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Impact of Pediatric Obesity on Grades in Elementary School

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Introduction

Pediatric obesity is associated with numerous physical and psychosocial consequences. These consequences, which are both immediate and long-term in nature, increase with higher levels of percent body fat.[1-3] This is particularly concerning in light of the high prevalence and increasing severity of childhood obesity. In addition to health consequences, such as insulin resistance and dyslipidemia,[1] children who are obese are at increased risk for problems in social and academic realms. For example, children who are obese report being teased more by peers and family members, having lower self-esteem, feeling socially isolated, and having lower health-related quality of life in social and academic domains.[4-6] Additionally, adults attribute more negative personality characteristics to children who are obese compared to those who are not.[7,8] These negative consequences have been shown to begin early in life.[9]

A few studies have also shown pediatric obesity to be inversely linked with objective measures of academic achievement such as performance on standardized tests and tests of cognitive functioning.[10-12] In addition, poorer physical fitness and dietary behaviors have also been associated with lower academic performance.[10,13,14] While the number of studies examining the relationship between obesity and academic performance are increasing, there is still a paucity of data in this area.

Additionally, few studies examine actual grades as an outcome measure when assessing academic performance and weight status. This is important as grades tend to be more subjective in nature.[15] Among the limited number of studies that specifically assess the link between weight and grades, most demonstrated that overweight middle- and high-school students had lower grade point averages (GPAs) than students who were normal weight.[16-18] Even less research has examined this relationship in younger children. The one study that was conducted with this age group showed no relationship between weight status and grades.[17]

The disparities observed in the academic performance of children with obesity and children with normal weight may be related to bias or weight stigmatization. Attribution theory provides one possible explanation of how this might occur.[19] According to attribution theory when encountering an individual with a condition such as obesity, people search for possible causes for these conditions.[19] These causes are often attributed to internal and controllable traits. For example, obesity is frequently associated with laziness and poor self-discipline. These perceptions can generalize to future behavior such as achievement.[19]

The current investigation was conducted in order to further assess the relationship between weight status and grades in younger school children. Specifically, the aim of this investigation was to examine the

association between weight status and school grades in second graders. We hypothesized that children who were overweight or obese would have significantly lower grades.

Methods

Study Design & Participant Recruitment

A cross sectional design using a representative sample from an ethnically and racially diverse school district in southeast Texas was employed. All 41 elementary schools from this independent school district were recruited for participation. According to school records, 28.3% of students were White, 23.3% Black, 23.1% Hispanic, and 25.3% Asian. This study was classified as exempt and approved by the Institutional Review Board for human subjects at Baylor College of Medicine and by the Fort Bend Independent School District review board. Parents were sent a letter explaining the nature of the research program and were given the option to retract from the study, but no parents declined participation. Students were included in the current analyses if they were present for measurements and received a year-end grade in reading, math, and science. Students were excluded from analysis if they met criteria for underweight.

Study Procedures

All 41 schools received a letter regarding the opportunity to participate in a research study investigating the association between obesity and academic functioning. School principals were also contacted by phone one week later to discuss the letter and their school's interest in participation. Following a script, researchers questioned school leaders about reasons for their interest or disinterest in the study. Eleven schools expressed interest, and face-to-face meetings were conducted with each of these interested schools. In face-to-face meetings, a presentation about the research proposal was made and a semi-structured interview assessing motivation and perceived barriers and facilitators to participation was conducted. Following these meetings, seven schools agreed to participate. All seven schools received a rating of "recognized" or higher, meaning that 80% or more of students met the standard for state standardized testing in each subject.

The current study was part of a larger investigation in which second graders were the focus. A meeting was conducted with all second grade teachers at the seven participating schools. Teachers were informed that researchers would be assessing the health status of their students. They were not informed that researchers would be assessing the association between obesity and academic performance, though teachers were aware

grades would be reported to researchers.

Schools provided demographic information regarding child sex and race/ethnicity. This data was based on parental report. Race/ethnicity categories were defined by the school as “White,” “Black,” “Hispanic,” and “Asian.” The school did not differentiate between race and ethnicity. Data were de-identified before being given to researchers.

School socioeconomic status was determined based on a school’s participation in the Title I program (ie, Title 1 school/non-Title 1 school). Schools are eligible to participate in the program if 40% or more of enrolled students are from low-income families.

Per requirements of the school district, students’ heights and weights were measured at the beginning of the school year. As part of the study, the research staff provided this training. Heights and weights were measured by school nurses who attended training conducted by the research staff. Training consisted of demonstration and written instructions for proper measurement of height and weight. Nurses participated in in-vivo practice of the procedure taking the heights and weights of three of their fellow nurses. Then the lead researcher measured the height and weight of a research assistant three times. All nurses took three measurements of height and weight on the same research assistant. Nurses’ measurements were compared to the gold standard, which was

defined as the measurement obtained by the lead researcher. In order to meet criteria for mastery the mean height and height measured by the nurses could not differ by more than .2 inches or .5 pounds. If a nurse failed the first trial, the procedure was repeated until they achieved mastery. One hundred percent of nurses met criteria for mastery at the end of the training.

Measurements

Anthropometrics Weights were obtained using a digital scale with participants wearing light clothing and no footwear. Height was measured using a stadiometer without participants wearing footwear. BMI was calculated using measured height and weight and was standardized (zBMI) using age and gender normative data.[20] Based on the Centers for Disease Control and Prevention (CDC) guidelines, children were classified into 1 of 3 weight categories: normal weight (5^{th} percentile to $<85^{th}$ percentile for BMI), overweight ($\geq 85^{th}$ to $< 95^{th}$ percentile for BMI), and obese ($\geq 95^{th}$ percentile for BMI).

Academic Outcomes Researchers gave no instructions regarding the grading procedures or how grades were to be given. Numerical grades were based on teacher rating of student performance in terms of both

effort and/or accuracy on classwork, homework, projects, quizzes, and unit tests. In order to improve consistency, teachers used a rubric for each assignment to assign grades, though this rubric differed across teachers. Despite efforts to standardize grading practices, subjectivity is likely to impact results especially with more detailed grading processes.[21] Student year-end final grades for reading, math, and science were de-identified and obtained from the respective school administrations. Grades were reported as a score between 0 and 100 for each subject. A GPA or mean score was calculated for each student by averaging their math, reading, and science scores.

Statistical Analyses

Statistical analyses were performed using Statistical Analysis Systems (version 9.3, 2011, SAS Institute Inc., Cary, NC). One-way analysis of variance (ANOVA) and chi-square test for independence were conducted to evaluate differences in baseline characteristics across weight classifications. Based on attribution theory, it was hypothesized that children classified as obese would have lower grades than children classified as normal weight and overweight. In order to analyze this, linear mixed models were created to evaluate differences in end of the year grades across weight classifications while taking into account the

clustered nature of the data (i.e, children nested within schools). Sex, ethnicity, absences, and school socioeconomic status (SES) served as covariates in the model. Pairwise comparisons were used to further assess these results. The interaction effects of weight classifications and gender/ethnicity were examined as well. The overall grade at the end of second grade was then examined more closely by separately analyzing the three subject areas that comprise this score.

Results

Preliminary Analyses

Data were collected from all 835 second grade students (46.2% female) enrolled in the participating schools. A total of 37 students were underweight, 477 students were normal weight, 135 were overweight, and 186 were obese. Due to small sample size, underweight students were excluded from analyses, resulting in a sample of 798 students. Students were between seven and nine years old and from diverse ethnic backgrounds (Asian=25.3%, Black=23.3%, Hispanic=23.0%, White=28.4%). This ethnic composition is similar to the diversity of the district as a whole (ie, 22.5% Asian, 29.3% Black, 26.6% Hispanic, 19.1% White, 2.8% Other). Baseline characteristics are presented in Table 1.

Table 1. Baseline characteristics of participants (means±s.d. or %).

Characteristics	Entire Sample (n = 798)	Normal Weight (n = 477)	Overweight (n = 135)	Obese (n = 186)
Age (years)	7.7±0.4	7.7±0.4	7.8±0.4	7.7±0.4
Gender (% female)*	46.2	49.5	48.1	36.6
Ethnicity (%)*				
Hispanic	23.0	50.5	15.2	34.3
Black	23.3	53.8	17.7	28.5
Asian	25.3	66.9	16.3	16.8
White	28.4	65.9	18.1	16.0

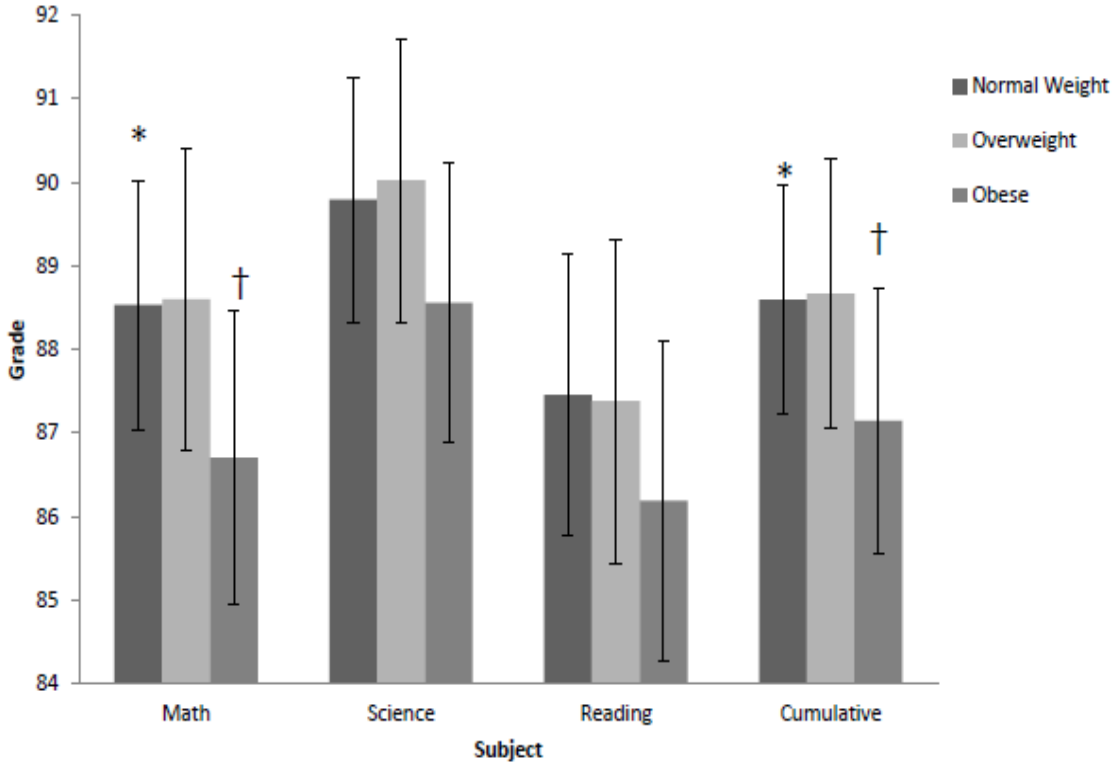
Note. * $p<0.01$

Several significant differences were found between weight classifications with respect to baseline anthropometric and demographic variables. In terms of ethnicity, children who were identified as Black or Hispanic were more likely to be obese than children classified as White or Asian. The percentage of males (43%) who were overweight and obese was greater than the percentage of females who were overweight and obese (36%; $p < .001$). Based on these findings, both sex and ethnicity were used as covariates for all analyses. While there were no significant differences in the number of absences or school SES across weight status classifications, absences and school SES were included in the model as these variables are potentially confounding factors.

Primary Outcome

The adjusted means of math, science, reading and the cumulative scores and their confidence intervals were presented in Figure 1. The linear mixed model revealed a significant main effect of weight class, indicating a significant difference in grades across weight classifications ($p<.05$). Pairwise comparisons revealed that children in the obese category had significantly lower grades (Mean=87.15) than children in the normal weight category (Mean=88.60). Children in the overweight weight category did not significantly differ from those in the normal weight or obese weight categories in their grades. In order to account for possible confounding variables, separate models were created to examine the interaction effect of weight classification, gender/ethnicity, absences, and school SES; however, the interactions were not significant.

Figure 1. Differences in grades across weight categories.



Note. * is significantly different from †, $p < .05$. Grade scores presented reflect the least square means which adjusted for ethnicity, gender, absences, and school SES.

Outcomes by Subject Area

Results similar to the primary outcome were found only for math ($p<.05$) with children who were obese scoring significantly lower than their peers

who were normal weight (-1.8, $p<.05$) (see Figure 1). In contrast, grades in science and reading did not significantly differ across weight classifications. Also, no significant interaction effects of weight classification and gender/ethnicity were found.

Discussion

The results of this study indicate that academic performance, specifically math grades, is lower in obese students compared to normal weight students. While this relationship between weight classification and grades has been demonstrated in middle and high school students,[16-18] the current study shows that this effect can be observed as early as second grade. The mean GPA of obese students and normal weight and overweight students differed by less than two points. While these results were statistically significant, they may not be clinically meaningful. However, it is not clear what the impact of consistently scoring slightly lower than their peers may have on students throughout their years of formal education.

There may be both physiological and psychological explanations for these differences. In terms of physiological explanations, it has been demonstrated that those with higher cardiovascular fitness perform better on standardized tests.[22] It is possible that cardiovascular fitness affects

standardized test scores by impacting children's underlying cardiovascular risk factors such as endothelial function or vascular constriction. Such risk factors may work to impair academic performance by affecting neurocognitive function.[22] Because overweight children tend to be less physically fit, they may be at even greater risk for poor academic performance.[23, 24] Additionally, studies suggest that cognitive functioning may be impaired by obesity,[25,26] and metabolic syndrome,[27] indicating additional pathways by which academic performance may be affected in obese children.

One possible psychological explanation for this finding is provided by a phenomenon called the Pygmalion effect. The Pygmalion effect, first introduced in a study by Rosenthal and Jacobson,[28] demonstrated that students' academic achievements and behavior were influenced by teacher's expectations of the student's abilities. In this seminal study, teachers were led to expect better academic performance from 20% of their students randomly selected by the experimenters. At the end of the school year, the students identified by the experimenters as being academically "gifted" showed greater intellectual growth, as measured by a standardized test, than students in the control group.[29] In addition, teachers described the "gifted" students as happier, more curious and interesting, and being more likely to succeed in the future.[29]

As positive expectations elicit improved performance by those who are perceived positively, negative expectations similarly elicit decreased performance, which is known as the Golem effect.[30] Individuals often have negative perceptions and expectations of obese individuals.[8] For example, health care providers, peers, and family members have reported viewing obese individuals as lazy, lacking willpower and self-discipline, incompetent, less intelligent, and having emotional issues.[7,31,32] A survey of 115 middle and high school teachers from a large urban school district revealed that 20% to 25% of teachers view obese people as being more emotional, less tidy, and less likely to succeed than non-obese individuals.[7] Another study compared the implicit and explicit "anti-fat prejudice" of a cross sectional sample of 180 students training to be physical education (PE) teachers compared to a sample of 164 students matched in terms of age, body mass index and education who were enrolled in psychology classes. Students preparing to be PE teachers exhibited stronger implicit prejudice compared to psychology students.[33] These attitudes may be latent or unconscious; nevertheless, negative expectations may be recognized and internalized by obese individuals. Thus, it is possible that teachers are inadvertently impacting obese students' academic performances through negative or low expectations.

Such low expectations directed at certain groups have more recently been termed as a form of "soft bigotry."[34]

Alternatively, the negative perceptions and stereotypes held toward those who are obese may lead to a more direct or overt discrimination, as opposed to the "soft" bigotry described above. Weight-based discrimination has increased in the last decade and remains a socially acceptable form of discrimination.[35-37] Overweight people have reported being stigmatized in the workplace and academic settings. Grades are susceptible to these biased attitudes due to their fairly subjective nature. Grades, even in young students, may be an area to be examined in future studies of weight discrimination.

Weight stigmatization can also create adverse psychological consequences. A secondary analysis of survey and anthropometric data from middle and high school students (N= 4,746) revealed that teasing about body weight was associated with emotional problems such as low self-esteem, depressive symptoms, suicidal ideation, and low body satisfaction, even after controlling for body weight.[3/8] Furthermore, a longitudinal study of 2,879 Canadian youth ages 10-11 found that obese children were more likely than their normal weight peers to exhibit increased depressive symptomatology, a decreased self-concept, and impaired social functioning.[39] Poorer mental health and emotional

difficulties are commonly associated with poorer academic functioning.[40] This association has been demonstrated in several longitudinal studies examining early onset depression and outcomes later in life.[41-43]

In addition to the effect that weight stigmatization has on people who are objectively overweight and obese, those who *perceive* themselves as being overweight or obese may also internalize the negative stereotypes associated with obesity. One study suggests that the relationship between obesity and poorer academic functioning is better explained by the child's perception of being overweight than by being medically defined as overweight.[40] Perception of being overweight has also been associated with poorer mental health[44] which may play a role in the association with poorer grades.[40] Although the Pygmalion and Golem effect partially explain these results, study in a multitude of areas is needed to fully explain these findings.

Interestingly, this study found that obesity was only related to academic performance in math and not reading or science. The results of this study contrast with longitudinal study of 4664 children ages 8-11, which found no relationship between obesity during early childhood and performance on a standardized math test.[45] One possible reason for this discrepancy in findings is that the current study examined the relationship between obesity and grades which are more subjective than standardized

tests.

In addition to the potentially harmful effects of weight based discrimination, several other variables could explain these findings. For example, overweight and obese children are more likely to be absent from school,[46] which could have a negative impact on their grades. Children who are overweight and obese are also more likely to come from disadvantaged families[47] and children of disadvantage households often under perform academically.[48,49] Furthermore, studies have suggested that SES, defined by household income and household education level, is inversely related to childhood obesity prevalence.[50,51] For example, children whose parents have less than 12 years of education have 50% higher odds of being obese compared to children with college-educated parents, and children living below the poverty threshold have 83% higher odds of obesity than their wealthier peers. As such, it is possible that the effects of obesity on grades may be mediated by SES. However, contrary to these findings, this study did not find a significant difference in absences or school SES across weight classifications. Additionally, the absences and school SES were not associated with differences in grades across weight classifications.

The current study was limited by the cross sectional design, which

merely shows a relationship between obesity and grades but does not explain the nature of this relationship.[52] Another limitation of this study is that the effects of socioeconomic status (SES) were assessed at the school level and not the individual level. Additionally this study is limited by lack of data pertaining to the participant's receipt of public assistance, violence exposure, family structure, and the built environment in surrounding neighborhoods. Other possible variables that have been linked to academic performance were not directly measured and may offer explanation for these findings. Some of these variables include fitness level,[23,24] intelligence,[53] thinking and learning styles,[54] cognitive and motor skills,[25,26,55,56] food insecurity,[57] perception of overweight,[40] negative self concept,[58] sleep patterns,[59] and mental illness.[44] Although measuring these variables was beyond the scope of this study, identifying a relationship that warrants increased attention and research is important.

Finally, the current study was considered to be exploratory and thus a power analysis was not conducted. It is possible that significant differences in science and reading grades were not found due to a lack of power to detect differences.[60] Future studies powered to detect differences across subject areas are needed to determine if reading and science grades may also differ for children based on weight status.

Based on the current study, future studies should examine if this

relationship between grades and weight status continues to exist after controlling for some of the limitations mentioned previously. Additionally further research is needed to examine the possible explanations or mechanisms for the poorer academic performance of obese students, particularly in math. Understanding the mechanism at work behind differential grades provides a potential area to intervene. For example, if teacher bias is shown to affect grading practice, training may reduce negative effects and improve grading consistency.[61]

Currently, a conflict exists within schools between the need for increased instructional time and the relative importance of physical and health-related activity.[62,63] Academic instruction and health-related instruction previously appeared to be two conflicting agendas. However, if overweight leads to decreased academic performance, the conflicting agendas may be ameliorated. This study extends the literature base by supporting that poor academic performance exists for younger school children who are obese. It is important that future research more fully clarify the connection between academic achievement and weight status because poor school outcomes in obese children as early as second grade can place children on a trajectory of poor academic outcomes. The need for early intervention regarding pediatric obesity is highlighted by these findings.

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