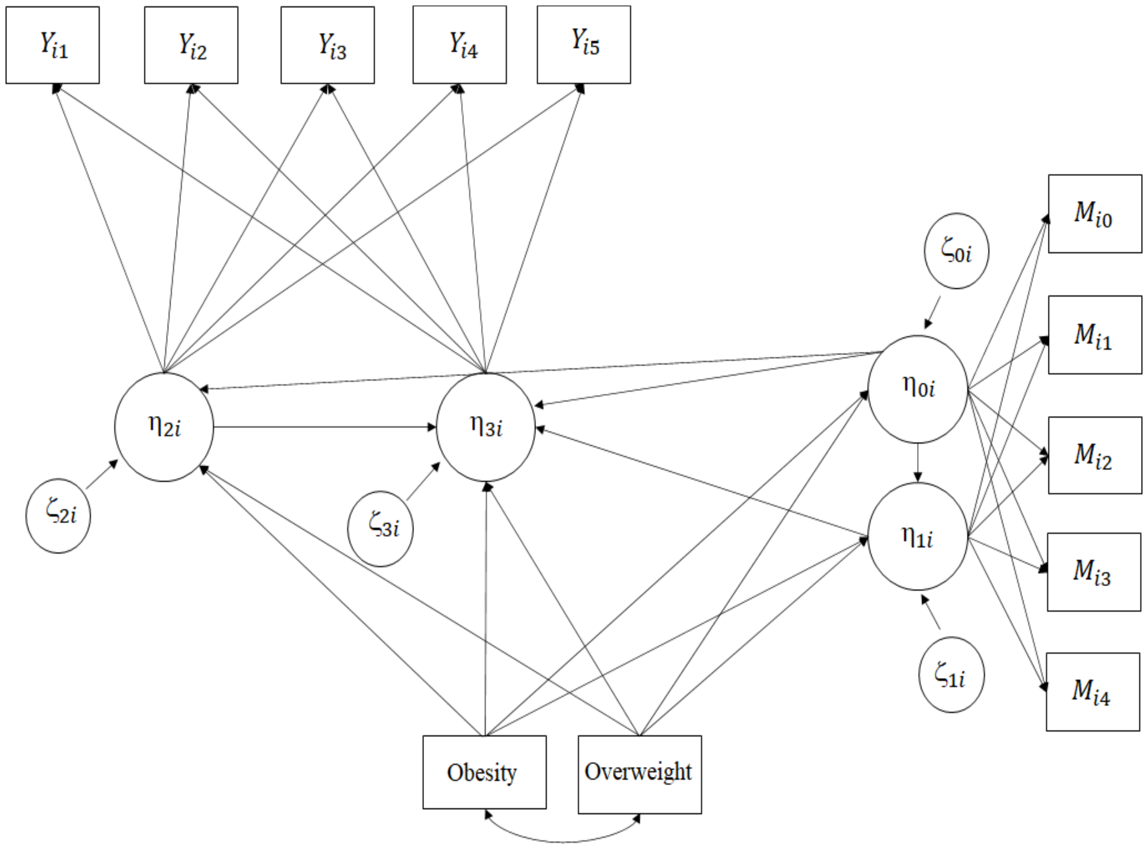


Figure 9. PP-LGM for Mediation Analysis

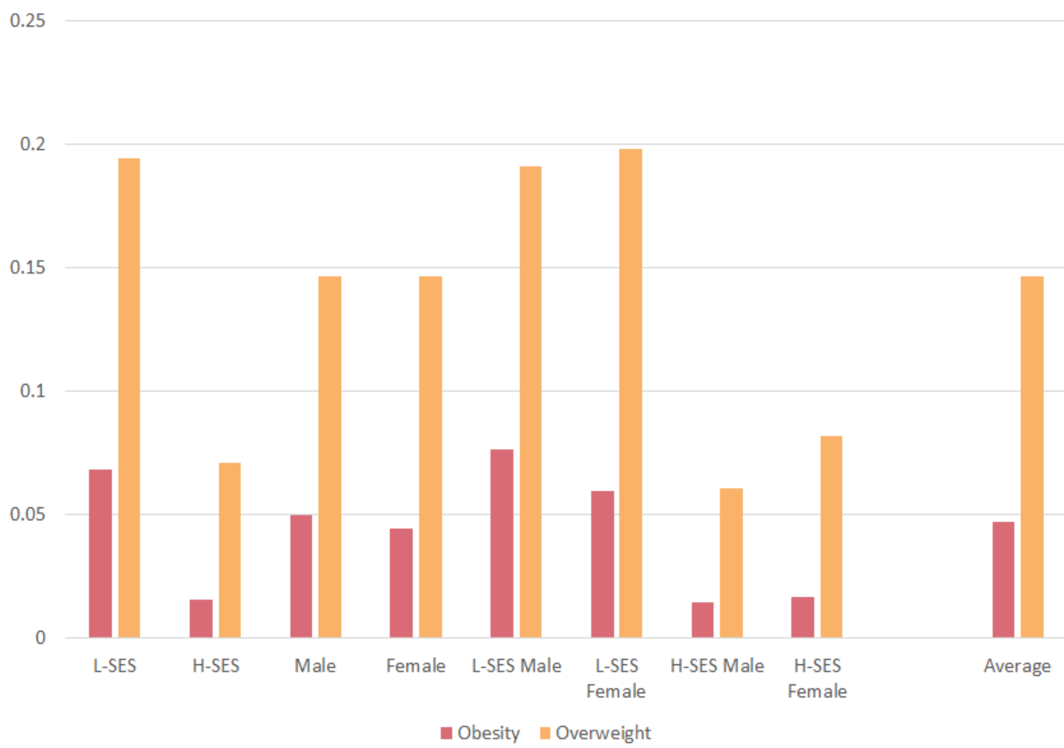


Figure 10. Proportions of Obesity/Overweight by Family Background and Sex

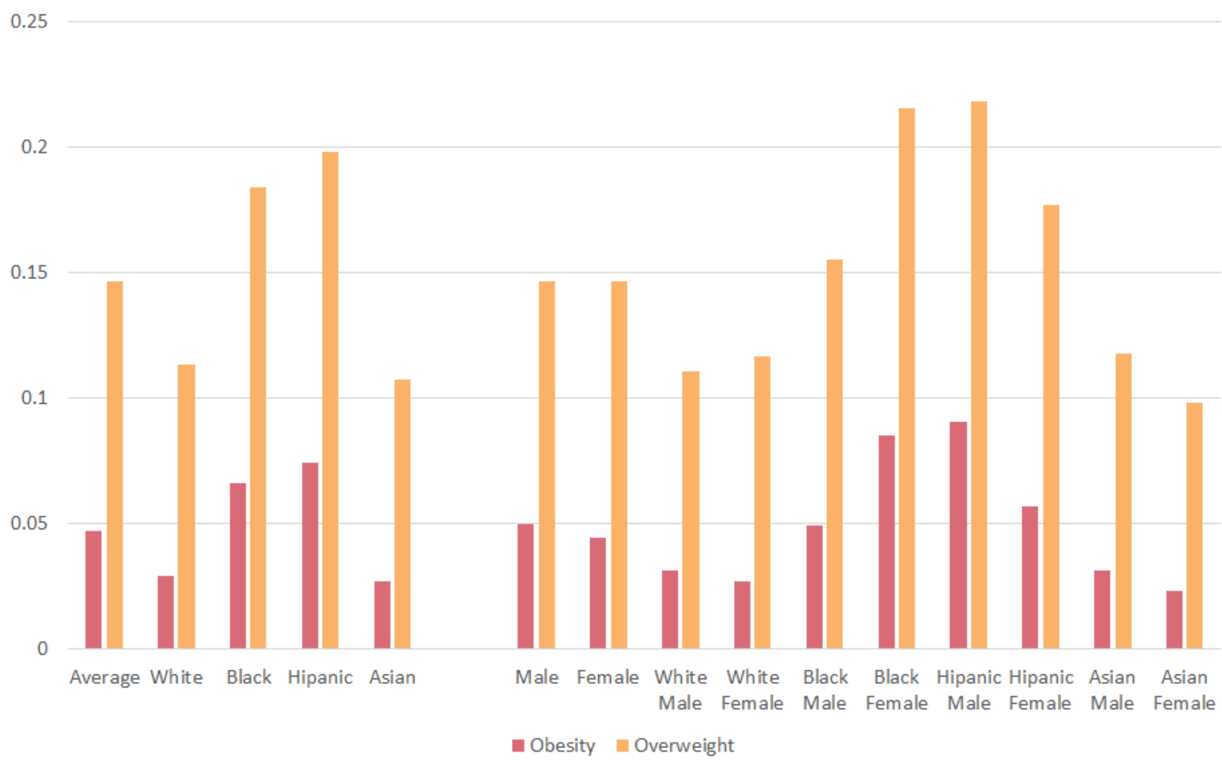


Figure 11. Proportions of Obesity/Overweight by Race/Ethnicity and Sex

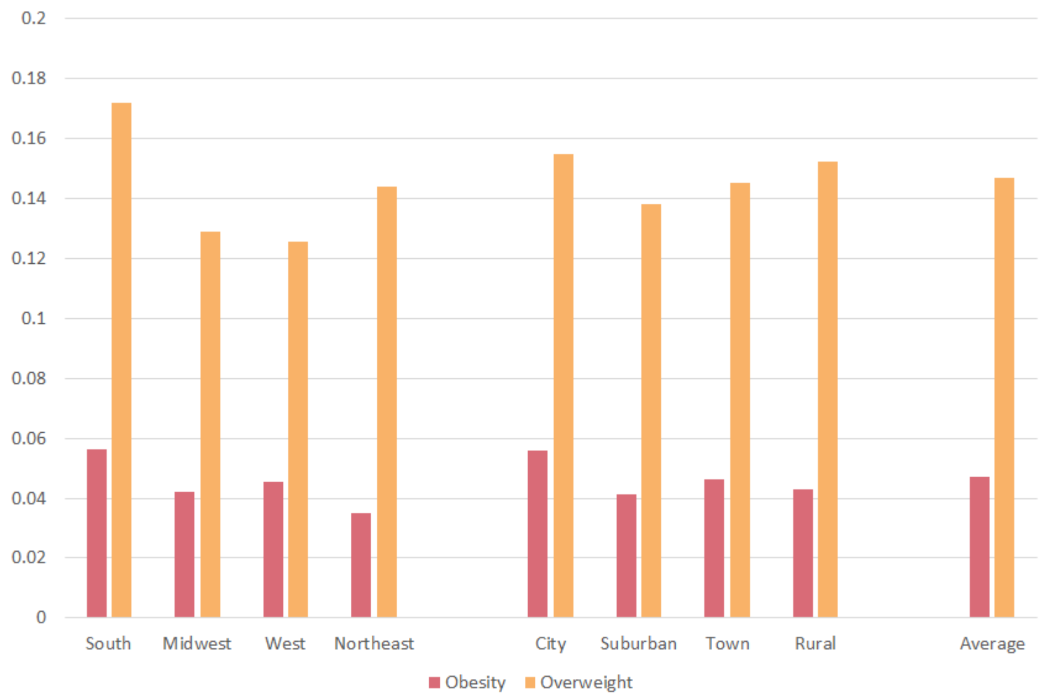
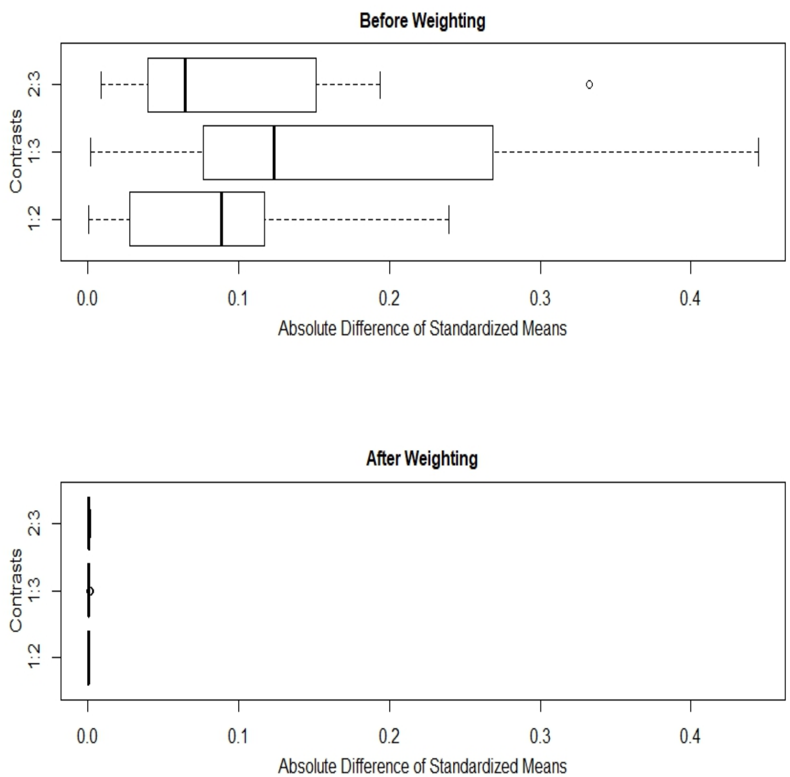
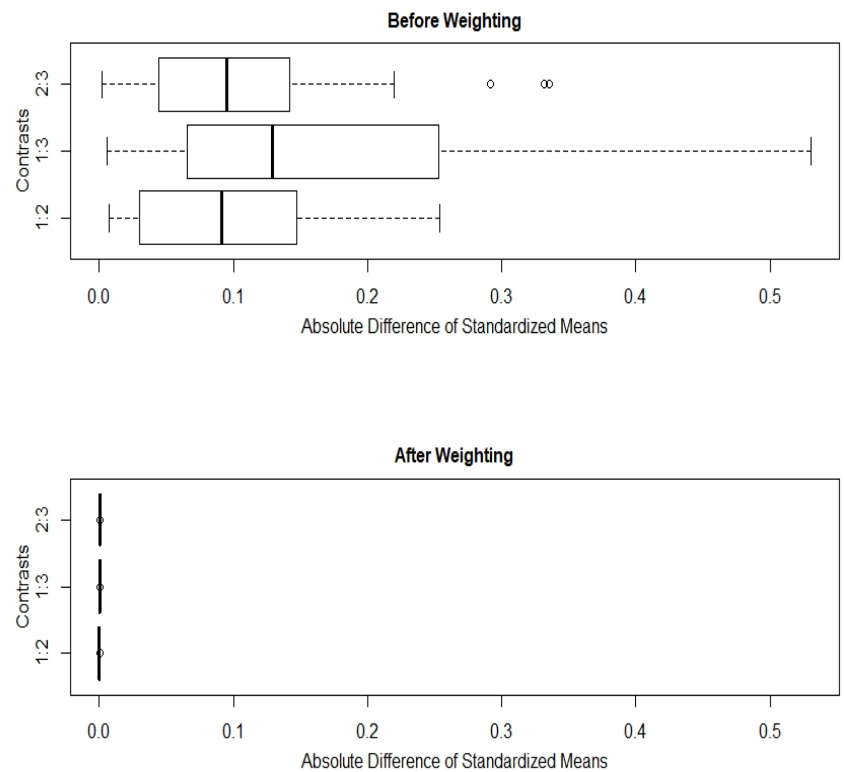


Figure 12. Proportions of Obesity/Overweight by Regions

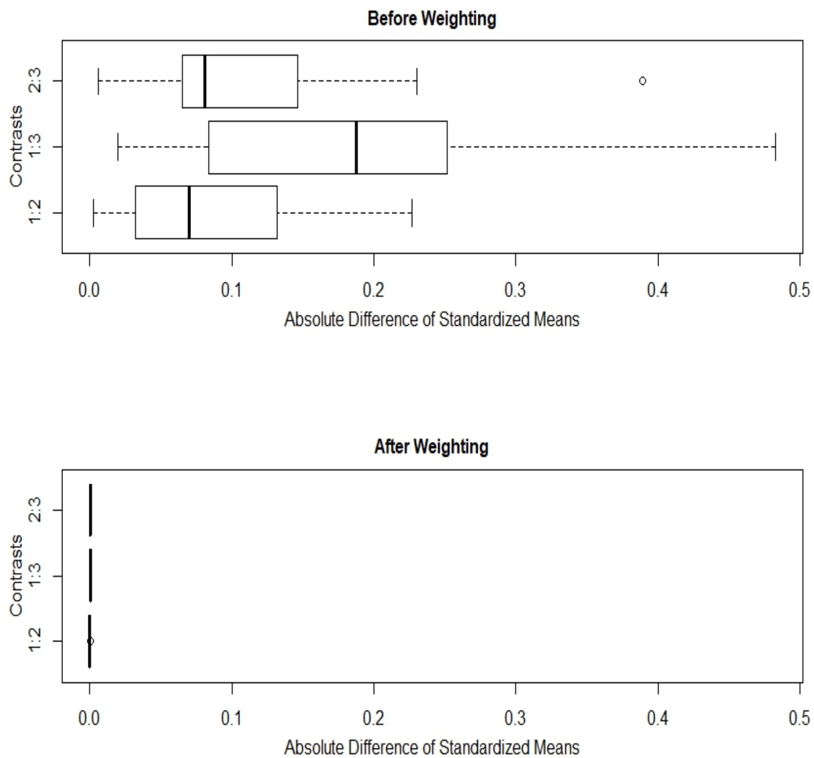
Appendix E Covariate Balance between Obesity Status (1=ref, 2=overweight, 3=obesity)



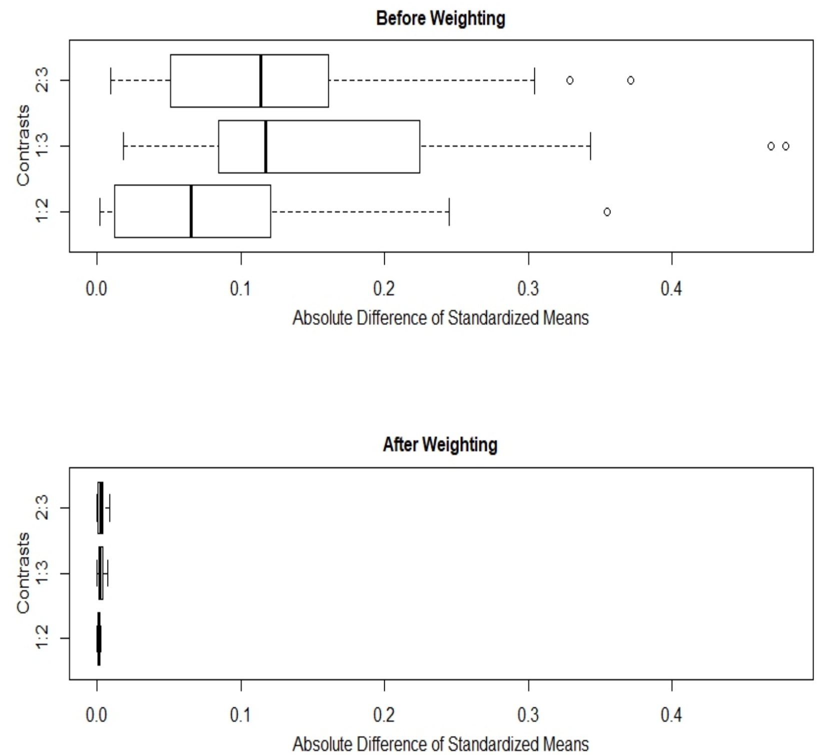


Total

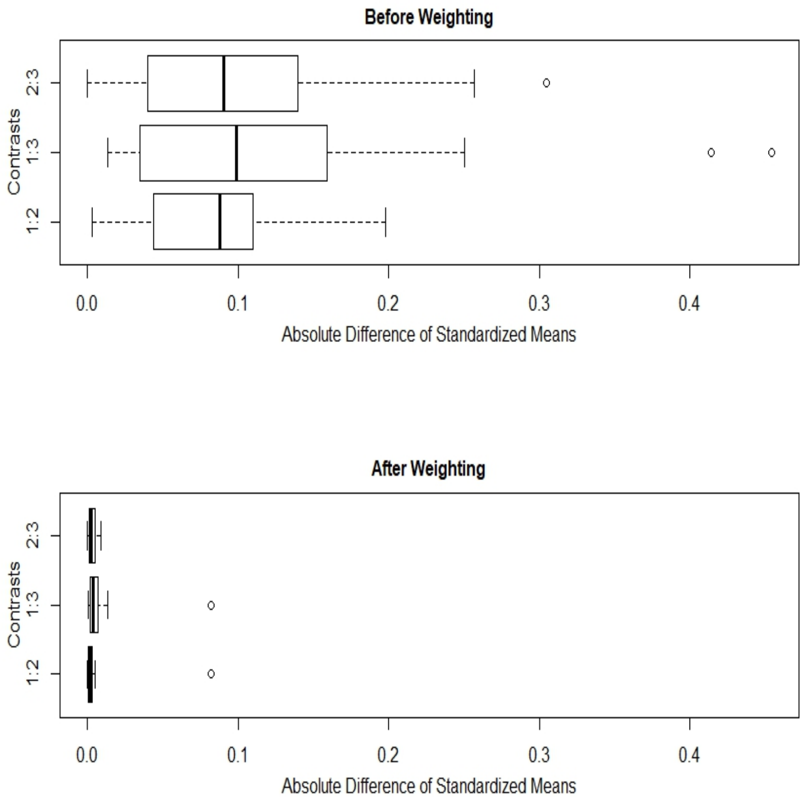
Male



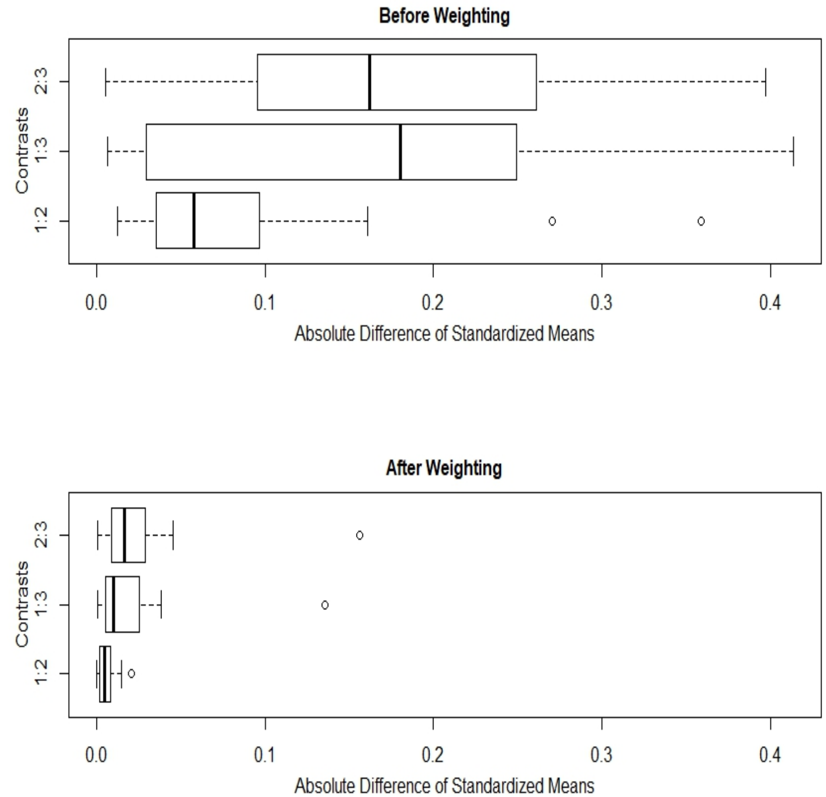
Female



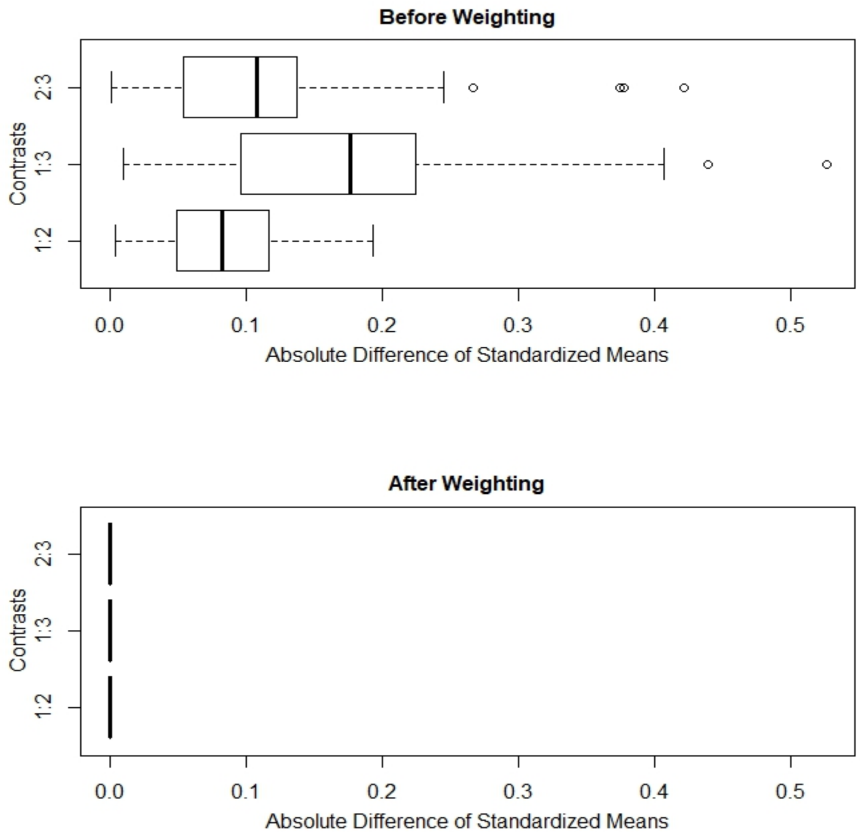
Black female



Hispanic female



Asian female



White female

4.0 Chapter 4: Summary and Conclusion

In the dissertation, I attempt to reveal the missing links between early cultural experience, obesity, and academic achievement in childhood. In particular, I focus on the intersection of race, sex, and body size to better understand the mechanisms of social and cultural reproduction. Although there are worries about official obesity criteria and potential negative influences (e.g., an over-concern with body weight or unnecessary body dissatisfaction, see more in Campos, 2004), considerable evidence has shown that there are increasing costs of obesity including direct medical, productivity, transportation, and human capital costs (Hammond & Levine, 2010; Tremmel et al., 2017). In particular, childhood obesity may contribute to a cycle of cumulative disadvantage in academic achievement, especially for minority students. It is also a strong predictor of *adulthood* obesity (Joe et al., 2009).

In tandem with changes in measured obesity, in the US weight discrimination has increased by 66% over the past decade and is now comparable to the prevalence of racial discrimination (Puhl & Heuer, 2009). Hebl et al. (2019), for instance, identify weight discrimination as one of the most important forms of modern discrimination. Importantly, because so much social interaction occurs in schools, children are highly vulnerable to weight discrimination and stigmatization from peers and teachers (Puhl & Peterson, 2012). As such, childhood obesity has become an urgent public health concern in the US and among many developed nations. To investigate the longitudinal relationships between early cultural experience, obesity, and academic achievement, I relied on the newly released Early Childhood Longitudinal Study 2011 5th grade follow-up, which is a nationally representative sample of American children. I attempt to exploit the advantages of structural equation modeling with a combination of econometric and quasi-experimental methods in addressing the research questions. The main findings of this study are as follows.

In the second chapter of the dissertation, I argue that cultural capital may contribute to shaping a student's body image or eating habits, thereby reducing the risk of being overweight. The results show that there are significant returns to global cultural capital for girls and White girls. Yet, due to limitations of the data structure that affect the scale of global cultural capital, I put more emphasis on findings from models of artistic cultural capital; the results demonstrate that arts participation in elementary schooling does reduce the risk of being overweight, and the influence of arts participation is stronger in later grades, as cultural capital theory posits. The observed longitudinal returns for early arts participation are slightly larger than the reported small effect sizes of school- and home-based obesity prevention programs found in a meta-analysis (Wang et al., 2015). My findings expand previous research on cultural capital which has primarily emphasized students' cognitive (or sometimes non-cognitive) outcomes; it reveals a significant new pathway of social reproduction via the accumulation of cultural capital and subsequent changes in BMI in elementary schooling.

In the third chapter of the dissertation, I investigate the longitudinal mediation process between kindergarten obesity, teacher evaluation, and academic achievement growth among marginalized subpopulations. The results reveal that the significant total effects of kindergarten obesity/overweight status on academic achievement growth in elementary schooling are primarily a function of observed child, family, and school characteristics. However, even after accounting for potential selection bias, teachers are likely to perceive obese children as having more problematic behaviors, especially for girls. In addition, the mediation analyses show significant mediating effects of teacher evaluation of obese/overweight children's non-cognitive skills, especially for girls and Hispanic girls. The estimated effect size is comparable to the pooled effect size between perceived racial discrimination experiences and academic outcomes among adolescents from a meta-analysis (Benner et al., 2018). That is, teachers may serve as a significant source of weight bias, which in turn affects child academic performance; kindergarten weight problems would be “double jeopardy” for minority children due to the lack of family support.

Taken together, the results show us the nuanced ways in which educational and health inequalities are perpetuated or exacerbated in childhood via the links between early cultural experience, obesity, and academic achievement. There are cumulative advantages in reducing weight from early arts participation, which is unevenly distributed between families and regions. The consequences of early-onset obesity are not the same for all children; it is particularly harmful for minority girls, who are already at higher risks of school failure or for poor health and psychological outcomes. In the following section, I first discuss several limitations of my analyses here before drawing policy implications.

4.1 Limitations and Future Studies

*Unobserved heterogeneity***.** While I refer to the estimated coefficients as “effects,” I recognize that there might be unobserved time-varying confounders that may threaten the internal validity of my findings. In particular, in health-related observational studies, unobserved genetic factors may be responsible for observed relationships. Yet, it should also be questioned how and why unobserved time-varying characteristics would be still strongly associated with cultural activities, obesity/overweight status, and academic achievement even after accounting for time-invariant and varying unit effects and observed time-varying controls in elementary schooling.

Future studies may need to consider longitudinal models that can effectively address time-varying confounding (e.g., marginal structural model; see also Daniel et al., 2013) to examine the proposed relationships in this study.

Measures of cultural capital and obesity status. This study employs two types of cultural capital, namely global and artistic/highbrow cultural capitals. In particular, the global cultural capital, which is widely used in previous studies, basically treats all cultural activities as an equivalent form of cultural capital. With respect to health outcomes, however, there are several reasons to hypothesize that “high-brow” cultural capital may lead to positive health outcomes via increased self-efficacy/esteem or informal access to health information. Bourdieu (1984) also argues that there are different fields in a society, and different types of capital carry different weights in each field. At least for health outcomes, careful attention should be paid to the creation and manipulation of cultural capital. It would be also worthwhile to explore the heterogeneity in cultural participation using a latent class/profile analysis (e.g., Pitzalis & Porcu, 2017). This study also utilizes obesity and overweight status at kindergarten as a primary independent variable for teacher evaluation and academic achievement. Although early-onset obesity is an important precursor of future academic success, it would also be interesting to investigate the longitudinal relationships with changes in obesity/overweight status in elementary schooling, though the variation of obesity status may not be sufficient. It should be noted that the prevalence of underweight may also matter for peer relationships or academic outcomes (Wang et al., 2018). Researchers may also need to be aware of that body mass index cannot be the sole measure of overweight and obesity (e.g., arbitrariness of the cut-off points) (see Evans & Colls, 2009).

Measures of outcomes. This study employs a continuous form of students’ body mass index as a primary outcome of early cultural experience as in the previous studies (e.g., Burns et al., 2020; Von Hippel et al., 2007). Other functional forms such as obesity/overweight specification will need to be considered in future studies to better estimate hazard ratios associated with obesity/overweight status. Yet, categorical data analyses often yield a model convergence issue dealing with complex models including weights, and estimated coefficients should be rescaled for appropriate interpretation (see Karlson et al., 2012). Importantly, as I discussed, there is a possibility that cultural capital may also affect other health outcomes such as subjective well-being or life satisfaction. Future studies will need to consider more diverse health outcomes using other national data sets including various health measures. In a similar vein, not only is weight bias of teachers is related to student academic achievement, it can also affect student health and psychological outcomes (e.g., depression and anxiety) (see also Sutin & Terracciano, 2017). It would also be interesting to explore the heterogeneity in growths of body mass index and academic achievement using a growth mixture model (e.g., Ames & Wintre, 2016).

Mediation mechanism. Although I attempt to provide several theoretical explanations for the possible links between the cultural capital and health outcomes and the weight bias and academic achievement, the mediating mechanisms are not directly tested in this study. For instance, in the present study it is difficult to disentangle cultural capital effects from social capital effects. Since the ECLS-K targets children in early childhood, the direct measures of psychological indicators (e.g., network, support, and friendship) are very limited. Future studies will need to explore the theorized mediation mechanisms with more appropriate data. It would also be worthwhile to investigate protective or ameliorating factors in reducing weight bias of teachers (see also Alberga et al., 2016).

National and cultural variations. This study employs the ECLS-K: 2011, which is a nationally representative sample of American children who entered kindergarten in 2010-2011.

Yet, it should be noted that the observed relationships may further vary by national and cultural contexts. According to Byun et al. (2012), for instance, while parental objectified cultural capital (e.g., availability of books of poetry or works of art at home) in S. Korea has a positive association with student academic achievement, children's embodied cultural capital (e.g., participation in cultural activities such as visiting museum, opera, or live theater) has a rather negative association with their academic achievement. Put another way, in the educational setting with the high degree of standardization and excessive focus on test taking skills, students' participation in cultural activities may have negative effects on their academic achievement; in such social circumstances that cultural knowledge and experiences are not widely recognized, the relationship between cultural capital and health outcomes may not be strongly associated. Previous studies also show that although the prevalence of obesity is increasing even among middle- and low-income nations, obesity rate is not generally high in East Asia. Yet, there are considerable variations between urban and rural areas among middle- and low-income nations (Ford et al., 2017; Martorell et al., 2000). Given that weight discrimination/stigmatization is closely related to social and cultural contexts as a norm or a "natural" standard, the relationships between obesity and teacher evaluation or academic performance are likely to vary according to national, societal or school contexts. Future studies will need to explore the heterogeneity in national and cultural background.

4.2 Policy Implications

Arts and cultural education for all. In the US, the amount that schools provide little or no arts education has increased in recent years, especially as the NCLB era unfolded. In particular, the non-participation rate is largest for children from low-SES families (Gara et al., 2018). The declining trend of arts education is also observed in other developed nations (Hickmore, 2019). My findings suggest that student cultural experiences are of importance in reducing the risk of being overweight. As schools provide less arts education, however, participation in artistic cultural activities will be largely determined by family SES. From a policy perspective, my findings suggest that schools need to play an important role in providing students with early arts experiences. Indeed, the model-based estimates show that early arts participation may generate positive returns comparable to school- and home-based obesity prevention programs.

I, however, do not want to conclude by arguing that early arts and cultural education is necessary for reducing the cost of obesity itself. In terms of cost efficiency, there are more cost-efficient ways to reduce the prevalence of childhood obesity including physical education. Yet, previous studies also suggest that not only is early arts participation related to adult arts participation (Dumais, 2019), but it also has significant relationships with early childhood development such as academic skills and psychological outcomes (Holochwost et al., 2017; Kisida et al., 2018). This study highlights the unexpected benefit (of reducing the risk of being overweight) from early arts/cultural participation, which can be alternative or supplemental explanations for reduced educational success among minority students (Reardon & Portilla, 2015). Unfortunately, cost-effective analyses for arts and cultural education are very rare. In advocating early arts and cultural education for all, however, educational researchers need to consider various short and long-terms returns. There are substantial body of evidence that arts and cultural education is of importance to various domains of child development (e.g., Fancourt & Finn, 2020; Rogers & Fancourt, 2020), though more rigorous longitudinal empirical studies are needed in this research area; there is also a movement to include art and design in STEM (i.e. STEAM see Costantino, 2018). Yet, I would argue at this time that given the multiple benefits of arts participation, and that it may also yield the unexpected health benefits explored in this study, there is value in greater funding for arts participation.

Reducing weight bias as a social justice issue. My findings suggest that teachers may serve as a significant source of weight bias, especially for minority girls, which in turn affects child academic achievement. Although children from low-SES families are likely to be obese (4.4 times) or overweight (2.7 times) at kindergarten compared to high-SES children, unfortunately, the consequences of early-onset obesity are not the same for all children. The observed weight bias of teachers can be an additional disadvantage for minority children who are already at higher risk for poor health and psychological outcomes and are also exposed to other forms of discrimination. Moreover, since kindergarten obesity is closely related to family/district SES, kindergarten weight problems would be “double jeopardy” for minority students due to the lack of family/district support.

From a policy perspective, this study draws the attention towards the importance of reducing weight stigma and discrimination among minority children for their educational success, as an issue of social justice. It suggests the need to incorporate weight and health education into teacher professional development, so that teachers can serve as a preventive actor in reducing the detrimental effects of kindergarten weight problems; these include emphasizing health and quality of life not weight, stop disseminating curriculum materials that has negative weight bias, and creating inclusive physical activities encompassing students with high body weight (see more in Ramos Salas et al., 2017; Russell-Mayhew et al., 2016); Rudd Center for Food Policy & Obesity provides more resources for schools/educators. They may need to be aware of that the negative effects of weight discrimination/stigmatization may be comparable to racial discrimination, as this study suggests. It should be, however, noted that teachers alone cannot solve the weight discrimination. Fostering a positive and supportive school climate, for instance, may also help obese children to avoid weight discrimination/stigmatization (Fair et al., 2018; Winter, 2009). Careful monitoring of children with early-onset obesity should also take place within families and schools with obesity intervention programs (see also Bleich et al., 2017; Jakicic & Davis, 2011). Replacing the widespread societal stereotypes of obesity, with greater tolerance for diverse body types and physical characteristics (Walker, 2014), would also be necessary.

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