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RESEARCH ARTICLE

Changes in Weight Over the School Year and Summer Vacation: Results of a 5-Year Longitudinal Study

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ABSTRACT

BACKGROUND: Evidence suggests that children gain more weight during the summer months compared with the school year. To examine the impact of the school and summer environment on children's weight further, we conducted a 5-year longitudinal study examining changes in standardized BMI (zBMI) of students entering kindergarten.

METHODS: Heights and weights were obtained at the beginning and end of each school year for 3,588 ethnically diverse (Caucasian: 27.2%, Black: 29.0%, Hispanic: 26.4%, and Asian 17.4%) students aged 5-7.

RESULTS: A significant difference in change in zBMI during the school and summer months was found (−0.52, 95% CI: −0.59 to −0.45, $p < .001$; Wald $\chi^2 = 171.89$, $p < .001$). Overall, children decreased BMI percentile during time spent in school by 1.5 percentile points and increased by 5.2 percentile points during summer months. Differences in the velocity of weight gain were found across weight classification categories with only overweight and obese children decreasing their zBMI during the school year.

CONCLUSION: Time spent in school was shown to have a beneficial impact on students' weight, especially for students who were overweight or obese. However, these results are alarming because weight gain during elementary school occurs primarily during the relatively short span of summer break.

Keywords: childhood obesity; summer; school; weight gain; elementary school.

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Currently, two-thirds of adults and one-third of children in the United States are overweight or obese.[1,2] Schools are often blamed for contributing to the increasing rates of obesity in children.[3] This is demonstrated in part by the concern for the quality of school lunch and new policies adopted by schools,[4] such as taking away recess or physical education to increase time spent engaged in academics.[5] Schools have been heavily criticized, but it is not clear what role summer vacation plays in the increasing rates of childhood obesity. In fact, it has been shown that kindergarten children increase their body mass index (BMI) at an accelerated rate during the summer months compared with the velocity of gain observed during the school year.[6] This suggests that the change in lifestyle that occurs during the summer months may substantially contribute to the increasing rates of obesity.

The structure of the school year provides a unique opportunity to track trends with respect to patterns of childhood weight gain. For example, longitudinally tracking anthropometric measurements of new schoolchildren can serve to cultivate useful data regarding changes in weight during school months versus summer months. Consequently, insight can be gained into how school and non-school influences affect weight gain. Information on this issue is important for several reasons. For example, determining when an increase in the velocity of weight gain is the greatest provides information as to when it is most

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critical to intervene. Furthermore, it will indirectly provide evidence concerning the effectiveness of school health policies.

This study sought to expand on previous results[6] by extending the time period that children were followed. A previous study focused on children in kindergarten and examined the summer months leading to first grade, whereas this study sought to examine changes that take place throughout elementary school. To do this, we tracked students entering kindergarten and followed them through elementary school documenting their heights and weights. Specifically, we examined changes in standardized BMI (zBMI) during school months compared with summer months. We predicted that the majority of weight gain would take place during the summer months. Differences in weight change were examined across ethnic groups and weight classifications.

METHODS

Participants

Participants included 3,734 children enrolled in the 2005 kindergarten class of a Southeast Texas independent school district, which included 41 elementary schools. Underweight (N = 138) and American Indian children (N = 8) were excluded from analyses because of the small sample size, resulting in a total sample size of 3588 children. Children were between the ages of 5 and 7 (mean = 5.67, SD = 0.3) and were ethnically diverse (Caucasian: 27.2%, Black: 29.0%, Hispanic: 26.4%, and Asian 17.4%). Baseline characteristics are reported in Table 1. As part of their participation in the study, all elementary schools were provided with educational materials such as books, handouts, and posters that could be used to enhance health and physical education curricula.

Table 1. **Baseline Characteristics of Participants (Means ± SD or %)**

Variable	Overall Sample (N = 3,588)
Age (years)	5.7 ± 0.3
Sex (% female)	48.7
Ethnicity	
White (n = 975)	27.2
Black (n = 1,040)	29.0
Hispanic (n = 947)	26.4
Asian (n = 626)	17.4
Height (cm)	44.7 ± 2.2
Weight (kg)	47.2 ± 9.4
Standardized BMI	0.5 ± 1.0
BMI percentile	63.4 ± 27.8
Weight category	
Normal weight (n = 2,520)	70.2
Overweight (n = 542)	15.1
Obese (n = 526)	14.7

BMI, body mass index.

Procedure

Children's heights and weights were measured twice annually in the fall and spring of each school year. Heights and weights were obtained using a digital scale and stadiometer with the children wearing light clothing and no footwear. Measurements were collected by school nurses who attended a training conducted by the research staff prior to each data collection. For nurses to qualify to take measurements for the study, they were required to match a ''gold standard'' on 3 consecutive trials for both height (±0.2 inches) and weight (±0.5 pounds). One hundred percent of nurses met criteria for mastery at the end of the training. BMI was calculated (weight (lb)/[height (in)]^2 × 703) and translated into a standardized score (*z*BMI) and percentile using sex and age normative data from the Centers for Disease Control and Prevention.[7]

On the basis of baseline BMI percentiles, children were classified into 1 of 4 weight categories: underweight (<5th percentile for BMI), normal weight (5th percentile to <85th percentile for BMI), overweight (≥85th to <95th percentile for BMI), and obese (≥95th percentile for BMI). Children remained part of their initial weight classification group throughout the study regardless of weight classification change.

To account for those who changed weight classifications during the study, children were divided into 3 distinct groups. By comparing the last observation (BMI percentile at the beginning of fifth grade) and the first observation (BMI percentile at the beginning of kindergarten), we determined if children: (1) increased their weight classification (ie, moved from normal weight to overweight or obese, or moved from overweight to obese classification); (2) remained in the same weight classification; or (3) decreased their weight classification (ie moved from obese to overweight or normal weight, or moved from overweight to normal weight). No children in these categories moved into an underweight classification. Analyses were conducted to examine change in zBMI for those who changed weight classifications.

Data Analyses

Statistical analyses were performed using SPSS (version 19; SPSS Inc., Chicago, IL). Total change in zBMI that occurred during the school year (kindergarten through fourth grade) and summer (summer between each grade level) was summed to allow for comparison of differences in the velocity of weight gain during the school and summer months. To evaluate differences in these velocities of weight gain while taking into account the clustered nature of the data (ie, children nested within schools), a generalized linear model was created to evaluate the main effect of zBMI change across school and summer months. Additionally, the

Table 2. **BMI Percentile Change During School and Summer (Means ± SD)**

Variable	BMI Percentile Δ	
	During School	During Summer
Overall	−1.5 ± 25.1	5.2 ± 27.1
Baseline weight category		
Normal weight	0.4 ± 28.2	6.2 ± 30.8
Overweight	−7.9 ± 18.0	4.2 ± 18.9
Obese	−3.7 ± 9.6	1.8 ± 8.2
Change in weight category*		
Increased	4.1 ± 21.7	17.9 ± 21.3
Decreased	−11.3 ± 21.8	−2.8 ± 22.8
Constant	−1.6 ± 26.0	2.6 ± 28.1
Ethnicity		
White	−1.0 ± 26.7	4.2 ± 28.0
Black	−1.6 ± 23.6	4.4 ± 26.6
Hispanic	−1.4 ± 22.8	5.8 ± 22.9
Asian	−1.9 ± 27.4	7.0 ± 30.9

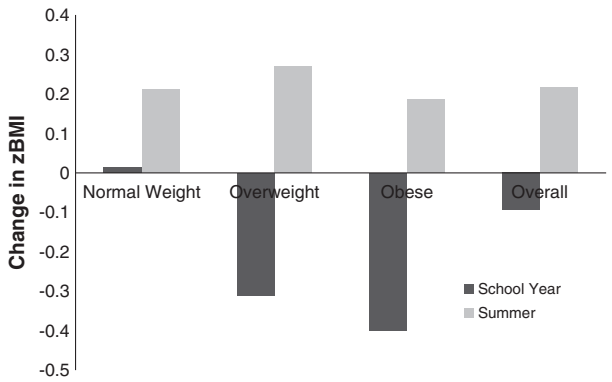
BMI, body mass index.
*Change in weight category based on BMI percentile at the beginning of kindergarten and the end of the fifth grade.

interaction between change in zBMI during these times and ethnicity, weight classification, and change in weight classification over time were analyzed. Pairwise comparisons were used to assess these results further.

RESULTS

The generalized linear model demonstrated a significant main effect of time (Table 2), indicating a significant difference between zBMI change during the school year and summer months (−0.52, 95% CI: −0.59 to −0.45, $p < .001$; Wald $\chi^2 = 171.89$, $p < .001$). Specifically, children lost weight during the school year and gained weight during the summer months (Figure 1). A significant interaction was not found for change in zBMI across ethnicity (Wald $\chi^2 = 3.14$, ns). However, there were significant interactions for change in zBMI and weight classification (Wald $\chi^2 = 64.6$, $p < .001$) and change in weight classification over time (Wald $\chi^2 = 65.4$, $p < .001$).

Figure 1. **Total Change in zBMI During the School and Summer Months Across Weight Classifications**



Weight Classification

From the school year to the summer months, overweight and obese children demonstrated significantly greater changes in zBMI than the normal-weight children (0.36, 95% CI: 0.22 to 0.50, $p < .001$ and 0.51, 95% CI: 0.37 to 0.65, $p < .001$, respectively). There was no difference in change in zBMI between the overweight and obese children (0.15, 95% CI: −0.03 to 0.32, ns). Post hoc analyses evaluating differences within weight classifications revealed that overweight and obese students decreased their zBMI during the school year and increased during the summer months ($t = -9.21$, $p < .001$ and $t = -13.23$, $p < .001$, respectively). However, normal-weight students increased their zBMI during both time periods, though increases were greater during the summer months compared with the school year ($t = -4.04$, $p < .001$).

Change in Weight Classification

Children who increased their weight classification changed their zBMI significantly more than children who remained constant in their weight classification or who decreased their weight classification (−0.47, 95% CI: −0.58 to −0.35, $p < .001$ and −0.53, 95% CI: −0.72 to −0.35, $p < .001$, respectively). There was not a significant difference in change in zBMI between those who maintained the same weight classification and those who decreased weight classification (−0.07, 95% CI: −0.23 to −0.09, ns).

DISCUSSION

Overall, these results show that elementary students experience a significant increase in the velocity of weight gain during summer break compared with the school year. Differences are also found across weight classifications with overweight and obese students experiencing accelerated weight gains during summer and obtaining healthier weights during the school year. Visual examination of changes in zBMI across weight classification groups over time revealed that overweight children decreased zBMI about as much during the school months as they increased zBMI during summer, thereby remaining relatively stable in terms of weight status. However, obese children decreased zBMI significantly more during the school year and gained about half of this decrease back over the summer. Despite a downward trend in weight status, a large majority of these students remained in the obese range (77.5%). On the other hand, normal-weight children appeared to be on an upward trend, gaining weight at an accelerated rate both during the

school year and summer, though this rate of gain was greater in summer.

In terms of children who changed weight classifications, those who increased weight classification increased zBMI during both school and summer, but gains were greater during the summer. Children who maintained their weight classification decreased zBMI during the school year and increased zBMI during the summer. Finally, children who decreased their zBMI decreased during both time periods; however, decreases were greater during the school year.

These findings highlight the important roles of summer vacation and the school year in the increasing rates of obesity. For example, if a child entered kindergarten as an overweight or obese child, the school environment promoted weight loss, whereas the environment during summer vacation led to accelerated weight gain. For overweight and obese students, the school environment had a protective effect against continued weight gain. This is interesting in light of the criticism that schools receive regarding health promotion;[8] however, there are many factors within the school environment that may promote healthy lifestyle habits. For example, many schools have improved the nutritional quality of competitive meals and the contents of vending machines.[9] Additionally, the National School Lunch Program (NSLP) has been modified to improve the nutritional quality of school meals. Currently, the NSLP provides children with the majority of their daily intake of nutrient-dense fruits and vegetables[10-12] and students eating school lunch consume less sugar and soda than students not enrolled in the program.[8] In terms of physical activity, schools provide students with access to physical education, sports, recess, intramurals, and afterschool programs.[5] Overall, it appears that the structure of a school day promotes a healthier lifestyle.

The school environment seemed to promote a healthier weight in children, whereas summer break promoted more rapid weight gain. Although it was beyond the scope of this study to determine summer factors associated with increased weights, several lines of evidence suggest possible reasons for this increase. For example, during leisure time, children engage in activities that are primarily sedentary,[13,14] resulting in deterioration of fitness levels during the summer months.[15] Additionally, the home environment may provide more unrestricted access to foods high in fat and sugar compared with the school environment which must adhere to the strict standards of the National School Lunch program.[16] Clearly, future inquiries are needed to address this issue.

When evaluating the velocity of weight gain among normal-weight students, it appears that they did not benefit as much from the school environment. Given these observed differences between normal and overweight children, it may be important to develop differential methods to intervene with children of differing weight classifications. A problem arises with this solution in that separating children based on weight class can have the detrimental effect of stigmatization.

Because rates of obesity in children are highest in minority populations,[1,2,17] we examined whether these trends were also observed across ethnic or racial groups. We found no differences in change in zBMI from school to summer across ethnicities or races. This is in contrast to another study that found black and Hispanic children experienced greater increases in BMI during the summer when compared with white children.[6]

IMPLICATIONS FOR SCHOOL HEALTH

On the basis of our results, interventions are needed during the summer months for elementary school-aged children. Up to this point, most interventions to improve the weight status of children have focused on schools. This is likely due to the fact that schools provide access to children and parents and education models which already incorporate health-promoting programs such as health education and physical activity classes.[18] As an important first step, a school-based summer program has been shown to be effective in increasing physical activity in children during summer break.[19-21] This is important as physical activity is integral to weight maintenance and prevention of weight gain;[22] however, the impact of this program on weight gain has not been evaluated.[19-21] The positive impact that the school year has on weight should be taken into consideration for other decisions as well. For example, these data provide a compelling reason to offer year-round schooling to prevent accelerated weight gain in childhood.

Overall, these results suggest that the school environment has a positive impact on the weight status of children who enter kindergarten, especially for those who are overweight or obese. This study provides indirect evidence that health promotion efforts, such as the NSLP and policies to increase physical activity, appear to be having a positive impact.[5,8] However, to address the deleterious effect of summer on weight gain, health promotion programs that address health behaviors during the summer months are needed.

Human Subjects Approval Statement

This study was approved by the Institutional Review Board of the Baylor College of Medicine.

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