Two Worlds of Obesity: Ethnic Differences in Child Overweight/Obesity Prevalence and Trajectories

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What is already known about this subject'

- Child overweight and obesity is a significant public health problem.
- Understanding trends in obesity is important because the prevalence of risk factors increases with severity of childhood obesity.
- Obesity and extreme obesity during early childhood are likely to continue into adulthood.
- Trends in overweight/obesity over time among children from ethnic minority groups do not follow those of white children.

'What this study adds' (up to three short bullet points for each)

- The prevalence of overweight and obesity differed for Hispanic and non-Hispanic white children and was higher for Hispanic children.
- The trajectory analyses clearly indicate Hispanic children begin heavier and continue to be overweight/obese throughout childhood period in this study.
- The two methods, descriptive statistics and mixed-model analyses to examine variables related to variations in weight status provided similar results and strengthen the conclusion of significant ethnic disparities..

ABSTRACT

BACKGROUND: Research on childhood obesity has examined the prevalence of overweight and obesity during childhood and developmental trajectories.

OJECTIVES: The study focuses on variations by time, gender, grade level, and school setting in the prevalence of overweight/obesity in elementary school children and trajectories in weight status for Hispanic and non-Hispanic white students in one community.

METHODS BMI values were examined both using standard scores (z-scores) and as categorical variables. Cross-sectional data from four years were used to examine prevalence, and panel data across two-year periods examined trajectories. Descriptive statistics and mixed models, controlling for school setting, were used.

CONCLUSION:
Hispanic students began first grade with higher prevalence of obesity and overweight and the differences were larger in higher grades and later years. The majority of students had stable weight status over the two period of the trajectory analysis, but Hispanic students began the panel with higher BMI-Z values, were more likely to increase and less likely to decrease BMI-Z. The findings suggest that the degree of childhood overweight/obesity, especially among Hispanics, is substantial and will likely have profound impacts on adult obesity and other associated health issues in the future. Findings confirm the need for early childhood interventions to influence BMI.

Introduction

Childhood overweight and obesity continue to be a major concern and focus of public health efforts in the United States. Overweight and obesity in childhood and adulthood are complex conditions that can develop from the interaction of genetic, metabolic, social, behavioral and cultural factors (Niclasen et al. 2006, Huang et al., 2009). The health risks of overweight and obesity in childhood include early onset of Type II diabetes, asthma, obstructive sleep apnea, cardiac structure and function and psychological distress (Koopman and Mertens 2014, Li et al. 2003, Shankran et al. 2011). Additionally, childhood obesity may track into adulthood (Baker et al.2007, Han et al. 2010, Santorelli et. al. 2013). In one of the largest studies of its kind, Cunningham, et al. (2014) found that obesity in adults could be traced back to weight at as early an age as pre-K, much earlier than had been previously thought. Recently a number of research themes have emerged in the childhood obesity domain. Two of these are relevant to the topic of this paper: 1) the prevalence of overweight and obesity during childhood and 2) the developmental trajectories of overweight/obesity during childhood.

Early studies on obesity prevalence suggested that the prevalence of obesity among children could reach 30% by 2030 (Wang et al. 2008). In 2010, more than one third of children and adolescents were overweight or obese and estimates of childhood obesity in the United States tend to be higher than in other countries (Ogden et al. 2012). Although significant increases occurred in obesity prevalence for children and adolescents during the 1980s and 1990s, recently there have been reports of stabilization and in some cases declines in prevalence

(CDC 2011; Gee 2013; Ogden et al. 2012). Ultimately, trend analyses suggest the rapid increases in obesity prevalence seen in the 1980s and 1990s did not continue in later decades.

While the report of a decline is encouraging, this decline may not be seen across all sub-groups of the population. For instance, Ogden et al (2012) indicate increases in obesity prevalence may be occurring among males and a more recent study by Ogden et al. (2014) indicates the most recent trends between 2003 and 2012 show child obesity prevalence remains high. Additionally, a recent study in Pennsylvania of BMI transition patterns indicated that although overweight and obesity prevalence leveled off in their sample, extreme high obesity, especially among elementary students was projected to increase substantially over time (Lohrman et al. 2014) and Skinner and Skelton suggest there is an upward trend of more severe forms of obesity (2014). Furthermore, trends in overweight/obesity over time among children from low income families as well as children from ethnic minority groups do not follow those of white children (Freedman et al 2005, Karlsen 2013, Reed 2013, Taveras et al. 2013, Weeden 2013). Examining such variations in the prevalence of childhood overweight and obesity is a key element of our paper.

While national surveys provide insight into overall childhood obesity trends and disparities, they do not identify patterns specific to individual states or communities. A growing number of researchers suggest school-based surveillance may be useful for identifying geographic disparities within states as well as for understanding and reducing the risk of childhood obesity (CDC 2011; Chomitz et al., 2003; Kolbo 2012; Madsen, 2011; McMurty & Jelian, 2010; Nihiser et al., 2009; Raczynski; Richmond 2014; Soto & White, 2010; West et al., 2008). Indeed, recent work in Texas strongly illustrates the importance of state and local surveys of child obesity, especially at regional levels, to "monitor the effects of local prevention efforts as well as to inform and provide evidence to decision makers, and to support policy and environmental change at the state and local level" (Hoelscher et al. 2010: 1367). Such community based analyses are no doubt particularly important when studying Hispanic populations given the large diversity within this ethnic group in national origin, socio-economic status, time in the United States, and other factors (Lopez, Gonzalez-Barrera, & Cuddington, 2013; Saenz, 2010).

A second research theme, closely related to BMI prevalence, focuses on the developmental trajectories of overweight during childhood and adolescence. Such life-course approaches offer valuable insights into heterogeneity in weight gain over the life course and subsequent consequences for related chronic diseases (Chen & Brogan 2012, Hoekstra et al 2011, Østbye et al. 2011). Additionally, information about the timing of weight gain may be helpful for the development of effective interventions (Balisteri and Van Hook 2011). A number of recent studies focusing on BMI change from childhood to adolescence or adolescence to adulthood highlight the importance of understanding growth trajectories (Chen & Brogan 2012, Hoekstra et al 2011, Lohrmann et al. 2014, Nonnemaker et al 2009, Østbye et al. 2011, Potter and Ulijasek 2013, Reilly et al 2011, Rzehak and Heinrich 2006).

Fewer studies have focused on BMI growth trajectories solely during childhood (Balesteri and Von Hook 2011, Lane et al. 2012, Li et al. 2007, Magee et al. 2012, YoussefAga et al. 2013), although they have all identified three or four developmental patterns. For instance, Li *et al.* (2012) tracked a sample of children from ages 2 to 12 years and using latent class analysis identified 3 trajectories, representing early onset (10.9%), late onset (5.2%) and never overweight. Pryor et al. (2011) identified three trajectories low stable, moderate and high rising. Their analysis indicated children continuing on an elevated BMI trajectory leading to obesity in middle childhood could be distinguished from children on a normative BMI trajectory as early as age 3.5 years. Following a sample of Australian children from age 4-5 through age 10-11, Magee et al (2012) identified four distinct developmental trajectories of raw BMI values: High Risk, Early Onset Overweight, Later Onset Overweight and Healthy BMI. Balesteri and Van Hook (2011) modeled prevalence of overweight and obesity in the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K) from K to 8th grade using semiparametric mixture (SPMM) models. They identified three trajectories: normal (~55%), overweight+ (~25%), and gradual onset (~20%). Similarly, Lane et al. (2012) though focusing on psychosocial factors, such as parenting style and maternal depression, used growth mixture models to identify distinct subtypes of BMI development. They identified three prototypic trajectories of BMI percentile growth: elevated, steady increase, and stable. Finally, Carter et al. using longitudinal BMI Z-score data from a sample of children aged 4 through 10 years of age identified four weight trajectory groups: low-increasing; low-medium, accelerating; medium-high increasing; and high-stable.

The studies of developmental trajectories have often noted that some groups are more at risk than others. For instance, Li et al (2012) determined that early onset overweight was more likely in males, African Americans, those with heavier mothers, those whose mothers had higher pregnancy weight gain, and those with higher birth weight. Balestreri and Van Hook (2011) found some evidence that the relationship between socioeconomic status and children's health may operate differently across gender. They also found Hispanic boys, black girls and children of immigrant parents who have had less exposure to the US were more likely to experience early and sustained overweight throughout elementary and middle school. This was particularly common for boys. Carter et al. found living in a semi-urban area was inversely related to weight in the low-increasing and medium-high trajectory groups while living in a rural area was positively related to weight in the high-stable group. Additionally, other important risk factors for the high-stable weight group included obesity status of the mother, smoking during pregnancy, and overeating behaviors. Magee et al. (2012) found that socio-demographic factors such as parent overweight/obesity, education, and smoking, and childbirth weight were significantly related with these trajectories. They propose their results suggest there may be some commonalities in BMI/obesity trajectories in different samples of children and that interventions could be tailored specifically towards these at-risk trajectories.

This paper adds to the literature by looking at variations in the prevalence of obesity and overweight and BMI growth trajectories of elementary aged Hispanic and Non-Hispanic White students over a three year period in a medium sized western city with a substantial minority of Hispanics with Mexican and Central American origins. Our first research question focuses on the prevalence of overweight and obesity in this sample, examining the extent to which changes in prevalence over time vary by ethnicity, gender, grade level, and school setting. Our second research question focuses on developmental trajectories. Using a sub-sample of the total group, we look at variations in individual students' BMI growth trajectories over a two-year period and factors related to these variations. We examine the extent to which our conclusions are replicated with different measures of obesity and overweight (categorical versus continuous measurements) and different types of analyses (a trend analysis, comparing aggregate data across grades versus growth trajectories of individual students). We contrast our results with those obtained with national samples and describe the implications of our work, especially for those concerned with developing effective interventions for local and regional communities and understanding variations in BMI growth trajectories by ethnicity.

Methods

Participants

The sample for the analysis included students in grades 1, 3, and 5 from 18 schools in two school districts in western Oregon. The districts are part of the same metropolitan area and separated by only a few miles. Several schools within one district were omitted from the analysis because of a lack of data. Two schools were omitted because there was very little data available, one school was omitted because it did not have individual-level data on race-ethnicity, and data for one year for one school were omitted because data for that year were only available for one grade. There is no indication that these schools differed from others in the sample in the key variables in the analysis.

Summary information about the schools' socio-demographic characteristics was obtained from the Oregon Department of Education and is given in Table 1. It indicates substantial variation in the sample. For instance, the schools ranged in size from less than 100 to over 700 students, with an average of 382. The largest schools had more grade levels, and there was less variation in the number of students per grade. There was also substantial variation in the percentage of Hispanics in the schools and the percentage of students receiving free or reduced lunch (FRL), our proxy measure of school-level SES. The schools ranged from having about 2 percent to over 30 percent of their students being of Hispanic heritage (mean = 18.3%). The percentage receiving free or reduced lunch varied from 26 to 83 percent, with an average of 56. The percentage receiving FRL and the percentage of Hispanic students were essentially collinear ($r = .94$).

Students with ethnicities other than Hispanic or non-Hispanic white, such as Asian-American, American Indian, or African American comprised only seven percent of the total available student population and were omitted from the sample to provide a more homogeneous population for comparisons by ethnicity. The sample was approximately evenly divided between boys and girls.

Procedure

Students' height and weight were measured at the start of each school year from 2005 through 2008. The 2005 data were obtained through a request for baseline county data made by the county Health Department and a local child health and obesity coalition. A letter from these organizations was sent to all school districts in the county. Administrators or staffs (primarily school nurses) who were interested in participating sent data from their health screening to one of the researchers for analysis. Some schools were interested in continuing to receive analysis from their screenings and voluntarily supplied the information to the researcher during the 2006-2007 through the 2008-2009 periods. Each school was responsible for its own data collection and no attempt was made to standardize collection procedures or demographic categories (e.g. ethnicity) throughout the district. The 2008-2009 data in one of the districts was collected by one of the researchers as part of a separate NIH project focusing on child obesity in that district. Student IDs were not included in the material sent from the schools for analysis and project ID numbers were assigned to each child, ensuring student confidentiality. Data included gender, ethnicity, date of screening, birth date, grade level (not specific class), height and weight. All of the data were entered into the EPI Info NutStat (2000) program for calculation of BMI values. This study was determined to be exempt by the Committee on the Protection of Human Subjects at the researchers' university.

Data Analysis

Data on each student's height, weight, gender, and age were used to calculate their Body Mass Index. For this analysis, the BMI values were translated into standard scores (z-scores), which provide a measure of children's weight relative to the national means for their age and sex. In the description below these are referred to as BMI-Z values. Extreme outliers (BMI-Z values greater than or equal to |3.0|) were omitted from the analysis. This involved less than one percent of the cases. The use of z-scores was important in allowing comparisons across grade levels and over time (Must and Anderson 2006).

We also examined students' weight status as a categorical variable. In the cross-sectional analysis of prevalence, with a relatively larger sample size, three categories (normal or underweight, overweight, and obese) were examined. Due to the small number of underweight children, they were included in the normal category. For the analysis of panel data, which followed students over time and had a smaller sample, BMI-Z values were classified into a simple dichotomy (overweight or obese=1, other=0). Results were substantively identical when the three categories were used. As shown in Table 1, there was substantial variability in average BMI-Z values and weight status across schools in the sample, indicating the importance of including a school level measure in the analysis.

To examine changes in the prevalence of obesity and overweight over time and variations in these changes by gender, ethnicity, grade and setting (the first research question), we calculated simple descriptive statistics on weight status by grade (grades 1, 3, and 5), gender, and time (2005 through 2008) for each ethnic group (Hispanic and non-Hispanic white). We then used a multivariate, mixed model analysis, regressing students' weight status on each of these independent measures. School was entered as a random effect and the percentage of free and reduced lunch was used as a school level explanatory variable to control for the context of school poverty. A series of models was examined, focusing on the independent effect of each independent measure and all possible two-way interaction effects. Preliminary analyses indicated that there were a number of significant interactions between ethnicity and the other independent variables. To simplify the presentation of results analyses were conducted separately within each ethnic group and the resulting regression coefficients for the two groups were compared. The analysis was conducted with both the BMI-Z values and the categorical measure of weight status as dependent measures, using the STATA programs xtmixed and xtmelogit. To conserve space, only the results for the continuous measure and the most parsimonious explanatory models are given below. Results with the categorical dependent measure and with other models were substantively identical.

Our analysis of BMI trajectories over time focused on a subsample of students for whom data were available across two time periods: from grade 1 to grade 3 and from grade 3 to grade 5. Using information on students' birth date, gender, ethnicity, and school we developed unique identifiers for each student and matched data for an earlier year (2005 or 2006) with that for two years later (2007 or 2008). Data for multiple years were available for 11 of the 18 schools in the sample used to analyze the first research question regarding prevalence; and we were able to match about half of the students. Of the 583 students in first grade in 2005 or 2006, 288 (49.4%) had data for third grade in 2007 or 2008. Of the 399 students in third grade in these schools in 2005 or 2006, 222 (55.6%) had data for fifth grade in 2007 or 2008. This sub-sample did not differ significantly from the larger group in BMI-Z values at any of the times of assessment. Paralleling our analysis of prevalence, we first calculated descriptive statistics and then used mixed-models to examine variables related to variations in weight status.

Results

Changing Prevalence (Research Question One)

Table 2 gives descriptive results regarding the prevalence of overweight and obesity and its relationship to students' characteristics. It shows the percentage of students in each weight category and the average BMI-Z values by year, grade, and gender for non-Hispanic whites and Hispanic students. The first panel of data gives results for the total group and indicates that Hispanic students were much more likely than the non-Hispanic white students to be overweight or obese and to have higher average BMI-Z values. Across all three grades and four years in the analysis a little more than one-third of the non-Hispanic white students were overweight or obese, in comparison to over half of the Hispanic students. The average BMI-Z value was .61 for the non-Hispanic white students and 1.01 for the Hispanic students. (For the difference in BMI-Z values, $t=11.75$, $df = 6447$, $p<.0001$; Cohen's $d = .37$; for the differences between the three weight categories, chi-square ($df=2$) = 148.84, $p<.0001$.)

The remaining panels of Table 2 report data on average BMI-Z values and the prevalence of obesity and overweight for the four years of data, the three grades in the analysis and for males and females within each ethnic group. The results indicate that the differences between the ethnic groups were larger in the last year of data collection, in the highest grade, and for males rather than females. In short, the cross-sectional descriptive results in Table 2 indicate that the Hispanic students had a substantially higher prevalence of obesity and overweight and higher average BMI-Z values than the non-Hispanic white students. Moreover, this gap became larger over the four years in the analysis and was more pronounced in the higher grades.

Table 3 reports the results of the mixed model analyses, in which BMI-Z values were regressed on year, grade, sex, and the school level measure of poverty (FRL). Results for non-

Hispanic white students are in the three columns on the left, and those for Hispanic students are in the three middle columns. The two columns at the right present results of testing the hypothesis that the regression coefficients for Hispanic and non-Hispanic students are equal. As noted above, a number of models that included interaction effects were tested, as were models that used the categorical measure of weight status as the dependent measure. None of the interaction effects (e.g. grade and sex) were significant; and substantively identical results were obtained when the categorical variable of weight status was used. To save space, these results are not included, but are available upon request from the authors.

The results in Table 3 confirm the interpretation of the descriptive results in Table 2. For both ethnic groups BMI-Z values were lower for females than for males. However, with the exception of the proxy measure of school poverty (FRL), all of the coefficients for the Hispanic sample were larger than those for the non-Hispanic white group. In addition, while BMI-Z values increased over time for the Hispanic students, they declined slightly for the last two years for non-Hispanic whites. The differences in the coefficients associated with the last year of data collection and the two higher grades were statistically significant. In other words, the mixed models confirm the conclusion that the Hispanic students had a higher prevalence in obesity and overweight than the non-Hispanic white students and that this difference was larger in the later years of data collection and the higher grades. The school context of poverty had no significant influence on BMI-Z values for either group.

Trajectories (Research Question No. 2)

As noted above, panel data were available for 288 students from grade 1 to grade 3 and for 222 students from grade 3 to grade 5. Table 4 gives descriptive statistics for non-Hispanic white and Hispanic students in this panel sample for students from grades 1 to 3, and Table 5 gives results for the panel sample for students from grades 3 to 5. The first sections of the tables report statistics of weight status operationalized as a categorical variable, the second sections report average BMI-Z values, and the third sections group the students into four trajectories of change over time.

The results from the two panel samples were very similar. First, paralleling the results with the cross-sectional analyses, there were large differences between the two ethnic groups in weight status in the starting grades, with half or more of the Hispanic students, but only about one-third of the non-Hispanic white students, initially classified as overweight or obese. Second, there was substantial stability in weight status over time. Of the students who had a normal weight status at the starting grade (1 or 3), three quarters or more had this status two years later (at grade 3 or 5). Similarly the vast majority of students who were overweight or obese at the earlier grade were also in this category at the higher grade. Third, however, when changes appeared, the patterns were strikingly different for students in the two ethnic groups, again paralleling results obtained in the cross-sectional analysis. Only one of the Hispanic students in either of the two panels moved from the overweight and obese category to the normal group, but about one-fourth of the non-Hispanic white students did so. The non-Hispanic white students were also less likely than the Hispanic students to move from the normal category to obese or overweight.

The analyses of the BMI-Z values support this conclusion. Average BMI-Z values declined over time for the non-Hispanic students, but increased substantially for the Hispanic students. As a result, the difference in BMI-Z values between the Hispanic and non-Hispanic students was substantially larger at the end of the two year period, increasing by close to a third of a standard deviation. At the starting point of the analysis the Hispanic students had higher average BMI-Z values and higher rates of obesity and overweight than the non-Hispanic white students, and this discrepancy was even greater two years later.

Table 6 gives the results of the mixed model analyses for the panel sample, where the BMI-Z scores at the end of the period (third grade for the grade 1 to grade 3 panel and fifth grade for the grade 3 to grade 5 panel) were regressed on initial BMI-Z score, ethnicity, and the school level measure of poverty (percentage of students receiving free and reduced lunch). Again, as with the cross-sectional analysis, none of the interaction effects were significant and the results with the continuous and dichotomous dependent variables were substantively identical. The results confirm those shown in the descriptive analyses. For both panel groups, students' BMI-Z score at the beginning of the period was the strongest predictor of their BMI-Z score two years later. However, the increase over time was significantly greater for the Hispanic students. At the end of the panel period the BMI values of the Hispanic students were predicted to be over .4 of a standard deviation higher than those of non-Hispanic white students who had identical BMI-Z values at the start of the period.

Discussion

In this study, using both descriptive and multivariate analyses of data from a western Oregon community, we found substantial differences between non-Hispanic white and Hispanic elementary students. The prevalence of overweight (18%) and obesity (21%) among the elementary non-Hispanic white school children in the sample was higher than would be expected by the established norms, but this prevalence did not substantially change over the four-year period of the study.. The prevalence of both overweight and obesity was substantially higher for the Hispanic children. The ethnic difference was large at first grade and then increased over time.Although recently decreases in the prevalence of obesity have been reported in some populations of youth in the United States (CDC 2013; Wen et al. 2012), the stability in our non-Hispanic white sample is consistent with some recent literature that point to no significant changes in obesity prevalence in youth (Bailey-Davis 2012, Ogden et al 2014; Skinner and Skelton 2014, Wang et al 2011). The increasing prevalence among the Hispanic students is consistent with other studies (Martinson et al 2012; Rundle et al 2012; Shuster et al 2012; Traveras et al 2013, Wang 2011).

The data showing that overall rates of overweight and obesity remain high, and ethnic disparities seem to be widening are important. The elimination of health disparities has been a national priority for years, but as seen in our study, as well as previous research, disparities in child overweight and obesity by race/ethnicity have not improved over the past decade but has, at least for this population, worsened. These findings suggest that the degree of childhood overweight/obesity, especially among Hispanics, is substantial and will likely have profound impact on adult obesity and other associated health issues in the future.

The number of studies using a life course or trajectory approach to understand change in childhood weight status patterns over time has been increasing. At present a variety of methods have been used such as Latent Growth Mixture Model (Bisset et al. 2013, Garden et al 2012, Lane et al. 2007, Li et al. 2007, Xie et al 2013), semiparametric mixture models (SPMM) (Balisteri et al. 2011) and SAS PROC TRAJ procedure (Carter et al. 2012, Huang et al. 2013, Pryor 2011). Additionally, most studies focused either on determining differential trajectory patterns or examining the association of socio-demographic variables with specific trajectories. Additionally, the trajectory patterns and number of trajectories varied among the different studies reflecting both the differences in analytical methods as well as objectives of the specific study. In general, all of the studies identified a group, regardless of how it was termed, that included those children who had a BMI in the "normal" category and did not change over time. The other categories in each paper reflected some patter of change, primarily moving toward overweight or obesity.

Findings in our study are consistent with the general patterns seen in other studies. First, they indicate a fair amount of stability in weight status over time for non-Hispanic white children. Over four-fifths of the students who were initially either classified as being in the normal BMI category or in the overweight/obese category were in that category two years later. However, movement patterns from one category to another were markedly different for students in the two ethnic groups. The Hispanic students consistently remained in the overweight/obese category while about one-fourth of the non-Hispanic students moved from the overweight/obese category to the normal weight category. The non-Hispanic students were also less likely than the Hispanic students to move from the normal category to obese or overweight. This type of ethnic disparity in which Hispanic children begin heavier and continue to be overweight/obese throughout childhood is consistent with results of other studies (Bailey-Davis et al 2012, Balisteri et al. 2011, Freedman et al. 2005, Karlson et al 2013,Taveras et al. 2013

The strength of our conclusions is bolstered by the replication of results with different methodological approaches as suggested by Rossen et al. (2012). In our study, similar conclusions appeared with a cross-sectional analysis and panel analyses with two different age groups. Similar conclusions also appeared when the dependent variable was measured continuously (BMI-Z values) and categorically. We suggest that it is important to include both types of measures, especially when examining subjects with high initial rates of obesity and overweight. Such subjects might appear, when looking at a categorical measure, to have a stable trajectory, yet, with a continuous measure, be seen to have either increased or decreased risk.

Future research could, of course, build on and extend our findings. First, we had very limited data on the individual characteristics of students in our sample and, no data on individual poverty status. More extensive data on students' individual characteristics would be an important addition to future research. In addition, our results represent only one community in the Northwest, a community where the Hispanic population has Mexican or Central American heritage, is clearly a numerical minority, and has a relatively high rate of poverty. It would be important to replicate the analysis in other communities, especially in those in which the Hispanic population is more diverse in cultural and economic characteristics. It also would be important to examine variations in prevalence and trajectories over time for a variety of ethnic groups. As noted in the introduction to this paper, there have been reports of a recent stabilization and even decline in the prevalence of obesity and overweight. Given our results it seems important to determine if this improvement is limited only to certain socio-demographic groups.

Additionally, the convergence of results using different analytical methods highlights the importance of considering life-course changes when developing interventions and policies. Like Schuster et al (2012) we suggest that school environments still have high potential for obesity prevention interventions and programs, especially when BMI data is collected longitudinally on all grades. However, the very high level of early establishment of obesity and overweight, especially among the Hispanic students in our sample, suggests that school based interventions could be especially important before the beginning of elementary school. Approaches that involve assessments of both local school environments and neighborhood conditions and the relationship of school interventions to family-level and community interventions could be especially valuable.

Conflict of Interest Statement,

The authors have no disclosures or conflict of interest to declare.

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Table 1
General Characteristics of Schools (n=18)

Statistic	Enrollment	% FRL*	% Hispanic	BMI-Z	% Overweight or Obese
Mean	382.3	56.4	18.2	0.67	38.0
Minimum	67.5	25.9	2.2	0.16	26.1
Maximum	724.0	82.8	33.8	0.94	49.8
St. Dev.	158.6	19.7	10.1	0.18	6.45

*FRL = Free and Reduced Lunch.

Note: Data on enrollment and % FRL were obtained from the Oregon Department of Education. Data on ethnic composition and BMI-Z values were obtained from the data set analyzed in this paper. Descriptive statistics were calculated with schools as the unit of analysis.

Table 2

Percentage Distribution in BMI Categories and Average BMI-Z Non-Hispanic Whites and Hispanics by Year, Grade, and Sex

Total Group										
	Non-Hispanic Whites					Hispanics				
Year	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N
Total	64	18	18	0.61	5,270	48	19	33	1.01	1179
Differences by Year										
	Non-Hispanic Whites					Hispanics				
Year	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N
2005	64	18	18	0.61	1,125	58	15	26	0.78	170
2006	61	20	18	0.72	1,084	46	17	37	1.12	238
2007	67	17	16	0.56	1,202	52	20	28	0.9	308
2008	64	18	18	0.59	1,859	43	20	37	1.1	463
Differences by Grade										
	Non-Hispanic Whites					Hispanics				
Year	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N
Grade 1	66	18	16	0.61	1,628	55	19	25	0.86	397
Grade 3	66	17	17	0.58	1,952	48	18	34	1.03	407
Grade 5	60	19	21	0.66	1,690	42	19	40	1.15	375
Differences by Sex										
	Non-Hispanic Whites					Hispanics				
Year	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N	% Normal or Under.	%Overwt.	%Obese	Average BMI-Z	N
Female	19	19	17	0.58	2,536	51	20	29	0.94	594
Male	18	18	19	0.64	2,734	46	17	37	1.08	585

Table 3

Mixed Model Results, Cross-Sectional Sample, Non-Hispanic Whites and Hispanics

	Non-Hispanics			Hispanics			Comparing Coefficients	
Variable	Coef.	S.E.	prob.	Coef.	S.E.	prob.	z	prob.
FRL (school)	0.001	0.002	0.690	-0.004	0.003	0.250	-1.14	0.254
Year 06	0.185	0.054	0.001	0.358	0.118	0.002	1.33	0.183
Year 07	-0.047	0.050	0.347	0.136	0.111	0.223	1.50	0.134
Year 08	-0.012	0.042	0.768	0.341	0.098	<.001	3.32	0.001
Grade 3	-0.037	0.035	0.299	0.189	0.074	0.011	2.76	0.006
Grade 5	0.045	0.036	0.207	0.307	0.075	<.001	3.16	0.002
Male	0.062	0.028	0.029	0.142	0.060	0.019	1.20	0.230
Constant	0.501	0.145	0.001	0.746	0.216	0.001	0.94	0.347

Note: Year 2005, Grade 1, and Female were omitted values for the dummy variables. The z-scores and probability values in the last two columns are associated with the test that the two regression coefficients are equivalent.

Table 4

Descriptive Statistics, Panel Sample, Grade 1 to Grade 3

Categories of Weight Status by Ethnicity

	Non-Hispanic		Hispanic	
Grade 3	Normal or Under, Gr. 1	Over or Obese, Gr. 1	Normal or Under, Gr. 1	Over or Obese, Gr. 1
Normal or Under	88	27	76	0
Overweight or Obese	12	73	24	100
Total (%)	100	100	100	100
Total (N)	154	84	25	25

BMI-Z Values (Continuous) by Ethnicity

	Non-Hispanic		Hispanic	
	Mean	s.d.	Mean	s.d.
Grade 1	0.62	0.98	0.97	1.31
Grade 3	0.51	1.09	1.19	1.16
Difference	-0.11	0.88	0.22	0.73
t-ratio (paired)	-2.43, p (2 tail) = .02		2.09, p (2-tail) =.04	

Trajectories by Ethnicity

	Non-Hispanic	Hispanic
Stable - Normal or Underweight	57	38
Increasing Weight over Time	8	12
Decreasing Weight over Time	10	0
Early Establishment of Obesity or Ovweight	25	50
Total (%)	100	100
Total (N)	238	50
Chi-square	16.53, p = .001	

Table 5

Descriptive Statistics, Panel Sample, Grade 3 to Grade 5

Categories of Weight Status by Ethnicity

	Non-Hispanic		Hispanic	
Grade 3	Normal or Under, Gr. 3	Over or Obese, Gr. 3	Normal or Under, Gr. 3	Over or Obese, Gr. 3
Normal or Under	87	23	75	4
Overweight or Obese	13	77	25	96
Total (%)	100	100	100	100
Total (N)	113	65	20	23

BMI-Z Values (Continuous) by Ethnicity

	Non-Hispanic		Hispanic	
	Mean	s.d.	Mean	s.d.
Grade 1	0.62	1.01	1.08	1.17
Grade 3	0.58	0.99	1.30	1.03
Difference	-0.07	0.77	0.22	0.59
t-ratio (paired)	-0.80, p (2 tail) = .42		2.44, p (2-tail) =.02	

Trajectories by Ethnicity

	Non-Hispanic	Hispanic
Stable - Normal or Underweight	55	35
Increasing Weight over Time	8	12
Decreasing Weight over Time	8	2
Early Establishment of Obesity or Ovw.	28	51
Total (%)	99	100
Total (N)	179	43
Chi-square	10.59, p = .01	

Table 6

Mixed Model Results, Panel Sample, Regressing Ending BMI-Z on Starting BMI-Z, Ethnicity, and School Level Poverty

	Grade 1 to Grade 3 Panel		Grade 3 to Grade 5 Panel	
	b	z	b	z
BMI - Year 1	0.732	18.08***	0.775	17.58***
FRL - School Level	-0.001	-0.23	-0.003	-0.82
Hispanic	0.420	3.130**	0.446	3.720***
Constant	0.070	0.240	0.253	0.980

For the Grade 1 to Grade 3 panel, n = 288 students from 11 schools. The number of students per school ranged from 10 to 67 with an average of 26.2. For the Grade 3 to Grade 5 panel, n = 222 students from 8 schools. The number of students per school ranged from 10 to 69 with an average of 27.8.