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Epidemiological Paradox or Immigrant Vulnerability? Obesity Among Young Children of Immigrants

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ABSTRACT

Although many U.S. born children of immigrants are disadvantaged by their parents' economic, linguistic, and legal marginalization, they are claimed to enjoy health advantages over children of U.S. born parents. We investigate child obesity as a potentially significant deviation from this "immigrant epidemiological paradox." Analyses of kindergarteners in the Early Childhood Longitudinal Study, Birth and Kindergarten cohorts were conducted. Our findings are opposite to those predicted by the immigrant epidemiological paradox: Children of U.S. born mothers are less likely to be obese than otherwise similar children of immigrant mothers; and among children of immigrants, greater maternal acculturation is associated with lower obesity. We develop an immigrant vulnerability explanation that attends especially to linguistic isolation.

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INTRODUCTION

The demographic importance of the immigrant second-generation among all children has grown sharply and will continue to grow in decades ahead (Passel 2011). One in four children in the United States now has at least one foreign born parent, and by 2020 this is projected to rise to 30 percent of all children. Overall 84 percent of these children (and 94 percent of those aged less than 6) were born in the U.S., and are thereby defined as second-generation immigrants (Passel 2011). Heterogeneous characteristics, conditions, and outcomes of the immigrant population and its U.S. born children have made some researchers optimistic about the prospects of this “new” second-generation (Farley and Alba 2002; Pearlmann and Waldinger 1997). However, several indicators point to major vulnerabilities. Almost 30 percent of second-generation children live in poor households (Borjas 2011). As many as 1 in 4 have an unauthorized immigrant parent (Passel 2011), reducing access to family welfare benefits (Fix and Zimmerman 2001), health care (Acevedo-Garcia and Stone 2008), and the formal economy (Massey and Gelatt 2010). Familial linguistic isolation, low maternal education, and race-and-ethnicity-based discrimination have been identified as additional disadvantages facing the children of recent immigrants (Hernandez 2004; Waters and Jimenez 2005). These adverse developmental contexts may underlie the more pessimistic findings in recent studies examining cognitive development and educational outcomes (Glick, Bates, and Yabiku 2009; Magnuson, Lahaie, and Waldofogel 2006; Mistry et al. 2008).

Contradicting these many disadvantages, however, is the claim of a broad health advantage of second-generation children. This “immigrant epidemiological paradox” was first proposed to account for the surprisingly good birth and perinatal outcomes of Hispanic children (Markides and Coreil 1986). Research on this paradox continues to focus on immigrant Hispanic children (Hummer et al. 2007; Lara et al. 2005) in no small part due to Mexico and Latin America being respectively the largest country and region of origin (Passel 2011). The paradox has been subsequently extended beyond the perinatal period to early-childhood health conditions of Hispanic immigrant children (Padilla, Hamilton, and Hummer 2009), and to the early and later childhood health outcomes of both Hispanic and other ethnic and country-of-origin groups (Hamilton et al. 2011; Jackson, Kiernan, and McLanahan Forthcoming; Mendoza 2009). An important corollary of the paradox is that greater acculturation to U.S. culture and society is claimed to weaken these initially positive health behaviors and outcomes (Lara et al. 2005; Salant and Lauderdale 2003). The force of the "immigrant paradox" hypothesis is such that it has recently been speculatively extended to early educational success (Palacios, Guttmannova, and Chase-Landale 2008).

On one health outcome, child obesity, the evidence for an epidemiological paradox extending to second-generation children is mixed at best, as we review below in some detail. The emergence of epidemic levels of child obesity in the U.S. decades has been described as an early phase of a broader crisis involving significantly worse health and wellbeing for a generation of adults to come (Ludwig 2007). The children of disadvantaged minorities, moreover, have been particularly strongly affected (Freedman et al. 2005a). In this context, the importance of childhood obesity for second-generation immigrant disadvantage is potentially great for several reasons. First, the domains of child health and overall development including educational progress are closely linked (Crosnoe 2006; 2007). Second, there is a strong tracking of obesity from childhood into adulthood, including among Hispanic and immigrant children (Freedman et al. 2005b; Harris, Perreira, and Lee 2009), resulting in an accumulation of adverse health consequences of obesity over adulthood (Ferraro and Kelly-Moore 2003). Additionally, obesity in adulthood brings social stigma (Carr and Friedman 2005) and disadvantaged outcomes both in the job market (Finkelstein, Ruhm, and Kosa 2005; Glass, Haas, and Reither 2010; Pagan and Davila 1997) and in marriage and family (Frisco et al. 2012; Glass et al. 2010; Mukhopadhyay 2008). Therefore if second-generation children are indeed substantially more likely to be obese than children of U.S. born parents, this would first call into question the overall characterization of a positive immigrant health paradox applying to the children of immigrants, and second add greatly to concern about the overall prospects of the "new second-generation" (Portes and Zhou 1993).

There remain major data impediments to investigating the prevalence of obesity in second-generation immigrant children. The most authoritative source of child obesity prevalence, the National Health and Nutrition Survey (NHANES) reliably identifies a mother's country of birth only in the case that she is the household head. The National Survey of Child Health (NSCH) provides large samples and the specific questions needed to identify children by parental countries of birth, but has the major disadvantage of relying on parents' reports of children's weight and height. Parent reports are considered especially unreliable during early-childhood when changes in height and weight are most rapid (Akinbami and Ogden 2009; Phipps et al. 2004). Cross-sectional surveys are inevitably weak, moreover, in their ability to control for the prenatal and early-life conditions that may be especially influential for child obesity (Salsberry and Reagan 2005). In particular, because parent-child obesity correlations are known to be high (Martin 2008), pre-pregnancy weight status of the mother is an especially important variable to include in evaluations of parental immigrant status on child obesity. Obtaining a large enough sample of children born to immigrant mothers, however, is challenging in longitudinal surveys.

In the present study, we overcome these data limitations in an innovative pooled-survey estimation of differences in the probability of being obese in kindergarten between children born to foreign born and U.S. born mothers. We pool two panel surveys that include measured height and weight of kindergarteners: The Early Childhood Longitudinal Study 1998 Kindergarten cohort (ECLS-K); and the Early Childhood Longitudinal Study 2001 Birth cohort (ECLS-B). Both surveys include whether the mother was born in the U.S. or abroad, when she first arrived in the United States, and her English-language ability. The ECLS-K, however, did not collect much information on pre-kindergarten conditions. In particular, the mother's pre-pregnancy weight was not collected. We show here that estimates of associations of race/ethnicity and of maternal nativity and acculturation with obesity in kindergarten are substantially different before and after controlling for maternal pre-pregnancy weight status. This indicates an omitted variable bias in models without that variable. We avoid this bias while still exploiting the large sample size of observations pooled between the ECLS-B and ECLS-K by employing a cross-survey multiple imputation method for pooled-survey analysis.

We find that, contrary to the immigrant epidemiological paradox, obesity is higher overall among children born to a foreign born mother than among children born to a U.S. born mother, both before and after controlling for prenatal, birth, and socioeconomic circumstances. Further contradicting the epidemiological paradox, we find that this result is strongest for the children of less acculturated foreign born mothers, especially those with lower English proficiency. We interpret these findings as consistent with broader immigrant disadvantage that extends to second-generation children's health.

LITERATURE REVIEW

An "epidemiological paradox" of health advantages among children of immigrants

Reviews of the literature on the health of children of immigrants (henceforth referred to as COIs) a decade apart (Mendoza 2009; National Research Council 1999) conclude that not only are COIs less likely to have low birth weight or to die in the first year of life compared to children of U.S. born mothers (henceforth referred to as CONBs), but that COIs typically experience fewer acute and chronic health conditions. Analyzing a large nationally-representative sample of U.S. children (the 2007 NSCH), Hamilton et al. (2011) observed in both age-standardized outcomes and in models adjusting for a broad range of sociodemographic variables that COIs had lower rates of allergies, asthma, developmental problems, and learning disabilities than CONBs from the same race/ethnicity. Apart from obesity, to which we return below, only ear infections and, in some ethnic-origin groups, headaches were more prevalent among COIs than CONBs. Similarly wide-ranging health advantages have been found even after controlling for health care use that may affect the likelihood of having undiagnosed conditions (Padilla et al. 2009). Using a sample of Mexican 5-year-old children from a national sample of urban preschool-age children (the Fragile Families study), they found that both asthma and an index of less prevalent chronic conditions (i.e., mental retardation, Downs syndrome, cerebral palsy, autism, sickle cell anemia, congenital heart disease, blindness, and deafness) were less common among COIs than among CONBs. In a sample of middle school and high school aged youth from the National Longitudinal Study of Adolescent Health (Add Health), the National Research Council (1999) found that COIs were advantaged over CONBs on both individual physical health problems and an index aggregating physical and developmental problems including missed school due to a health or emotional problem, learning difficulties, obesity, and asthma. However, there remains some skepticism about whether the paradox may be overstated due to underdiagnosis of conditions among disadvantaged immigrant children (Watt and Martinez-Ramos 2009).

Consistent with the immigrant epidemiological paradox, studies suggest that increased acculturation decreases the health advantages of COIs. On birth outcomes including low birth weight and prematurity, researchers have found that the health advantages of having an immigrant mother are reduced or eliminated with increased maternal acculturation (Landale, Oropesa, and Gorman 2000; Lara et al. 2005). Across all the health outcomes reviewed by Lara et al. (2005), negative health assimilation was observed most consistently for maternal health behaviors and conditions relevant for child health, including pre-pregnancy weight status, breastfeeding, smoking, substance abuse, and diet during pregnancy. In adolescence too, the health advantages of COIs have been found to decline the longer their parents have been in the U.S (Harris et al. 2009; National Research Council 1999).

Explanations for a broad-based immigrant epidemiological paradox include favorable selection into migration and subsequent socio-cultural protections enjoyed by immigrants in the receiving country from the potentially deleterious health environment found in the U.S. (Hamilton et al. 2011; National Research Council 1999). Immigrants are claimed to be favorably selected on social, psychological, and physical resources and conditions (Chiswick, Lee, and Miller 2008; Jasso et al. 2004; Palloni and Arias 2004), and the children of immigrants are expected to benefit from these advantages (Donato and Duncan 2011). Socio-cultural protections following migration include immigrants' cultural orientations toward more positive health behaviors and the salubrious role of strong family bonds, community social networks, and stronger social cohesion reported for immigrant enclaves (Kimbro 2009; Palloni and Arias 2004) in both supporting these healthful behaviors and helping immigrants manage stress (Mulvaney-

Day, Alegria, and Sribney 2007). COIs are expected to benefit from these sociocultural protections, for example through healthier prenatal and perinatal exposures and through the healthier nutritional content of a traditional diet (Akresh 2007; Neuhouser et al. 2004). Conversely, parental acculturation to the U.S. is expected to disrupt immigrants' traditional orientation towards healthy life-styles and strong family and community networks (Mulvaney-Day et al. 2007), and this again is likely to reduce the health benefits of their immigrant status accruing to their children.

Health vulnerability among children of immigrants

Even given the existence of a general immigrant epidemiological paradox for COIs, however, its applicability to reducing COIs' obesity risk cannot be assumed. As indicated by the "paradoxical" nature of immigrant health advantages, prevailing theories for social disparities in health (House, Landis, and Umberson 1988; Link and Phelan 1995) suggest that the socioeconomic disadvantages of many immigrant families should make COIs amongst the most vulnerable to poor health. Socioeconomic disadvantages, moreover, are expected to be highest among the least acculturated parents. More acculturated immigrants may have arrived in the U.S. as children, completed more years of education (Hirschman 2001), and developed high English proficiency, leading to higher incomes as adults (Allensworth 1997). Longer time in the U.S. is also associated with improved access to health care (Leclere, Jensen, and Biddlecom 1994).

In addition, immigrant parents – especially those with lower acculturation – may experience difficulties in sheltering their children from unhealthy aspects of mainstream culture as their children develop independence. Portes and Rumbaut (2001) describe dissonant acculturation as the phenomenon whereby children of immigrants acculturate to the U.S. faster than their immigrant parents and differences in acculturation between parents and children become a point of contention within immigrant families. Children's health behaviors may come to resemble those of their immigrant parents less and less as they begin to experience a broader range of exposure to the U.S. environment than their parents. Children in immigrant families typically experience schooling exclusively in American schools, watch American television, and socialize with other U.S. born peers. On factors specifically affecting obesity, children are often exposed to marketing and messages concerning foods, especially low nutritional quality foods, from peers, schools, and television (Gantz et al. 2007). Qualitative research on Latino (Himmelgreen et al. 2007) and Vietnamese (Babington and Patel 2008) mothers finds that these immigrant mothers feel that they have less control of their children's diets in the U.S. than they would in their origin countries and that their children often prefer more "American" foods.

Additionally, the traditional cultural orientations of immigrant parents that are protective in the first year of life, including breastfeeding and lower exposure to smoking and drug use in the prenatal period, may give way to less healthful cultural orientations to nutrition in early-childhood (Guendelman et al. 2010; Rosas et al. 2010). Researchers have noted that immigrant parents often originate from countries where child under-nutrition poses more of a serious health concern than over-nutrition (Popkin and Doak 1998), and thus they hypothesize that immigrant parents may be less adept at viewing child obesity as a health concern (Cheah and Van Hook 2012; Crawford et al. 2004).

The preceding arguments suggest that less parental acculturation, far from insulating children from adverse health influences, may instead lead to greater risk for obesity. Less acculturated immigrant parents may be less adept at helping their more "American" children navigate the U.S. nutritional environment (Gray et al. 2005; Park et al. 2011). Lower parental acculturation may also result in less exposure to beneficial messages concerning child's health that may counteract mass media messages to parents and children from food and drink marketers. Child obesity is a highly publicized health concern in the U.S. (Ogden et al. 2010) and increased exposure to this message may result in greater awareness and resistance to child obesity. For example, Guendelman et al. (2010) in a binational study found that Mexican-American mothers identified thinner images of children as ideal compared to Mexican mothers in Mexico. Immigrant mothers indicated that this changing preference was due to a greater awareness of child obesity as a health concern as a result of migration to the U.S. Greater English proficiency also increases immigrants' access to health care resources in their new environment (Yin et al. 2009).

Existing evidence of an immigrant epidemiological paradox for child obesity

The research evidence until now is mixed on the effects of parental nativity and acculturation on child obesity. Perreira and Ornelas (2011) describe a typical immigrant epidemiological paradox pattern of increasingly more obesity from first, to second, to third and higher generations of adolescent children found in the National Longitudinal Study of Adolescent Health. Hamilton et al. (2011) found among children age 10 to 17 in the 2007 NSCH that, adjusting for social-demographic variables, black children fit the immigrant paradox pattern of increasing obesity from first to second to third and higher generation children. They found no substantial differences, however, in adjusted obesity prevalence between the different generations of Hispanic children, and for white and Asian children they found an inverse-U relationship in which second-generation children exhibit the highest obesity prevalence after adjusting for socio-demographic differences. In a large sample of Mexican-origin children in Houston, Texas, Hernández-Valero et al. (2007) found that children born to U.S. born mothers were twice as likely to be obese as were children born to Mexico-born mothers, after controlling for factors including maternal education and maternal overweight and obesity. This is again consistent with an immigrant epidemiological paradox. Using data from the Fragile Families study, however, Padilla et al. (2009) found no statistically significant differences in obesity between second-generation and third-and-higher-generation Mexican-origin children. Jackson, Kiernan, and McLanahan (Forthcoming) similarly found a lack of difference by parental nativity with the Fragile Families data, but across all immigrant origin countries.

A number of other studies have reported inconsistent or null findings for disparities by nativity and various acculturation indicators (Balistreri and Van Hook 2011; Cheah and Van Hook 2012; Li et al. 2011; Liu et al. 2009; Singh, Kogan, and Yu 2009; Taverno, Rollins, and Francis 2010; Van Hook and Baker 2010; Van Hook and Balistreri 2007). Using the 2003 NSCH, Singh et al. (2009) found lower odds of obesity for COIs than for CONBs in Asian children, but no statistically significant differences in white, black, and Hispanic children. Taverno et al.'s (2010) analyses of Hispanic COIs and CONBs with these same data did not find generational differences in childhood obesity. Analyzing the Early Childhood Longitudinal Study, Birth cohort (ECLS-B), Li et al. (2011) found higher odds of obesity among COIs than CONBs at age 4, but these differences were reduced to non-significance after controlling for sociodemographic characteristics, mother's health, early feeding practices, and early weight gain. Analyzing the Early Childhood Longitudinal Study, Kindergarten cohort (ECLS-K), Van Hook and Baker (2010), however, found higher BMI percentile at kindergarten and more growth in BMI percentile from kindergarten through fifth grade among boys with at least one foreign born parent compared to CONBs.

Some studies also point to adverse effects of lower parental acculturation on children's obesity. In analyses of the 2003 NCHS restricted to Hispanics, both Liu et al. (2009) and Taverno et al. (2010) observed that children who did not primarily speak English at home were significantly more likely to be obese than were children who did, though there were no differences by generation. Van Hook and colleagues' analyses of the ECLS-K found higher obesity among male COIs whose mothers arrived in the U.S. after age 13 (Balistreri and Van Hook 2011) or who had lower maternal English proficiency (Van Hook and Baker 2010). These findings are contrary to the acculturation predictions of the immigrant epidemiological paradox.

METHODS

We conduct separate and pooled analyses of the Early Childhood Longitudinal Study 1998 Kindergarten cohort (ECLS-K) and the Early Childhood Longitudinal Study 2001 Birth cohort (ECLS-B). Both surveys were directed by the National Center for Educational Statistics (NCES) to assess children's early learning environments, health, and development. The ECLS-K followed a nationally representative cohort of children attending kindergarten in the U.S. in 1998 and assessed children in the fall and spring of kindergarten, fall and spring of first grade, third grade, fifth grade, and eighth grade (U.S. Department of Education 2009a). The baseline kindergarten sample was selected using a three-stage probability-sampling design and oversampled Native Hawaiian/Pacific Islanders and children attending private schools. The ECLS-K's stratified sample design ensures national and regional geographical representativeness. Sample numbers are rounded to the nearest 10 following ECLS-K conditions of use. An overall unweighted response rate of 68.8% was achieved for the baseline (kindergarten) child assessment of 19,070 children (U.S. Department of Education 2009b). The main source of non-response was the non-participation of 26.3% of sampled schools, leaving 1,010 schools participating in the baseline sample.

Our analysis is of obesity measured at the spring kindergarten wave. Our analytical sample is limited to U.S. born children whose biological mothers responded to the parent survey (91.6% of the sample) and who were present in the spring of first grade or latter waves when questions pertaining to parent's place of birth were asked. Some 16.5% of the original sample is no longer present. We exclude children who were born outside the U.S. (390 cases) to achieve comparability between the ECLS-K and the ECLS-B. No foreign born children are included in any of our analyses. An additional 15.1% of cases are excluded due to their missing information on one or more of the other study variables.

The ECLS-B is a nationally-representative sample of the cohort of children born in the U.S. in 2001. Assessments were conducted at 9 months, 2 years, 4 years and kindergarten (Snow et al. 2009). Computer-assisted, in-home interviews were conducted with mothers (or in about 5% of the cases, fathers or other guardians) and assessments of children were conducted by trained field interviewers. The ECLS-B oversampled low birth weight, twins, Asians, and Native American children. Mothers less than 15 years old when they gave birth to their child were excluded in the ECLS-B sample design. Our analyses use the kindergarten wave, in which approximately 66% of the original cohort remained in the sample. Child height and weight were assessed in the year the child started kindergarten, either in the 2006-2007 or the 2007-2008 school year. All ECLS-B counts are rounded to the nearest 50 to comply with NCES confidentially requirements.

We excluded cases (4.5% of the total) in which the responding parent was not the biological mother. Additionally, we excluded cases where the child was homeschooled (2.0%), went straight to first grade (0.5%), or where the grade they were enrolled in was unknown or ungraded (3.2%). This was done to ensure that the ECLS-B and ECLS-K sampled from the same universe of children in kindergarten. Of the potential 6,300 children who met the criteria listed above, an additional 12.6% of cases were excluded because they had missing information on one or more of the other study variables.

Variables

The dependent variable in our study is obesity, defined as a BMI at or above the 95^{th} percentile using the U.S. Centers for Disease Control reference population and procedures (Kuczmaski et al. 2002) that account for developmental differences in growth by age and gender. The ECLS-K and ECLS-B used comparable measurement protocols for assessing child height and weight, using a Shorr board for height, a digital bathroom scale for weight, and requiring that children were wearing light clothing when weighed.

The main explanatory variables of interest are maternal nativity and maternal acculturation. Mothers are defined as foreign born if they were born outside the U.S. or in the U.S. territories including Puerto Rico. The latter mothers are also classified as foreign born because as migrants to the U.S. mainland from territories with distinct linguistic and cultural contexts they may undergo the same kind of cultural change as do international migrants.

We examine the association between child obesity and English language proficiency or of mother's age at arrival in the U.S.. We used these indicators of parental acculturation because of their use in previous studies and because of their general interest in differentiating immigrant child and adult outcomes (Rumbaut 2004). For mother's age at arrival we create two dummy variables using Portes and Rumbaut's (2001) distinction of immigrants who arrived in the US at or after age 13 (the "1.0 generation") from immigrants who arrive prior to age 13 (the "1.5 generation"). Because socialization in childhood has lifelong consequences for preferences, tastes, and beliefs, age at arrival in the U.S., especially whether some or all of the immigrant's school years occurred in the U.S., is a frequently-used indicator of the strength of immigrants' traditional cultural orientation and exposure to U.S. culture. Mother's greater duration in the U.S. or earlier age at arrival in the U.S. has been previously associated, either positively or negatively, with child health outcomes and access to health care (Balistreri and Van Hook 2011; Leclere et al. 1994; Van Hook and Balistreri 2007).

English language proficiency is determined in the 9th month wave of the ECLS-B and in the fall kindergarten wave of the ECLS-K using four questions that ask mother's to self-assess their ability to speak, read, write, and understand English on a four point, scale ranging from "very well" to "not well at all." These four questions are administered to mothers who indicated that any other language besides English was spoken at home. We coded immigrant mothers who performed all of these tasks "very well" or exclusively spoke English at home (23.2% in ECLS-K and 18.1% in ECLS-B) as having "high English" proficiency, and as having "low English" proficiency otherwise. English language use has long been identified as a key indicator of social integration or isolation between immigrants and natives (Gordon 1964). Greater English language use or proficiency has been previously associated, again either positively or negatively, with child health outcomes and access to health care (Ayala, Baquero, and Klinger 2008; Sussner, Lindsay, and Peterson 2009; Taverno et al. 2010; Van Hook and Baker 2010; Yin et al. 2009).

We include in our multivariate analyses controls for socioeconomic status, maternal pre-pregnancy health, and child's early life outcomes and conditions. We assess socioeconomic status using several indicators including mother's education mother's marital status, and household income, all measured in the child's kindergarten year. Household income is a continuous measure in ECLS-K while in the ECLS-B it is measured using a 13 category variable ($5,000 or less; $5,001 to 10,000; etc., up to $200,001 or more). The NCES in both surveys used a hot deck method to impute income for cases where it was missing. In order to harmonize across the two datasets, we coded each of the categories of the ECLS-B to the middle of the range (with the open ended category coded to $408,500). We adjusted these values for inflation by measuring income in 1998 dollars (U.S. Department of Labor 2012), and transformed this inflation-adjusted income into the log of household income.

We also include controls for mother's age at birth, whether the child was a singleton birth or part of a twin or higher order birth, birth weight, and mother's pre-pregnancy weight status. Mother's age at birth is a continuous measure of the mother's age in years when she gave birth to the study child. Birth weight is obtained from birth certificates in ECLS-B and parental reports in ECLS-K and is categorized as low birth weight (less than 2,500 grams, reference), average birth weight (2,500 to 3,999 grams), and high birth weight (4,000 grams or heavier). Pre-pregnancy weight status is only observed in the ECLS-B, in which mothers report both their pre-pregnancy weight and their current height in the 9 month wave. BMI is then calculated as weight (kg)/height $(m)^2$. Because higher maternal BMI has been found to be strongly associated with child's early-life obesity risk, we implement a cross-survey multiple imputation method to include BMI also among the ECLS-K children's predictor variables (see 'ANALYSES' below).

We also control in our multivariate analyses for several demographic variables. These are mother's race/ethnicity, child's age, child's gender, and number of siblings (mother's report). Mother's race/ethnicity is self-identified and coded for our analysis into seven categories: non-

Hispanic white, Hispanic, non-Hispanic black, Asian, Native Hawaiian/Pacific Islander, Native American/Native Alaskan, and multi-racial. Child's age is measured in months and corresponds to the age they were when the height and weight measurements were taken.

Analyses

We first compared obesity prevalence and means or proportions of the predictor variables between children whose mothers were born outside the U.S. (COIs) and children whose mothers were U.S. born (CONBs), and between COIs by two maternal acculturation indicators: high English proficiency versus low English proficiency; and 1.0 generation (mother arrived at age 13 or older) versus 1.5 generation (mother arrived before age 13). We then estimated logistic regression models to examine the extent that maternal nativity and maternal acculturation is associated with child obesity. In all models children with the least acculturated mothers are the reference group. According to the immigrant epidemiological paradox both the children of more acculturated mothers and the children of U.S. born mothers are expected to be more likely to be obese after controlling for socioeconomic and other relevant variables.

Each regression model was first estimated separately on the ECLS-K and ECLS-B samples and re-estimated on a sample that pooled observations across the two surveys. The methodology used for our pooled-survey estimation is adapted from that described in Rendall et al. (2011). We used cross-survey multiple imputation (MI) to impute mother's pre-pregnancy body mass index (BMI) from the ECLS-B to every observation in the ECLS-K. This cross-survey MI method allows our preferred regression specification to be used for the pooled-survey estimation whereas otherwise this specification could only be used on the ECLS-B sample. As a result, our best specification can be estimated on a sample whose size is triple that of the ECLS-

B alone. We show that estimates of both race/ethnicity and nativity associations with kindergarteners' obesity are substantially different before and after controlling for maternal pre-pregnancy BMI. The cross-survey multiple imputation method thus overcomes what would otherwise be omitted variable bias if the less preferred specification of only variables in common between the ECLS-B and ECLS-K were used.

Because our estimation combines observations from two nationally representative, longitudinal surveys conducted using similar protocols but administered eight years apart, we begin by assuming that they sample from a common social process except for a potential difference in levels of the outcome variable (obesity in kindergarten). As described in the appendix, we test the validity of this assumption by conducting diagnostics under a model-fitting framework (see Rendall et al. 2011 or Weden, Brownell, and Rendall Forthcoming for an example of this model-fitting procedure applied to pooling of the ECLS-B and the National Longitudinal Survey of Youth when only variables common to both surveys are included). Our finding of model-fit improvement when adding an intercept shift variable for overall child obesity level differences between the surveys we argue is not problematic (see APPENDIX for a further discussion). However, had we found a model-fit improvement when adding a full set of covariate interactions with "survey," this would have constituted evidence against the assumption that the surveys sample from a common social process, calling into question the appropriateness of a pooled-survey method.

Estimates are weighted in the analysis model (but not in the imputation model) using survey weights to account for oversampling and attrition. Confidence intervals, standard errors, and significance tests adjust not only for clustering due to the multi-stage stratified design of the surveys, but also for the additional uncertainty introduced by the cross-survey multiple imputation process.

RESULTS

Descriptive Statistics

Table 1 displays weighted means and percentages for the ECLS-K and Table 2 displays weighted means and percentages for the ECLS-B samples by mother's nativity and by our two dimensions of acculturation (language proficiency and age at arrival). The separate presentation of estimates of children's obesity and predictor variables in the two surveys also allows for a first opportunity to assess the comparability of the two surveys, and therefore also their suitability for pooled analysis. Recall that both the ECLS-K and ECLS-B are designed to be nationally representative with respect to the cohorts they sample from, respectively children who entered kindergarten in 1998 and children who entered kindergarten in 2006 or 2007. We know from analyses of NHANES data that the prevalence of child obesity changed relatively little between 1999 and 2007 (Ogden et al. 2010). In this context, we remark upon the substantially higher overall prevalence of obesity seen in the ECLS-B (17.0%) than in the ECLS-K (11.5%), a difference that is statistically significant ($p<0.001$, not shown). A previous study of the ECLS-B children at the pre-school wave (Anderson and Whitaker 2009) found that they were significantly more likely to be obese than were similar-aged children in the NHANES. That study also found, however, that differences in obesity by race were comparable between the ECLS-B and NHANES. In separate analyses reported in the appendix, we compared the kindergarten waves of ECLS-B and ECLS-K children in to the NHANES children of the same or similar ages and averaged over study years near those respectively of the ECLS-K's 1999 year and ECLS-B's 2006-7 year of observation of children in kindergarten. Consistent with Anderson and Whitaker (2009), we found the ECLS-B obesity prevalence to be significantly higher than that found in the NHANES. We found the ECLS-K obesity prevalence, on the other hand, to be very close to that for the NHANES. As we show in our multivariate analyses below, the higher level of obesity prevalence in the ECLS-B remains after including a range of controls, but does not imply different relationships of the predictor variables to the kindergarten obesity outcome.

[TABLES 1 AND 2 ABOUT HERE]

We also compared the weighted ECLS-K and ECLS-B sample estimates on other predictor variables as seen in Tables 1 and 2. We found that, across the measures of nativity and acculturation, mothers in the ECLS-B were more likely to be Hispanic than were mothers in the ECLS-K and were less likely to be non-Hispanic white. Additionally, we found a higher prevalence of foreign born mothers in the ECLS-B than the ECLS-K (14.8% in ECLS-K versus 20.0% in ECLS-B). These differences are consistent with demographic shifts in the racial/ethnic composition and parental nativity of the U.S. child population that occurred between the two surveys (Ennis, Rios-Vargas, and Albert 2011; Passel 2011).

We did not find any statistically significant overall differences between the ECLS-K and ECLS-B surveys on the other control variables. We did, however, find significant differences between the ECLS-K and ECLS-B children in the patterns of these control variables by mother's nativity and acculturation. In the ECLS-K, high English proficient mothers were older, while there was little age-difference between generation 1.5 and 1.0 mothers, but in the ECLS-B the opposite was observed. More acculturated mothers were younger, with the largest differences between generation 1.5 and 1.0 mothers. In the ECLS-K, the proportions of children classified as high birth weight were similar across mother's nativity and acculturation, but in the ECLS-B, high English proficient foreign born mothers had much lower prevalence of high birth weight than low English proficient foreign born mothers.

Hispanic origin, high birth weight, and older age of the mother at birth are all risk factors for child obesity (Anderson and Whitaker 2009; Classen and Hokayem 2005), and therefore may explain part of the overall higher obesity prevalence in the ECLS-B than in the ECLS-K. By including these variables in our multivariate analyses, we therefore increase the comparability of the two surveys for estimating conditional nativity and acculturation associations.

Our first substantively important result seen in Tables 1 and 2 is that children of immigrant mothers (COIs) are overall significantly more likely to be obese than are children of U.S. born mothers (CONBs). This is seen in both the ECLS-K (17.2% of COIs versus 10.5% of CONBs) and the ECLS-B (24.2% of COIs versus 15.1% of CONBs). Moreover, the differences in obesity prevalence by our two dimensions of acculturation (language proficiency and age at arrival) are both in the direction of more obesity among children of less acculturated immigrant mothers, though the differences are only statistically significant for the English proficiency dimension. Obesity is more prevalent among children whose mothers are classified as low English than as high English (19.9% versus 13.0% in the ECLS-K, and 28.2% versus 15.4% in the ECLS-B).

Consistent with other research on immigrants (e.g., Passel 2011), we find that a large percentage of children with foreign born mothers identify as Hispanic (61.4% in the ECLS-K and 68.0% in the ECLS-B). Hispanic children are the dominant racial/ethnic group especially among children with low English proficient mothers. Some 77.4% of children of low English proficient mothers in the ECLS-K and 79.8% in the ECLS-B are Hispanic. Hispanic children are also the dominant racial/ethnic group among children with high English proficient mothers

(35.8% in the ECLS-K and 42.3% in the ECLS-B); however, non-Hispanic white children (31.5% in the ECLS-K and 22.0% in the ECLS-B) and Asian children (15.0% in the ECLS-K and 21.0% in the ECLS-B) are also numerous. Unlike language proficiency, the racial/ethnic distribution is generally similar for children with foreign born mothers who arrived prior to age 13 and those with mothers who arrived at age 13 or older. There is some tendency, however, for children whose mothers arrived prior to age 13 to be non-Hispanic white, and for mothers who arrived at age 13 or older to be Asian.

On maternal education and household income, COIs, especially those with less acculturated mothers, were disadvantaged relative to CONBs. In both surveys, about a third of the COIs had mothers with less than a high school degree or GED, while the corresponding figure for CONBs was 8.2% in ECLS-K and 9.8% in ECLS-B. The lowest levels of maternal education were observed among children of low English mothers and, to a lesser extent, among children whose mothers arrived in the U.S. at the age of 13 or older, for whom about 26.5% and 19.4% in the ECLS-K and ECLS-B, respectively, had mothers with less than a 9th grade education. Low English children are more likely to have never married mothers and high English children are more likely to have formerly married mothers in both ECLS-K (13.5 versus 9.8% and 14.8 versus 8.5%, respectively) and ECLS-B (21.9 versus 11.9% and 11.9 versus 9.4%, respectively) and COIs are more likely to have married mothers than CONBs (73.2 versus 77.0%), but only in ECLS-K.

The birth weight and pre-pregnancy weight status variables provide results consistent with the immigrant epidemiological paradox: COIs, and especially COIs with less acculturated mothers, were more likely to experience better early life and prenatal health conditions. In the ECLS-K, COIs were more likely to have had a normal birth weight than CONBs, though the differences were small in the ECLS-B. Additionally, low English children were less likely to have been low birth weight (seen in both the ECLS-K and the ECLS-B). Finally, examining pre-pregnancy weight status (only available in the ECLS-B), immigrant mothers' mean pre-pregnancy BMI was lower than that of U.S. born mothers (24.3 versus 25.1), though no statistically significant differences were found between more and less acculturated immigrant mothers.

Multivariate Analyses

Results from our logistic regression models of obesity in kindergarten on full sets of predictor variables are presented in odds ratio (OR) form in Table 3. Our best-fitting model specifies low versus high English language proficiency as the acculturation variable (specification comparisons discussed below). Our best estimates come from fitting this model to the pooled ECLS-B and ECLS-K observations after multiply imputing maternal pre-pregnancy BMI to the ECLS-K (see first column of Table 3).

[TABLE 3 ABOUT HERE]

Compared to COIs with low-English-proficient mothers, CONBs have much lower odds of being obese: only 0.62 as high (95% Confidence Interval: 0.50, 0.78). COIs with high English proficient mothers also have much lower odds of being obese in kindergarten than do COIs with low-English-proficient mothers: only 0.71 as high (CI: 0.53, 0.95). In results not reported in Table 3, the odds of obesity were statistically indistinguishable between COIs with high English proficient mothers and CONBs (OR 1.10, p=0.36). Therefore only for the second-generation children of less acculturated mothers do we find a statistically significant difference in obesity from that of CONBs. Crucially, this difference is in the opposite direction of that predicted by the immigrant epidemiological paradox.

Examining the odds ratios for the socioeconomic variables, we see results that are consistent with those found elsewhere in the literature on the determinants and associations with early-childhood obesity (Classen and Hokayem 2005; Shrewsbury and Wardle 2008; Weden et al. Forthcoming). Of the larger racial/ethnic groups, children with Hispanic mothers have the highest odds of obesity relative to the children of non-Hispanic white mothers (OR 1.39, CI: 1.14, 1.70), followed by children with black mothers (OR 1.22, CI: 1.00, 1.49). Mother's education has a strong inverse relationship to child obesity. Compared to the reference category of less than 9th grade, the odds of the child's obesity decrease from 0.66 (CI: 0.49, 0.90) for children of high school graduate mothers to only 0.46 (CI: 0.32, 0.66) for children of college graduate mothers. Higher household income and having a married mother are both associated with lower obesity, though these are significant only at the $p < 0.10$ level. Overall, the odds ratios for the sociodemographic variables are in the expected directions; lower child obesity is associated with socioeconomic advantage.

Both the child's birth weight and the mother's pre-pregnancy BMI are strong predictors of the child's obesity at kindergarten (Classen and Hokayem 2005; Salsberry and Reagan 2005; Weden et al. Forthcoming). Low birth weight children have lower odds of obesity (OR 0.66, CI: 0.53, 0.81) and high birth weight children have higher odds of obesity (OR 1.74, CI: 1.44, 2.10). A one unit increase in maternal pre-pregnancy BMI is associated with a 7% increase in the odds of child obesity (OR 1.07, CI: 1.06, 1.09). The other statistically significant control variable is number of siblings; each additional sibling is associated with a 21% reduction in the odds of obesity in kindergarten (OR 0.79, CI: 0.74, 0.84). Finally, the odds of obesity in kindergarten are overall higher in the ECLS-B than in the ECLS-K (OR: 1.49, CI: 1.28, 1.73).

For comparison, this same model is also estimated separately on the ECLS-B observations and on ECLS-K observations in model 1 with imputed pre-pregnancy BMI (see second and third sets of columns in Table 3). The main results are similar between the two surveys. Compared to COIs with low English proficient mothers, both CONBs and COIs with high English proficient mothers have much lower odds of being obese in kindergarten. However, the sampling variability about these odds ratios in the single-survey estimates is larger than in the pooled-survey estimates, reducing our ability to draw statistically reliable conclusions. In the ECLS-B, the odds ratio is statistically significantly different from 1 only in the comparison between CONBs and COIs with low English proficient mothers (OR: 0.71, CI: 0.52, 0.97). In comparing COIs whose mothers have high versus low English proficiency, the point estimate for the odds ratio is unchanged from that in the pooled-survey estimate (OR 0.71), but the 95% confidence interval is now too wide (0.41 to 1.21) to be considered statistically different from 1. The increase in variability about the odds ratio in the single-survey estimate over that in the pooled-survey estimate is less in the ECLS-K than in the ECLS-B, consistent with the much larger ECLS-K sample size in the kindergarten wave (12,050 children, versus 5,550 in the ECLS-B).

Substantively, the contrast between the obesity of COIs with low English proficient mothers and the obesity of CONBs is greater for the ECLS-K sample (OR 0.52, CI: 0.39, 0.70) than for the ECLS-B sample (OR 0.71, CI: 0.52, 0.97). However, there is a high degree of overlap in their confidence intervals. In addition, the main result is that in both surveys the odds of obesity in kindergarten are much lower for CONBs than for COIs with low English proficient mothers after controlling for their mothers' lower education and for their greater likelihood of being Hispanic, among other variables predicting higher child obesity. This result of higher obesity among the U.S. born children of the least acculturated mothers is again opposite to that predicted by the immigrant epidemiological paradox.

Still comparing the separate estimates of the ECLS-B and ECLS-K samples, the odds ratios for the control variables are all in the same directions of difference from 1 between the two surveys, though with variations in statistical significance and different non-statistically significant findings for the two least prevalent racial/ethnic groups (Native American Hawaiian/ Pacific Islander and multi-race children). The odds ratios for Hispanic and black children are lower (and not statistically different from 1) in the ECLS-K as compared to in the ECLS-B, and the inverse educational gradient is also less steep in the ECLS-K than in the ECLS-B. These differences in the magnitudes of ORs between the ECLS-B and ECLS-K model estimates, however, do not change our main substantive findings. Therefore we argue that the separate estimates of the model from the ECLS-B and ECLS-K are best interpreted as replicating our study's main findings across two independent samples.

The final comparison presented in Table 3 is between ECLS-K model 1, which uses the full model including multiply imputed maternal pre-pregnancy BMI, and the ECLS-K model 2 which omits this variable (see the rightmost set of columns). We find that controlling for differences in pre-pregnancy BMI increases the obesity contrasts between COIs with low English proficient mothers and CONBs, and within COIs, between those with low and high maternal English proficiency. Indeed, the contrast between low English COIs and high English COIs is only significant at the 0.10 level (OR 0.73, CI 0.53, 1.01) when pre-pregnancy BMI is omitted from the model, but is significant at the 0.05 level (OR 0.70, CI 0.50, 0.97) after accounting for pre-pregnancy BMI. In results not reported here, we found a similar direction of change in the odds ratios in the ECLS-B sample alone when omitting the pre-pregnancy BMI variable from the model. Overall, then, we find evidence of protection afforded to COIs from lower exposure to high maternal pre-pregnancy BMI, but this is not sufficient to counter the major obesity disadvantages of COIs relative to CONBs.

Omitting pre-pregnancy BMI from the models also changes the odds ratios for race/ethnicity. In the ECLS-K model without the pre-pregnancy BMI variable, the odds ratios for Hispanic and for black children increase (though still not to statistical significance in these single-survey estimates). This finding is expected given the higher BMI of Hispanic and black women (Flegal et al. 2010), and again demonstrates the utility of our methodology for including pre-pregnancy BMI in our study's main, pooled-survey estimates.

[TABLE 4 ABOUT HERE]

Next, we compare the above results for our preferred maternal nativity and acculturation specification with those from two alternate specifications (see Table 4). The first measures maternal acculturation by age at arrival in the U.S., with those arriving when aged 13 or older (the "1.0" generation) as the less acculturated reference category and those arriving when aged less than 13 (the "1.5" generation) as the more acculturated immigrant group. In our pooled-survey estimate, we again find that the prevalence of obesity of CONBs is significantly lower than for the children of the less acculturated immigrant mothers, now represented by the "1.0 generation": CONBs' odds of obesity are only 0.69 as high (CI: 0.55, 0.87) as for children of 1.0 generation mothers. However, we do not now find a statistically significant difference in COIs' odds of obesity by mother's acculturation: children of 1.5 generation mothers do not differ statistically from those of the children of 1.0 generation mothers. CONBs, however, have statistically significantly lower odds of obesity than the children of the more acculturated maternal group, the 1.5 generation (p=0.02, not shown). Both the AIC and BIC model fit statistics worsen (get larger) when substituting mother's age at arrival for mother's English language proficiency as the measure of acculturation (see appendix table A1). We therefore conclude that English proficiency better captures the consequences of maternal acculturation for children's obesity than maternal age at arrival in the U.S. And again, these relationships are in a direction opposite to that predicted by the immigrant epidemiological paradox: COIs with less acculturated mothers have the highest obesity after controlling for socioeconomic, pre-natal, and birth-outcome differences.

In a second alternative specification, we include nativity but no acculturation variable (neither English proficiency nor age at arrival in the U.S.). In our pooled-survey estimate, we find that CONBs have odds of obesity that are only 0.72 (CI: 0.59, 0.88) those of COIs after controlling for the full set of sociodemographic and maternal pre-pregnancy and child birth weight variables shown in Table 4. This estimate provides our simplest and most direct contradiction of the application of the immigrant epidemiological paradox to second-generation children's early-childhood obesity. This model, however, fits the data less well than does either of the models that include maternal acculturation variables in addition to maternal nativity (see appendix table A1). In summary, our pooled-survey estimates of the associations of maternal nativity and acculturation on kindergarteners' obesity provide evidence opposite to predictions from the immigrant epidemiological paradox in both its simple form and in its extended form wherein the greatest immigrant health benefits are hypothesized to be enjoyed by the children of the least acculturated immigrants.

In Table 4, we also present for comparison these same alternate specifications of nativity and acculturation estimated in equations separately for the ECLS-B and the ECLS-K observations. The sampling variability about these odds ratios is again larger than in the pooled-survey estimates, and especially so for the ECLS-B. Even though the point estimates for the ECLS-B odds ratios puts CONBs at substantially lower risk of obesity than either children of the 1.0 generation or of all COIs, in both cases the 95% CIs around those odds ratios include 1. In the ECLS-B, only the 0.71 odds ratio for the ECLS-B CONBs' obesity relative to that for children with low English proficient mothers is statistically significantly different from 1 at the 0.05 level (CI: 0.52, 0.97). In the ECLS-K, however, the obesity odds ratios for CONBs are significantly less than 1 in both the alternate acculturation specification in which children of the 1.0 generation are used as the reference group and in the specification that ignores acculturation and uses all COIs as the reference group. These alternate specifications of maternal nativity and acculturation estimated separately in the ECLS-B and ECLS-K therefore provide further evidence against the immigrant epidemiological paradox, replicated across the two surveys, even while not as strongly as in our best specification of maternal nativity and acculturation.

DISCUSSION

In the present study, we evaluated the immigrant epidemiological paradox's application to "new" second-generation children by examining the relationships of mother's nativity and acculturation to early-childhood obesity in recent cohorts of children. We applied an innovative pooled-survey estimator with cross-survey multiple imputation to two nationally-representative longitudinal surveys with measured (not parent-reported) child weight and height, and with questions to identify maternal country of birth, age at arrival, and English proficiency. These data allowed us to overcome limitations of alternate data sources, including difficulty identifying second-generation children, error in parental reports of their children's height and weight, omission of maternal pre-pregnancy weight status, and non-national sampling frames. The pooled-survey estimation method allowed us to overcome the limitations in single-survey analyses of small sample sizes with which to distinguish children of immigrants from children of U.S. born parents and with which to distinguish between immigrant mothers by their acculturation level, and to do so with models that include a fuller set of key predictor variables for early-childhood obesity.

Our findings respective to early childhood obesity were opposite to the predictions of the immigrant epidemiological paradox. We found that U.S. born children whose mothers were also U.S. born (CONBs) were significantly less likely to be obese in kindergarten than were U.S. born children of first-generation immigrant mothers (COIs), both before and after controlling for socioeconomic, prenatal, and birth circumstances. Moreover, we found that the biggest obesity contrast was that between CONBs and the U.S. born children of the least acculturated immigrant mothers. Depending on whether maternal English proficiency or maternal age at arrival was used as the acculturation indicator, the obesity outcomes of the children of more acculturated mothers were either more similar to those of CONBs (when mother's high English proficiency was the marker of greater acculturation) or more similar to those of the children of less acculturated mothers (when mother's younger age at arrival in the U.S. was the marker of greater acculturation). Given that English proficiency is counted among the direct measures of acculturation whereas duration in the country is a considered to be a proxy only (Lopez-Class, Castro, and Ramirez 2011), the greater sensitivity of child's obesity to maternal English language proficiency is unsurprising. The finding that the health outcomes of children of more acculturated mothers falls somewhere between the health outcomes of children of the least acculturated mothers and of the children of U.S. born mothers, moreover, is consistent with the general character of the immigrant epidemiological paradox hypothesis. The direction of association that we found, however, is opposite to that of the paradox. Whereas the epidemiological paradox describes the children of the least acculturated mothers as enjoying the greatest health advantages when taking into account their socioeconomic disadvantages, we found instead that less acculturation was associated with more early-childhood obesity both before and after accounting for these disadvantages.

The immigrant epidemiological paradox was first proposed to account for the surprisingly good birth and perinatal health of immigrants, especially among those with lower acculturation. Substantial evidence exists to suggest that both better birth outcomes and better childhood health accrue to COIs, including lower prevalence of asthma, allergies, and learning disabilities (Hamilton et al. 2011; Mendoza 2009; National Research Council 1999; Padilla et al. 2009). However, a growing body of research, including the findings presented here, suggests that this health advantage does not extend to child obesity. The immigrant vulnerability hypothesis, first developed by Van Hook and Baker (2010), offers an alternative framework to examine the health of COIs. This theory focuses attention on both the lower resources available in immigrant families and on the disadvantages of low-income country orientations concerning children's appropriate body size, diet, and of unfamiliarity with the obesogenic character of many American meals. It proposes that early socialization in a society where under-nutrition has posed more of a serious health concern than over-nutrition becomes a potential risk factor for children's obesity. The findings of our study provide stronger support for this immigrant vulnerability hypothesis than those of Van Hook and Baker (2010) and other previous studies due to our having replicated our findings across two nationally-representative surveys, our having tested the robustness of our findings to alternate specifications of nativity/acculturation, and by our having obtained more precise estimates of our findings by pooling observations across the two surveys. Results consistent with the key prediction of the vulnerability hypothesis --- that the direction of difference between COIs and CONBs' obesity will be opposite to that predicted by the immigrant epidemiological paradox --- were found across all specifications and in both the single-survey and pooled-survey estimates.

According to the immigrant epidemiological paradox, limited English language proficiency and other characteristics of lesser acculturation result in isolation from the negative health environment in the U.S., and thereby contribute to better health among less acculturated immigrants and their children. We argue that, with respect to child obesity, any such advantages are very limited, and instead there are strong disadvantages either coincident with or directly caused by linguistic isolation among less acculturated mothers. These include lower maternal education (Allensworth 1997), higher poverty (Borjas 2011), and less access to high quality health care (Acevedo-Garcia and Stone 2008; Leclere et al. 1994; Yin et al. 2009). Advantages of mother's linguistic isolation are offset by children's greater exposure to the U.S. environment through American schools, U.S. born peers, and English language media (Portes and Rumbaut 2001). For example, English language acquisition among limited English proficient children changes rapidly as they enter American schools (Kindler 2002) and often outpaces the proficiency of their immigrant parents (Portes and Rumbaut 2001). Qualitative research on Latino mothers has found that these mothers often consider school environments to be responsible for their children's unhealthy, "American" food preferences (Himmelgreen et al. 2007). Immigrant mothers with lower English proficiency may experience more difficulty helping their more acculturated children navigate the U.S. environment. Additionally, lower

English proficiency may prevent immigrant mothers from receiving beneficial messages concerning child obesity from health practitioners and other sources. Obesity is a highly publicized health concern in the U.S. (Ogden et al. 2010) and past research attributes immigrant mothers' changing child weight preferences to exposure to this message (Rosas et al. 2010).

An additional contribution of our study is its having taken into account the known strong positive intergenerational correlations of obesity. This is an important issue because, as we and previous studies have shown (Goel et al. 2004; Park et al. 2009), first-generation immigrant women tend to have a healthier weight status than U.S. born women. We indeed found that the children of foreign born mothers were more likely to experience protection from child obesity due to mother's lower pre-pregnancy BMI. However, this advantage was not sufficient for immigrant mothers to be able to transmit their healthier body weight to their U.S. born children. We again suggest that this may be due to a disconnect between the role of nativity and acculturation in shaping mothers' health and health behaviors and the role of these same forces in shaping the likelihood of obesity in their children. In addition to the barriers of limited maternal English proficiency as discussed immediately above, the stronger traditional cultural orientations among less acculturated mothers that are protective in the first year of life, including breastfeeding and lower exposure to smoking and drug use in the prenatal period, may give way to less healthful cultural orientations to nutrition and potential overfeeding in early-childhood.

COIs represent a racially and ethnically diverse group, and research examining differences between immigrants and natives and between immigrants who differ by level of acculturation have stressed the importance of examining this phenomenon within specific racial/ethnic groups or by specific country of origin (Portes and Rumbaut 2001; Waters and Jimenez 2005; Zsembik and Fennell 2005). In our descriptive table we noted that the low English foreign born mothers are predominantly Hispanic, accounting for almost four-fifths of all low-English mothers, whereas white, black, and to a lesser extent Asian foreign born mothers are more likely to be highly proficient in English. Segmented assimilation theory posits that racial/ethnic differences among immigrants and their children may represent a barrier to successful integration and assimilation (Portes and Rumbaut 2001; Portes and Zhou 1993). Hispanics may represent one group particularly susceptible to racialization and a poorer assimilation trajectory with worse socioeconomic status and potentially worse health and health behaviors (Frank, Cerda, and Rendon 2007). Conversely, past research on Asian-American children has found especially low odds of overweight and obesity for this group compared to other racial/ethnic groups (Anderson and Whitaker 2009; Singh et al. 2009). This represents a potential source of bias in our regression estimates if the relationship between mother's English proficiency and child obesity in kindergarten is largely due to the different racial/ethnic composition by mother's English proficiency. To explore this possibility we ran additional regressions interacting mother's nativity/acculturation and mother's race/ethnicity (model fit statistics are presented in appendix table A2 and explained in greater detail in the appendix). We found that including interactions between mother's race/ethnicity and nativity/acculturation, either for Hispanics alone or across all ethnic groups, resulted in a worse model fit. Therefore even with the large combined sample size of the ECLS-K and ECLS-B surveys and with the oversampling of Asian children in the ECLS-B, we did not find evidence that the effect of maternal acculturation/nativity differs by race/ethnicity. This mirrors findings of an immigrant epidemiological paradox for other health behaviors and outcomes that are consistent across racial/ethnic groups and countries of origin (Frisbie et al. 2007; Goel et al. 2004; Landale et al. 2000; Lara et al. 2005; Macmillan et al. 2011; Park et al. 2009; Salant and Lauderdale 2003). We conclude that maternal nativity represents a distinct additional risk factor to be considered when speculating about the future prospects of American children.

Limitations

Although this study amasses substantial evidence demonstrating that not only is low maternal English language proficiency associated with obesity among COIs, but also that it is a better indicator of obesity risk than maternal generation or nativity alone, the data and approach we used are not without their limitations. First, although we cited other research indicating that immigrant mothers' cultural orientations were towards preferring heavier children or perceiving heavier children as healthier, unfortunately there are no direct measures of cultural orientations in either survey used in our study. Future research may shed light on this possibility by examining whether and which foreign-born mothers are more likely to rate their obese or overweight children as healthier compared to U.S. born mothers, and whether greater English language proficiency maps to a greater likelihood of associating child obesity with poor health.

A second explanation we proposed was that immigrant mothers may be less familiar with American grocery stores and foods and have difficulty adjusting to their children's more American preferences. Young children with low English proficient parents may have limited early exposure to the English language, but this changes rapidly as children enter kindergarten and progress to higher grades (Kindler 2002). As such, entrance into kindergarten may represent a pivotal time period to examine the health of children of immigrants and the extent that low maternal acculturation changes from a protective factor to a risk factor for children's health. Prior to kindergarten, COIs with low English proficient mothers are likely to have less exposure to the potentially deleterious health effects of English language media or English-speaking U.S.

born peers. Although we speculate that the difficulty of low English proficient immigrant mothers to monitor and influence their American children's diet may emerge when their children enter kindergarten and are exposed to U.S. peers and preferences through schools, future research might profitably address at what ages COIs become more susceptible to obesity compared to CONBs. For our purposes, however, the kindergarten year was the only period in common between the two surveys, and therefore we were unable to apply the advantages of our pooled-survey approach to other ages.

The two cohorts, both separately and together, provide large and nationally-representative samples of all U.S. kindergarteners and of COI kindergarteners in particular. They include measured child height and weight, and they include predictor variables defined similarly between the two surveys. Nevertheless, there are also potential concerns with the data. First, there was notable attrition in both surveys. In the ECLS-B about a third of the sample was lost by the kindergarten wave and in the ECLS-K we had to discard 16.5% of the sample because the questions on the birth places of the child and the mother were not asked until the spring of first grade. We attempted to overcome these limitations by employing weights that correct for survey attrition.

Second, English proficiency was self-assessed and was done so at different child ages between the ECLS-B and ECLS-K. Previous research has found some biases in self-assessment of immigrants' English proficiency (Akresh and Frank 2011; Ayers 2010). Moreover, mothers' proficiency in English is expected to improve with time in the country, and this is a potential source of difference in the effect of English proficiency on obesity between the two surveys --- the ECLS-K's low English proficient mothers being a potentially more selected group given their English level was asked at their child's kindergarten assessment, whereas the ECLS-B's mothers were asked at their child's 9 month assessment. The greater selectivity of low English proficient mothers in the ECLS-K than in the ECLS-B may be in part responsible for the stronger magnitude of obesity contrast estimated between their children and CONBs in the ECLS-K than in the ECLS-B, although we note that confidence intervals about the odds ratios in all cases overlapped substantially between surveys.

A third data limitation was that mothers in the ECLS-B were asked to retrospectively report their pre-pregnancy weight, and that this was not asked at all of mothers in the ECLS-K. Pre-pregnancy weight reporting may be subject to recall bias and to other biases that make it less reliable than measured weight. However, the maternal pre-pregnancy BMI measure we calculated from these retrospective reports was still highly predictive of their child's obesity in kindergarten and differences in prevalence by acculturation are what one would expect given past research.

A fourth limitation of our study is that the children in the ECLS-B are more likely to be obese overall than they are in the ECLS-K. Patterns of relationships of the predictor variables to obesity between the two surveys, however, are very similar. Our statistical comparisons of model fit when including interactions between survey and the covariates were overall supportive of our pooled-estimation strategy that assumes sampling from a common social process in the two surveys.

A final important limitation of our study is that it compares immigrant generations and their level of acculturation in cross-section only. In analyses of other immigrant outcomes by generation including schooling (Smith 2003) and fertility (Parrado and Morgan 2008), findings that compare immigrant generations that are the descendant cohorts often do not align with cross-sectional comparisons of different generations. An important extension of the present research would therefore be to evaluate the applicability of the immigrant epidemiological paradox to obesity of successive generations of immigrants to the U.S. Following this logic, evaluations of the consequences of acculturation that followed the same mothers as they bore children over a period of increasing acculturation to the U.S. would provide an especially useful extension to the present study's contrasts between cross-sections of more and less acculturated immigrant mothers.

In summary, using two different data sets both separately and in pooled analyses, we identified children of low English proficient immigrant mothers as being particularly vulnerable to the development of obesity in early-childhood. This has adverse implications both in terms of overall minority ethnic disadvantage in the U.S. and in terms of the current and future overall inequality in the health and development of U.S. children and their success as adults. Child health, and more specifically obesity, has been linked to lower academic achievement (Crosnoe 2006), lower rates of college attendance (Crosnoe 2007; Glass et al. 2010), disadvantages in the job market (Finkelstein et al. 2005; Pagan and Davila 1997), and to social stigma extending more broadly (Carr and Friedman 2005). This research suggests that obesity may be an especially important barrier for the successful assimilation of the new second-generation. Given the size and growth of the second-generation, failure to address nativity and acculturation differences in the development of obesity beginning in early childhood may not only widen health disparities in the future, but also economic and social inequalities in the American population.

APPENDIX

We present in this appendix the results of our model fit procedures that evaluate the comparability of the ECLS-B and ECLS-K observations and hence suitability for pooled estimation. We note first that a frequently-used epidemiological method for effectively pooling data across studies is that of meta-analysis (Rao et al. 2008). That method combines a limited set of moments across studies, but does not incorporate the full covariance structure of each data source as we do here. Various methods have been developed for estimation from microdata pooled across two surveys possibly including deviations from the assumption of sampling from exactly the same universe (Hellerstein and Imbens 1999; Schenker, Raghunathan, and Bondarenko 2009). We follow the penalized model-fit based approach developed specifically for cross-survey multiple imputation by Rendall et al. (2011). The model-fit evaluations are based on variables in common between the two surveys, and therefore in the present application are for the regression model specification that excludes pre-pregnancy BMI. Recall that this variable is available only in the ECLS-B.

[APPENDIX TABLE A1 ABOUT HERE]

Our first set of procedures to address survey differences between the ECLS-B and ECLS-K entailed the comparisons of the univariate distributions of the outcome and predictor variables between the two surveys as shown in Tables 1 and 2. We noted in describing those results that obesity prevalence was consistently higher in the ECLS-B. This higher obesity prevalence in the ECLS-B than in the ECLS-K in kindergarten accords with Anderson and Whitaker's (2009) finding of high obesity prevalence in the ECLS-B pre-school wave relative to Ogden et al's (2008) obesity prevalence estimates using the "gold standard" NHANES in which children's height and weight are assessed by medical professionals. Anderson and Whitaker speculated that the younger average age of the NHANES group (age 2-5), combined with different clothing protocols in the measurement of weight, might account for the lower obesity prevalence in the NHANES. We conducted a more rigorous comparison between the ECLS-B and microdata from the NHANES, in which we were able to match age and period more closely between the ECLS-B and NHANES. We also compared the ECLS-K, whose weight and height measurement protocols were similar to those of the ECLS-B, with NHANES microdata. Results are shown in Table A2. We found that the ECLS-B kindergarten obesity prevalence was significantly and substantially higher than that in the NHANES (17% in ECLS-B versus 12.1% in NHANES 2005-2005, age 4 to 6), whereas the ECLS-K obesity prevalence was very close to that for the NHANES (11.5% in ECLS-K versus 11.4% in NHANES 1999-2000, age 4 to 6). This leads us to conclude that the ECLS-B obesity prevalence in kindergarten is upwardly biased. Given the strength of the ECLS-B's height and weight measurement protocols, and the close similarity of these protocols between the ECLS-B and ECLS-K, the most likely reason for the higher obesity in the ECLS-B is differential attrition of children with lower obesity. One question is whether this differential attrition is on observed variables included in our regression model or on variables not included in our regression model (and possibly unobserved in the ECLS-B). A second important issue is whether such differential attrition leads to bias in the estimated relationships between our included regressor variables and the obesity outcome variable. Our approach to answering these questions was to pool observations across the ECLS-B and ECLS-K and to investigate model-fit improvement when successively including an "ECLS-B" intercept shift variable only, and when including both the ECLS-B intercept shift variable and a complete set of interaction variables for ECLS-B and each predictor variable.

[APPENDIX TABLE A2 ABOUT HERE]

According to the AIC and BIC model fit statistics presented in Table A2, the best fitting pooled-survey regression specification is that shown in the first column of Table 1, identical to that estimated on the ECLS-B alone except for the addition of a survey indicator variable that captures the higher overall obesity prevalence in the ECLS-B that was not produced by differences in distributions in the observed variables in the model. Moreover, not only in our preferred specification of maternal nativity and acculturation, but in the two alternate specifications of nativity and acculturation, we determined that model fit was typically improved by including an intercept shift coefficient for “ECLS-B.”

Crucially, however, we found that the fit was not further improved with model specifications that included interactions between the survey indicator variable and all other covariates. The magnitude of the results varied somewhat across specifications of maternal nativity and acculturation, but in all cases the AIC and BIC statistic resulted in a worsening of model fit when the survey interactions were included. We thus conclude that the ECLS-B and ECLS-K are samples drawn from the same social process relating socioeconomic, demographic, and biological predictor variables to obesity in kindergarten. A pooled analysis is therefore appropriate.

In addition to examining differences across survey we also examined whether the effect of maternal nativity acculturation differed by race/ethnicity. In order to assess this possibility two additional specifications were included, one interacting black, Hispanic, and Asian with maternal acculturation (model 4), and one interacting only Hispanic with maternal acculturation (model 5). In both models and across the measures of maternal acculturation and nativity, including these interactions did not improve model fit according to both the AIC and BIC statistics. This indicates that on the basis of the data available in the ECLS-B and ECLS-K we cannot conclude that the effect of maternal nativity and acculturation operates differently across the racial/ethnic groups examined.

The last two sets of columns in the appendix table also assess racial/ethnic variation in the effect of maternal acculturation and nativity separately for the ECLS-K and the ECLS-B. For the ECLS-K, including the interactions for Black, Hispanic, and Asians, and separately for Hispanics alone, did not improve model fit according to both the AIC and BIC statistic across all specifications of maternal acculturation and nativity. However, in ECLS-B, including the interactions between black, Hispanic, and Asians, and for Hispanics alone resulted in improved model fit as indicated by the AIC. Coefficient-by-coefficient, the regression results indicate that COIs with Asian mothers were less likely, and COIs with Hispanic mothers were more likely, to experience obesity compared to COIs with non-Hispanic white mothers. However, the effect of mother's nativity/acculturation was not statistically different between the other racial/ethnic groups (results not shown). Additionally, while the AIC indicated that the interactions resulted in a better model fit, the BIC statistics indicated a model without interactions was a better fit for the patterns found in the data.

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Table 1. Weighted Percentages and Means for Study Variables from Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K) 1998, Spring Kindergarten Wave[1]

	Children of Immigrants (COIs)					Children of Native Borns (CONBs)	Total
	Low English	High English	Gen. 1.0	Gen. 1.5	Total		
Child obese (BMI% >=95)	19.9	13.0	17.9	15.5	17.2	10.5	11.5
	p<0.001		p=0.288			p<0.001	
Mother's nativity by English proficiency							
Low English COIs	---	---	74.5	28.0	61.5	---	9.1
High English COIs	---	---	25.5	72.0	38.5	---	5.7
CONBs	---	---	---	---	---	---	85.2
Mother's generation status[2]							
Generation 1.0	87.2	47.6	---	---	72.0	---	10.7
Generation 1.5	12.8	52.4	---	---	28.0	---	4.1
CONBs	---	---	---	---	---	---	85.2
Mother's race/ethnicity							
White	6.6	31.5	11.1	29.1	16.2	75.4	66.6
Hispanic	77.4	35.8	65.2	51.7	61.4	7.6	15.5
Black	1.2	13.5	5.5	7.0	5.9	14.1	12.9
Asian	13.4	15.0	16.0	8.9	14.0	0.5	2.5
Native American[3]	---	---	---	---	---	---	1.2
Hawaiian/Pacific Islander[3]	1.2	2.8	1.8	2.1	1.8	0.4	0.6
More than one race[3]	---	---	---	---	---	---	0.6
	p<0.001		p<0.001			p<0.001	
Mother's education							
Less than 9th grade	30.8	4.7	26.5	5.9	20.8	1.0	3.9
9th-12th grade	16.3	8.1	13.3	12.8	13.1	7.2	8.1
High school/GED	28.0	22.3	24.5	29.1	25.8	31.5	30.6
Some college	14.0	34.8	17.5	33.6	22.0	34.9	33.0
Bachelor's degree	8.2	19.2	12.9	11.1	12.4	17.1	16.4
At least some graduate school	2.7	10.9	5.2	7.5	5.9	8.4	8.0
	p<0.001		p<0.001			p<0.001	
Log household income	10.01	10.66	10.17	10.50	10.26	10.66	10.60
	p<0.001		p<0.001			p<0.001	
Mother's marital status							
Never married	13.5	9.8	11.7	13.0	12.1	12.8	12.7
Married	78.0	75.4	78.4	73.2	77.0	73.7	74.2
Formerly married	8.5	14.8	9.8	13.8	10.9	13.5	13.1
	p<0.001		p=0.124			p=0.049	

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Table 1 (continued). Weighted Percentages and Means for Study Variables from ECLS-K, Spring Kindergarten Wave

	Children of Immigrants (COIs)					Children of Native Borns (CONBs)	Total
	Low English	High English	Gen 1.0	Gen 1.5	Total		
Birth weight							
Low	4.8	9.0	5.6	8.5	6.4	7.1	7.0
Average	83.8	79.9	82.9	80.7	82.3	80.9	81.1
High	11.4	11.1	11.5	10.8	11.3	12.0	11.9
	p=0.009		p=0.093			p=0.436	
Mother's age at birth (years)	27.7	29.1	28.6	27.3	28.2	27.7	27.8
	p<0.001		p<0.001			p=0.027	
Singleton	97.9	97.3	97.8	97.4	97.7	97.6	97.6
	p=0.608		p=0.728			p=0.886	
Child's age (months)	73.6	73.9	73.5	74.2	73.7	74.9	74.7
	p=0.294		p=0.003			p<0.001	
Female	47.6	49.6	48.1	49.3	48.4	48.8	48.8
	p=0.438		p=0.689			p=0.789	
Siblings	1.73	1.48	1.68	1.52	1.64	1.44	1.47
	p<0.001		p=0.010			p<0.001	
Observations[4]	1,220	780	1,460	540	2,000	10,040	12,050

[1] Tests of statistical significance are reported for contrasts between high English proficiency foreign born and low English proficiency foreign born, generation 1.0 and generation 1.5, and foreign born and U.S. born; they adjust for stratification and clustering in the sample designs.

[2] Generation 1.0 is defined as arriving in the U.S. at age 13 or older and generation 1.5 is defined as arriving in the U.S. prior to age 13.

[3] Some cells are left intentionally blank to comply with NCES disclosure guidelines.

[4] Observations are rounded to the nearest 50 to comply with NCES disclosure guidelines.

All percentages and means are weighted using ECLS-K and ECLS-B sample weights.

Table 2. Weighted Percentages and Means for Study Variables from Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) 2001, Kindergarten Waves[1]

	Children of Immigrants (COIs)					Children of Native Borns (CONBs)	Total
	Low English	High English	Gen 1.0	Gen 1.5	Total		
Child obese (BMI% >=95)	28.2	15.4	24.9	21.8	24.2	15.1	17.0
	p=0.004		p=0.47			p<0.001	
Mother's nativity by English proficiency							
Low English COIs	---	---	80.8	27.4	68.5	---	13.7
High English COIs	---	---	19.2	72.6	31.5	---	6.3
CONBs	---	---	---	---	---	---	80.0
Mother's generation status[2]							
Generation 1.0	90.8	46.9	---	---	77.0	---	15.4
Generation 1.5	9.2	53.1	---	---	23.0	---	4.6
CONBs	---	---	---	---	---	---	80.0
Mother's race/ethnicity							
White	6.4	22.0	10.5	14.1	11.3	69.2	57.6
Hispanic	79.8	42.3	68.5	66.2	68.0	11.2	22.5
Black	3.2	13.4	6.1	7.2	6.4	16.0	14.1
Asian	10.5	21.0	14.4	11.6	13.8	0.5	3.2
Native American[2]	---	---	---	---	---	---	0.7
Hawaiian/Pacific Islander[2]	---	---	---	---	---	---	0.1
More than one race[2]	---	---	---	---	---	---	1.8
	p<0.001		p=0.28			p<0.001	
Mother's education							
Less than 9th grade	23.4	2.6	19.4	8.2	16.9	0.9	4.1
9th-12th grade	18.0	7.1	14.2	15.8	14.6	8.9	10.0
High school/GED	33.9	19.6	30.7	25.0	29.4	27.1	27.6
Some college	14.7	36.2	16.7	37.5	21.5	33.7	31.3
Bachelor	5.3	19.8	10.4	8.2	9.9	17.8	16.2
At least some graduate school	4.7	14.7	8.6	5.4	7.8	11.5	10.8
	p<0.001		p<0.001			p<0.001	
Log household income	10.03	10.75	10.22	10.40	10.26	10.53	10.47
	p<0.001		p=0.013			p<0.001	
Mother's marital status							
Never married	21.9	11.9	16.5	26.5	18.8	19.7	19.5
Married	68.7	76.2	72.8	65.1	71.0	68.9	69.3
Formerly married	9.4	11.9	10.7	8.4	10.2	11.4	11.2
	p=0.007		p=0.096			p=0.547	

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Table 2 (continued). Weighted Percentages and Means for Study Variables from ECLS-B 2001, Kindergarten Waves

	Children of Immigrants (COIs)					Children of Native Borns (CONBs)	Total
	Low English	High English	Gen 1.0	Gen 1.5	Total		
Birth weight							
Low	5.5	9.4	6.3	8.2	6.7	7.6	7.4
Average	86.3	85.5	86.5	84.5	86.1	82.4	83.1
High	8.2	5.2	7.2	7.3	7.2	10.0	9.5
	p=0.044		p=0.606			p=0.041	
Mother's age at birth (years)	28.0	27.9	28.8	24.9	27.9	27.2	27.4
	p=0.87		p<0.001			p=0.023	
Singleton	98.0	1.0	1.0	1.0	1.0	1.0	96.9
	p=0.849		p=0.728			p=0.886	
Child's age (months)	67.5	68.0	67.6	67.8	67.6	68.3	68.1
	p=0.268		p=0.74			p=0.003	
Female	47.1	49.4	47.7	48.1	47.8	50.0	49.5
	p=0.61		p=0.93			p=0.282	
Siblings	1.62	1.30	1.55	1.42	1.52	1.49	1.50
	p<0.001		p=0.115			p=0.65	
Mother's pre-pregnancy BMI	24.5	24.0	24.1	24.9	24.3	25.1	25.0
	p=0.22		p=0.14			p=0.001	
Observations[4]	850	550	1,100	300	1,400	4,150	5,550

[1] Tests of statistical significance are reported for contrasts between high English proficiency foreign born and low English proficiency foreign born, generation 1.0 and generation 1.5, and foreign born and U.S. born; they adjust for stratification and clustering in the sample designs.

[2] Generation 1.0 is defined as arriving in the U.S. at age 13 or older and generation 1.5 is defined as arriving in the U.S. prior to age 13.

[3] Some cells are left intentionally blank to comply with NCES disclosure guidelines.

[4] Observations are rounded to the nearest 50 to comply with NCES disclosure guidelines.

All percentages and means are weighted using ECLS-B sample weights.

Table 3. Logistic Regression Models Predicting Obesity (BMI% >=95) among Kindergarteners using Data from the Early Childhood Longitudinal Study, 1998 Kindergarten Cohort (ECLS-K) and 2001 Birth Cohort (ECLS-B) by Hispanic Ethnicity, Odds Ratios (OR) and 95% Confidence Intervals (CI)

	Hispanic						Non-Hispanic[1]						All children					
	Model 1			Model 2			Model 1			Model 2			Model 1			Model 2		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
Mother's nativity by English proficiency																		
Low English Children of Immigrants (COIs)																		
High English COIs	0.65	(0.43,	0.99)	0.62	(0.41,	0.94)	0.95	(0.61,	1.47)	0.86	(0.55,	1.35)	0.75	(0.56,	1.01)	0.71	(0.53,	0.95)
Children of Native Borns (CONBs)	0.71	(0.53,	0.96)	0.61	(0.45,	0.83)	0.83	(0.53,	1.31)	0.70	(0.44,	1.12)	0.72	(0.58,	0.90)	0.62	(0.50,	0.78)
race/ethnicity																		
(White)																		
Hispanic	---	---	---	---	---	---	---	---	---	---	---	---	1.55	(1.28,	1.87)	1.39	(1.14,	1.70)
Black	---	---	---	---	---	---	1.44	(1.18,	1.76)	1.26	(1.03,	1.53)	1.40	(1.15,	1.69)	1.22	(1.00,	1.49)
Asian	---	---	---	---	---	---	0.99	(0.67,	1.46)	1.06	(0.72,	1.57)	0.94	(0.69,	1.27)	1.02	(0.75,	1.38)
Native American	---	---	---	---	---	---	1.44	(1.04,	2.00)	1.32	(0.95,	1.84)	1.41	(1.02,	1.95)	1.31	(0.94,	1.82)
Hawaiian/Pacific Islander	---	---	---	---	---	---	1.40	(0.85,	2.30)	1.30	(0.76,	2.20)	1.38	(0.86,	2.24)	1.24	(0.74,	2.06)
More than one race	---	---	---	---	---	---	1.59	(0.89,	2.83)	1.47	(0.81,	2.64)	1.56	(0.88,	2.79)	1.45	(0.80,	2.63)
Mother's education																		
(Less than 9th grade)																		
9th-12th grade	0.77	(0.49,	1.21)	0.73	(0.46,	1.15)	0.79	(0.41,	1.53)	0.79	(0.41,	1.53)	0.73	(0.52,	1.03)	0.73	(0.51,	1.03)
High school/GED	0.65	(0.45,	0.94)	0.67	(0.46,	0.97)	0.72	(0.38,	1.37)	0.71	(0.37,	1.35)	0.66	(0.49,	0.89)	0.66	(0.49,	0.90)
Some college	0.65	(0.42,	1.01)	0.66	(0.42,	1.03)	0.71	(0.38,	1.36)	0.68	(0.36,	1.30)	0.66	(0.49,	0.90)	0.64	(0.47,	0.88)
Bachelor's	0.59	(0.31,	1.10)	0.63	(0.32,	1.23)	0.46	(0.24,	0.89)	0.48	(0.25,	0.93)	0.43	(0.31,	0.61)	0.46	(0.32,	0.66)
Some grad. school	0.38	(0.16,	0.91)	0.45	(0.19,	1.07)	0.48	(0.24,	0.96)	0.52	(0.25,	1.05)	0.43	(0.29,	0.65)	0.48	(0.31,	0.72)
income	0.95	(0.82,	1.09)	0.97	(0.84,	1.12)	0.89	(0.82,	0.97)	0.92	(0.84,	1.00)	0.91	(0.84,	0.97)	0.94	(0.87,	1.01)

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Table 3 (continued). Logistic Regression Models Predicting Obesity (BMI% >=95) among Kindergarteners using Data from the Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K) and Birth Cohort (ECLS-B), Odds ratios (OR) and 95% Confidence Intervals (CI)

	Hispanic				Non-Hispanic[1]				All children			
	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
status												
(Never married)												
Married	0.73	(0.52, 1.03)	0.72	(0.51, 1.02)	0.94	(0.74, 1.19)	0.91	(0.72, 1.16)	0.84	(0.69, 1.03)	0.82	(0.67, 1.01)
Formerly married	0.98	(0.64, 1.48)	0.98	(0.64, 1.49)	0.92	(0.70, 1.21)	0.92	(0.70, 1.21)	0.91	(0.73, 1.14)	0.91	(0.73, 1.13)
Birth weight												
Low	0.63	(0.38, 1.02)	0.64	(0.38, 1.05)	0.66	(0.52, 0.83)	0.66	(0.52, 0.83)	0.65	(0.53, 0.80)	0.66	(0.53, 0.81)
(Average)												
High	2.64	(1.85, 3.76)	2.42	(1.68, 3.48)	1.84	(1.50, 2.26)	1.55	(1.25, 1.93)	2.01	(1.68, 2.40)	1.74	(1.44, 2.10)
Mother's age at birth	1.02	(1.00, 1.04)	1.01	(0.99, 1.03)	1.01	(1.00, 1.03)	1.00	(0.99, 1.02)	1.02	(1.01, 1.03)	1.01	(1.00, 1.02)
Singleton	1.07	(0.58, 1.98)	1.13	(0.58, 2.19)	1.10	(0.78, 1.55)	1.20	(0.85, 1.71)	1.09	(0.81, 1.48)	1.19	(0.87, 1.63)
Child is Female	0.77	(0.61, 0.98)	0.78	(0.61, 1.00)	1.05	(0.91, 1.20)	1.02	(0.89, 1.17)	0.96	(0.86, 1.08)	0.95	(0.85, 1.07)
Child's age	0.98	(0.95, 1.00)	0.97	(0.94, 1.00)	1.01	(0.99, 1.02)	1.01	(0.99, 1.02)	1.00	(0.98, 1.01)	1.00	(0.98, 1.01)
Number of Siblings	0.86	(0.75, 0.98)	0.84	(0.74, 0.97)	0.78	(0.73, 0.83)	0.76	(0.72, 0.82)	0.80	(0.76, 0.85)	0.79	(0.74, 0.84)
Maternal pre-pregnancy BMI[2]	---	--- ---	1.07	(1.04, 1.09)	---	--- ---	1.07	(1.06, 1.09)	---	--- ---	1.07	(1.06, 1.09)
Survey sample control												
ECLS-B (vs. ECLS-K)	1.61	(1.21, 2.14)	1.61	(1.21, 2.15)	1.47	(1.24, 1.76)	1.45	(1.21, 1.73)	1.51	(1.30, 1.75)	1.49	(1.28, 1.73)
Observations[3]	3,100				14,500				17,600			

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

1 Includes white, black, Asian, Native American, Hawaiian/Pacific Islander, and multi-racial who indicated that they were not Hispanic.

2 Mother's pre-pregnancy BMI is calculated from reported height and weight for the ECLS-B sample and is imputed for the ECLS-K sample.

3 All observations are rounded to comply with NCES disclosure guidelines.

All regressions are weighted using ECLS-K and ECLS-B normalized sample weights; confidence interval estimates adjust for stratification and clustering in the sample designs.

Table 4. Alternative Maternal Nativity and Acculturation Specifications for Logistic Regression Models Predicting Obesity (BMI% >=95) among Kindergarteners using Data from the Early Childhood Longitudinal Study, 1998 Kindergarten Cohort (ECLS-K) and 2001 Birth Cohort (ECLS-B), Odds Ratios (OR) and 95% Confidence Intervals (CI)[1]

	Hispanic				Non-Hispanic				All Children			
	Model 1		Model 2[2]		Model 1		Model 2[2]		Model 1		Model 2[2]	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Mother's nativity by English proficiency												
Low English Children of Immigrants (COIs)												
High English COIs	0.65	(0.43, 0.99)	0.62	(0.41, 0.94)	0.95	(0.61, 1.47)	0.86	(0.55, 1.35)	0.75	(0.56, 1.01)	0.71	(0.53, 0.95)
Children of Native Borns (CONBs)	0.71	(0.53, 0.96)	0.61	(0.45, 0.83)	0.83	(0.53, 1.31)	0.70	(0.44, 1.12)	0.72	(0.58, 0.90)	0.62	(0.50, 0.78)
Mother's Generation Status[3]												
(Generation 1.0)												
Generation 1.5	0.99	(0.69, 1.43)	0.90	(0.62, 1.29)	1.00	(0.60, 1.68)	0.91	(0.54, 1.52)	0.97	(0.72, 1.32)	0.87	(0.64, 1.17)
CONBs	0.80	(0.58, 1.09)	0.67	(0.48, 0.92)	0.86	(0.58, 1.28)	0.74	(0.50, 1.11)	0.81	(0.64, 1.01)	0.66	(0.52, 0.82)
Mother's Nativity												
(COIs)												
CONBs	0.80	(0.60, 1.05)	0.69	(0.52, 0.92)	0.86	(0.62, 1.20)	0.77	(0.55, 1.07)	0.81	(0.69, 0.96)	0.68	(0.56, 0.83)
Observations[4]	3,100				14,500				17,600			

[1] All models control for race/ethnicity, mother's education, log of household income, mother's marital status, mother's age at birth, child's age, gender, birth weight, number of siblings, and singleton status.

[2] Model 2 adds mother's pre-pregnancy BMI, which is calculated from reported height and weight for ECLS-B and is imputed for ECLS-K.

[3] Generation 1.0 is defined as arriving in the U.S. at age 13 or older, and generation 1.5 is defined as arriving in the U.S. prior to age 13.

[4] All observations are rounded to comply with NCES disclosure guidelines.

All regressions are weighted using ECLS-K and ECLS-B normalized sample weights; confidence interval estimates adjust for stratification and clustering in the sample designs.

Table A1. Percentage Obese in the Early Childhood Longitudinal Study, 1998 Kindergarten Cohort (ECLS-K) and 2001 Birth Cohort (ECLS-B), and National Health and Nutrition Survey (NHANES) 1999-2000 and 2005-2008

	Observations	Obesity	95% CI	
ECLS-K 1998, Spring Kindergarten[1]	12,050	11.5	(10.7,	12.2)
NHANES 1999-2000, Age 4-6	497	11.4	(7.6,	15.2)
ECLS-B 2006-7, Kindergarten[2]	5,550	17.0	(15.6,	18.4)
NHANES 2005-8, Age 4-6	1,217	12.1	(9.4,	14.7)

[1] Observations are rounded to the nearest 10 to comply with NCES disclosure guidelines.

[2] Observations are rounded to the nearest 50 to comply with NCES disclosure guidelines.

All percentages are weighted using ECLS-K, ECLS-B, and NHANES sample weights; confidence interval estimates adjust for stratification and clustering in the sample designs.

Table A2. AIC and BIC Model Fit Statistics for Multivariate Logistic Regressions Predicting Obesity (BMI% >=95) among Kindergartners using Pooled Data from the Early Childhood Longitudinal Study, 1998 Kindergarten Cohort (ECLS-K) and 2001 Birth Cohort (ECLS-B)

	Pooled					ECLS-K			ECLS-B		
	Model 1[1]	Model 2[2]	Model 3[3]	Model 4[4]	Model 5[5]	Model 1[1]	Model 2[4]	Model 3[5]	Model 1[1]	Model 2[4]	Model 3[5]
Mother's nativity by English proficiency											
AIC	10,742.3	10,702.8*	10,716.8	10,705.5	10,704.9	5,881.4*	5,895.2	5,884.1	4,654.8	4,648.3*	4,654.8
BIC	10,791.9	10,754.7*	10,818.0	10,770.9	10,761.2	5,927.3*	5,961.8	5,934.1	4,694.6*	4,702.1	4,698.1
Mother's generation status											
AIC	10,748.0	10,708.0*	10,722.4	10,716.7	10,711.6	5,884.5*	5,894.3	5,885.7	4,657.9	4,655.0*	4,656.5
BIC	10,797.6	10,759.9*	10,823.7	10,782.0	10,768.0	5,930.3*	5,960.9	5,935.7	4,697.7*	4,708.7	4,699.8
Mother's nativity alone											
AIC	10,746.1	10,706.0*	10,720.1	10,710.8	10,707.7	5,882.6*	5,889.6	5,884.4	4,656.4	4,652.3*	4,655.6
BIC	10,793.5	10,755.7*	10,819.2	10,767.1	10,759.6	5,926.4*	5,945.8	5,930.2	4,694.5*	4,699.4	4,695.4

* Indicates the best-fitting model of the variations for the respective pooled-survey or individual-survey specifications; smaller AIC or BIC indicates better model fit.

[1] Model controls for race/ethnicity, mother's education, log of household income, mother's marital status, mother's age at birth, child's age, gender, birth weight, number of siblings, and singleton status.

[2] Model adds a survey sample control variable (ECLS-K vs. ECLS-B) to model 1.

[3] Model adds interactions between all study variables and the survey indicator to model 2.

[4] Model adds interactions between mother's nativity/acculturation and black, Hispanic, and Asian to model 2 for pooled-survey specification and to model 1 for single-survey specifications.

[5] Model adds interactions between mother's nativity/acculturation and Hispanic to model 2 for pooled-survey specification and to model 1 for single-survey specifications.

All regressions are weighted using ECLS-K and ECLS-B normalized sample weights and adjust for stratification and clustering in the sample designs.

Table A3. Logistic Regression Models Predicting Obesity (BMI% >=95) among Kindergarteners using Data from the Early Childhood Longitudinal Study, 1998 Kindergarten Cohort (ECLS-K), Odds Ratios (OR) and 95% Confidence Intervals (CI)

	Hispanic		Non-Hispanic		All Children	
	OR	95% CI	OR	95% CI	OR	95% CI
Mother's nativity by English proficiency						
Low English Children of Immigrants						
High English COIs	0.61	(0.38, 0.97)	0.65	(0.37, 1.16)	0.70	(0.50, 0.97)
Children of Native Borns (CONBs)	0.55	(0.39, 0.78)	0.44	(0.24, 0.80)	0.52	(0.39, 0.70)
Mother's race/ethnicity						
(White)						
Hispanic	---	--- ---	---	--- ---	1.12	(0.89, 1.40)
Black	---	--- ---	1.03	(0.81, 1.30)	1.06	(0.84, 1.33)
Asian	---	--- ---	0.89	(0.53, 1.47)	1.02	(0.71, 1.47)
Native American	---	--- ---	1.29	(0.87, 1.91)	1.33	(0.90, 1.97)
Hawaiian/Pacific Islander	---	--- ---	0.93	(0.54, 1.59)	0.97	(0.58, 1.61)
More than one race	---	--- ---	0.80	(0.36, 1.80)	0.85	(0.37, 1.92)
Mother's education						
(Less than 9th grade)						
9th-12th grade	0.95	(0.57, 1.56)	0.86	(0.39, 1.88)	0.96	(0.66, 1.40)
High school/GED	0.88	(0.58, 1.36)	0.73	(0.30, 1.77)	0.85	(0.57, 1.25)
Some college	0.87	(0.54, 1.40)	0.70	(0.30, 1.63)	0.81	(0.56, 1.18)
Bachelor's	0.73	(0.37, 1.45)	0.48	(0.21, 1.10)	0.55	(0.36, 0.84)
At least some graduate school	0.67	(0.16, 2.78)	0.49	(0.20, 1.18)	0.56	(0.35, 0.88)
Log household income	1.07	(0.90, 1.27)	0.93	(0.86, 1.01)	0.97	(0.90, 1.04)
Mother's marital status						
(Never married)						
Married	0.77	(0.51, 1.17)	0.81	(0.63, 1.05)	0.80	(0.64, 0.99)
Formerly married	0.84	(0.47, 1.49)	0.88	(0.65, 1.20)	0.88	(0.67, 1.15)
Birth weight						
Low	0.73	(0.41, 1.30)	0.72	(0.53, 1.00)	0.73	(0.55, 0.99)
(Average)						
High	1.99	(1.33, 2.98)	1.66	(1.36, 2.02)	1.71	(1.44, 2.03)
Mother's age at birth	1.02	(0.99, 1.04)	1.01	(0.99, 1.02)	1.01	(1.00, 1.02)
Singleton	0.71	(0.25, 1.98)	1.53	(0.73, 3.20)	1.34	(0.73, 2.47)
Female	0.74	(0.56, 0.96)	1.05	(0.91, 1.21)	0.98	(0.86, 1.11)
Child's age	1.01	(0.97, 1.05)	1.00	(0.98, 1.02)	1.00	(0.99, 1.02)
Number of Siblings	0.86	(0.76, 0.98)	0.80	(0.75, 0.85)	0.82	(0.77, 0.87)
Maternal pre-pregnancy body mass index[1]	1.05	(1.02, 1.09)	1.06	(1.04, 1.08)	1.06	(1.04, 1.07)
Observations[2]	1,870		10,180		12,050	

[1] Maternal pre-pregnancy BMI is imputed from ECLS-B.

[2] All observations are rounded to comply with NCES disclosure guidelines.

All regressions are weighted using normalized sample weights; confidence interval estimates adjust for stratification and clustering in the sample designs.

Table A4. Logistic Regression Models Predicting Obesity (BMI% >=95) among Kindergarteners using Data from the Early Childhood Longitudinal Study, 2001 Birth Cohort (ECLS-B), Odds Ratios (OR) and 95% Confidence Intervals (CI)

	Hispanic		Non-Hispanic		All Children	
	OR	95% CI	OR	95% CI	OR	95% CI
Mother's nativity by English proficiency						
(COIs)						
High English COIs	0.63	(0.31, 1.25)	1.10	(0.53, 2.28)	0.71	(0.41, 1.21)
Children of Native Borns (CONBs)	0.64	(0.41, 0.99)	1.19	(0.61, 2.31)	0.71	(0.52, 0.97)
Mother's race/ethnicity						
(White)						
Hispanic	---	--- ---	---	--- ---	1.75	(1.26, 2.43)
Black	---	--- ---	1.62	(1.14, 2.32)	1.47	(1.05, 2.05)
Asian	---	--- ---	1.34	(0.76, 2.36)	1.01	(0.66, 1.55)
Native American	---	--- ---	1.29	(0.74, 2.24)	1.21	(0.71, 2.07)
Hawaiian/Pacific Islander	---	--- ---	4.11	(1.21, 7.87)	3.28	(0.96, 11.2)
More than one race	---	--- ---	1.83	(0.84, 4.00)	1.80	(0.82, 3.95)
Mother's education						
(Less than 9th grade)						
9th-12th grade	0.58	(0.29, 1.17)	0.72	(0.19, 2.79)	0.53	(0.29, 0.96)
High school/GED	0.54	(0.30, 0.96)	0.69	(0.23, 2.11)	0.50	(0.31, 0.81)
Some college	0.54	(0.26, 1.13)	0.67	(0.21, 2.20)	0.50	(0.30, 0.83)
Bachelor's	0.55	(0.18, 1.67)	0.50	(0.15, 1.68)	0.39	(0.21, 0.73)
At least some graduate school	0.38	(0.12, 1.20)	0.56	(0.16, 1.99)	0.41	(0.21, 0.80)
Log household income	0.82	(0.63, 1.07)	0.91	(0.76, 1.08)	0.89	(0.76, 1.03)
Mother's marital status						
(Never married)						
Married	0.73	(0.43, 1.23)	1.10	(0.71, 1.69)	0.89	(0.64, 1.23)
Formerly married	1.14	(0.65, 2.00)	1.00	(0.60, 1.67)	0.98	(0.68, 1.41)
Birth weight						
Low	0.56	(0.26, 1.24)	0.58	(0.42, 0.81)	0.58	(0.42, 0.79)
(Average)						
High	3.16	(1.73, 5.77)	1.42	(0.92, 2.20)	1.81	(1.28, 2.56)
Mother's age at birth	1.00	(0.97, 1.04)	1.00	(0.98, 1.03)	1.01	(0.98, 1.03)
Singleton	1.70	(0.72, 3.99)	1.00	(0.73, 1.36)	1.08	(0.80, 1.45)
Female	0.81	(0.54, 1.23)	0.98	(0.75, 1.29)	0.99	(0.87, 1.12)
Child's age	0.94	(0.90, 0.99)	1.01	(0.98, 1.04)	1.00	(0.99, 1.02)
Number of Siblings	0.82	(0.65, 1.03)	0.72	(0.64, 0.80)	0.82	(0.78, 0.87)
Maternal pre-pregnancy body mass index	1.08	(1.05, 1.12)	1.09	(1.06, 1.12)	1.09	(1.06, 1.11)
Observations[1]	1,250		4,300		5,550	

[1]All observations are rounded to comply with NCES disclosure guidelines.

All regressions are weighted using normalized sample weights; confidence interval estimates adjust for stratification and clustering in the sample designs.