Pediatric Obesity and Mental Health Illness

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Health Related Question:

Through this midterm project, we investigated mental health outcomes in relation to obesity status in Children(18 years and below) in the United States. Particularly, we were interested in **how diagnosis of anxiety and related indicators of mental health align with the BMI (Body Mass Index) status of the child**.

Background and Significance:

Childhood Obesity is a serious epidemic in the United States today that continues to be on the rise in school age children.[1] About 1 in 6 school-aged children is deemed to be suffering from obesity.[2] Childhood obesity is an important problem that necessitates further exploration as it has immediate and additive long-term effects on an individual's physical, social, and emotional health and overall well-being. Additionally, children who are overweight (OV) or obese (OB) are more likely to be OV/OB as adults. Adults who were obese as children are more likely to suffer from metabolic disorders that can result in chronic insulin resistance, a well known contributor to the development of Type II Diabetes Mellitus (DMII).[3] BMI status (OV/OB) can affect future pathways of pathophysiology by increasing risks for CHD, DM, and MI, the greatest disease burdens on the healthcare system today.[4]

Prognostically, children who are obese are more prone to suffer from additional chronic health conditions such as asthma, sleep apnea, and musculoskeletal problems (arthritis, reduced bone density leading to increased risk of fractures).[5] Socially, children who are obese have lower self esteem scores and are at increased risk for comorbid mental illness such as depression.[6] Body Mass Index (BMI) is widely utilized in the clinical setting as a measure of adequate weight for the child's height.

Mental illnesses that develop during childhood typically affect learning, behavior, and emotional maturation. Thus, they contribute to overall development of the pediatric patient. Mental health is an important aspect of an individual's life as it affects the quality of life, everyday functionality, and the overall health and well-being. Mental health illness is a significant risk factor among children of all ages, genders, ethnic and racial backgrounds.

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[1] Karnik, S., & Kanekar, A. (2012). Childhood Obesity: A Global Public Health Crisis. International Journal of Preventive Medicine, 3(1), 1–7.

[2] Hesketh, K., & Campbell, K. (2010). Obesity prevention interventions for early childhood: An updated systematic review of the literature. Childhood Obesity Prevention, 396-407. doi:10.1093/acprof:oso/9780199572915.003.0034

[3] Lloyd LJ, Langley-Evans SC, McMullen S. Childhood obesity and risk of the adult metabolic syndrome: a systematic review. *Int J Obes (Lond).* 2012;36(1):1–11

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[5] Baruwa, P., & Sarmah, K. R. (2013). Obesity and asthma. *Lung India : Official Organ of Indian Chest Society*, *30*(1), 38–46. http://doi.org/10.4103/0970-2113.106132

[6] Sahoo, K., Sahoo, B., Choudhury, A. K., Sofi, N. Y., Kumar, R., & Bhadoria, A. S. (2015). Childhood obesity: causes and consequences. Journal of Family Medicine and Primary Care, 4(2), 187–192. http://doi.org/10.4103/2249-4863.154628

According to the National Research Council and Institute of Medicine report, approximately 1 out of every 5 children (20% of children living in the United States) is diagnosed with a mental illness every year.[7] The economic burden of childhood mental illnesses on families, individuals, and society is estimated to be $247 billion annually. The incremental lifetime direct medical cost from the perspective of a 10-year-old obese child relative to a 10-year-old normal weight child ranges from $12,660 to $19,630 when weight gain through adulthood among normal weight children is accounted for and from $16,310 to $39,080 when this adjustment is not made.[8]

Dataset Description

We utilized the 2011-2012 National Survey of Children's Health sponsored by the Maternal and Child Health Bureau of the Health Resources and Services Administration. This dataset deals with indicators and markers of the physical and emotional well-being of children between the ages 0 and 17 years of age. Particular focus was placed on associated factors regarding child health such as medical homes, family interactions, parental health, school and after-school experiences, and safe neighborhoods, insurance status of the child to assess parental awareness of, experience with, and interest in enrolling in Medicaid and the State Children's Health Insurance Program (CHIP). 95,677 child-level interviews were conducted between February of 2011 and 2012.

The dataset was curated by the Centers for Disease Control (CDC) through the State and Local Area Integrated Telephone Survey (SLAITS). This method of data collection was developed by the National Center for Health Statistics (NCHS) of the CDC. The original purpose of the dataset was to supplement the nationwide compendium of child health data that could be accessed easily by state and local public health policymakers. This data can be utilized to target subsets of the population who are not currently receiving adequate care. Intervention strategies can be potentiated based on the current status quo to improve health outcomes that are unaligned with national statistics.

The *Outcome* we examined was *BMICLASS* (1=Underweight, 2=Normal Weight, 3=Overweight, 4=Obese) as a measure of BMI Status. BMI status of 1 (Underweight) in pediatric survey participants includes children whose BMI is under the 5th percentile for their age. BMI Status of 2 (Normal Weight) includes children whose BMI is between the 5th and 85th percentile. BMI Status of 3 (Overweight) includes children whose BMI is greater than the 85th percentile but less than the 95th percentile. BMI Status of 4 (Obese) includes children whose BMI is greater than the 95th percentile. According the CDC, BMI 'does not measure body fat directly, but research has shown that BMI is correlated with more direct measures of body fat, such as skinfold thickness measurements, bioelectrical impedance, densitometry (underwater weighing), dual energy x-ray absorptiometry (DXA) and other methods'. Thus, BMI can be considered an alternative to direct measures of body fat.[9]

The *Exposure* measure we considered is Anxiety/Behavioral Problem Diagnosis *K2Q33A* (Yes/No). As suggested above, mental health illness is commonly seen in children that

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[7] OConnell, M. E., Boat, T. F., & Warner, K. E. (2009). Preventing mental, emotional, and behavioral disorders among young people: progress and possibilities. Washington, D.C.: National Academies Press.

[8] Finkelstein, E. A., Graham, W. C., & Malhotra, R. (2014). Lifetime Direct Medical Costs of Childhood Obesity. *Pediatrics, 133*(5), 854-862. doi:10.1542/peds.2014-006

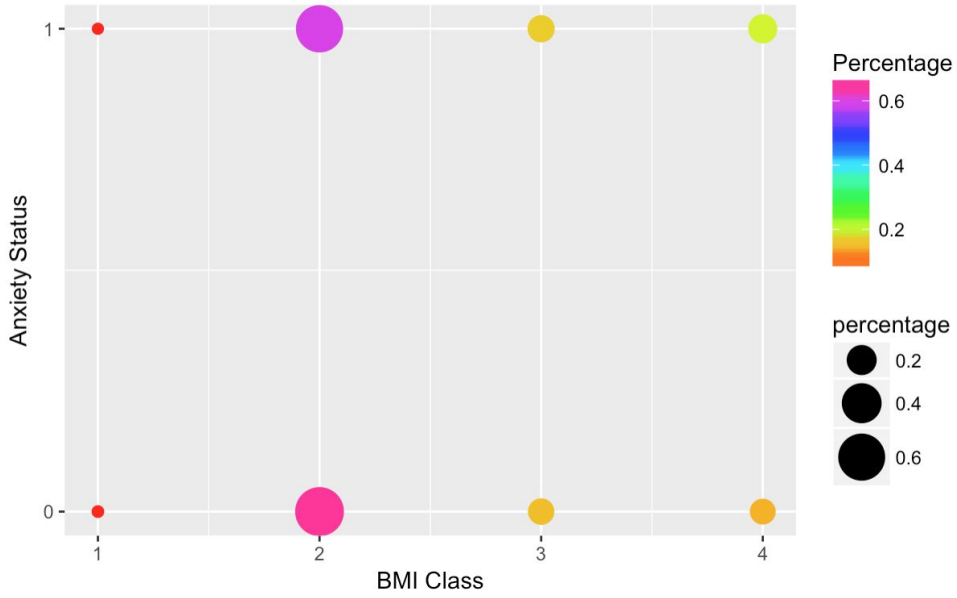
[9] Freedman, D.S., Horlick, M. & Berenson, G.S., 2013. A comparison of the Slaughter skinfold-thickness equations and BMI in predicting body fatness and cardiovascular disease risk factor levels in children. *Am. J. Clin. Nutr.*, 98(6), pp.1417–24.

meet obesity or overweight criteria.[10] Of note, anxiety is reported to be the most common mental health illness reported among pediatric populations.[11] Many studies indicate the internalizing coping mechanisms utilized by OV/OB youth can lead to development of mental dysfunction.[7] Mental, Emotional, and Behavioral (MEB) Problems present important clinical pathways that run in parallel to each other.

Confounding Variables examined include Dental Health *K4Q21R* where the number of visits to the dentist was established, and Dental Health *K2Q01_D* where participants were asked to describe the conditions of the child's teeth as Excellent, Very Good, Good, Fair, and Poor. Dental Health contributes to nutritional intake of the pediatric patient. In addition, dental health outcomes also overall health outcomes such as cardiac and liver health.[12]

Analysis (Part 1)

We hypothesised that a child suffering from anxiety is more likely to be in the less than 5th percentile or in the greater than or equal to 85th percentile BMI category(i.e., 1,3 or 4)



For analysis 1, we chose to plot our data on a count plot. The reason we chose to use this plot is to better visualize the difference in proportion size. The colors were added to make the distinction between the sizes clearer. In this plot, the percentage represents the proportion of individuals in each BMI Classes with and without anxiety.

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[10] Lim, C. S., Espil, F. M., Viana, A. G., & Janicke, D. M. (2015). Associations between Child Anxiety Symptoms and Child and Family Factors in Pediatric Obesity. *Journal of Developmental and Behavioral Pediatrics : JDBP*, *36*(9), 664–672. http://doi.org/10.1097/DBP.0000000000000225

[11] Anderson, S. E., Cohen, P., Naumova, E. N., Jacques, P. F., & Must, A. (2007). Adolescent Obesity and Risk for Subsequent Major Depressive Disorder and Anxiety Disorder: Prospective Evidence. *Psychosomatic Medicine, 69*(8), 740-747. doi:10.1097/psy.0b013e31815580b4

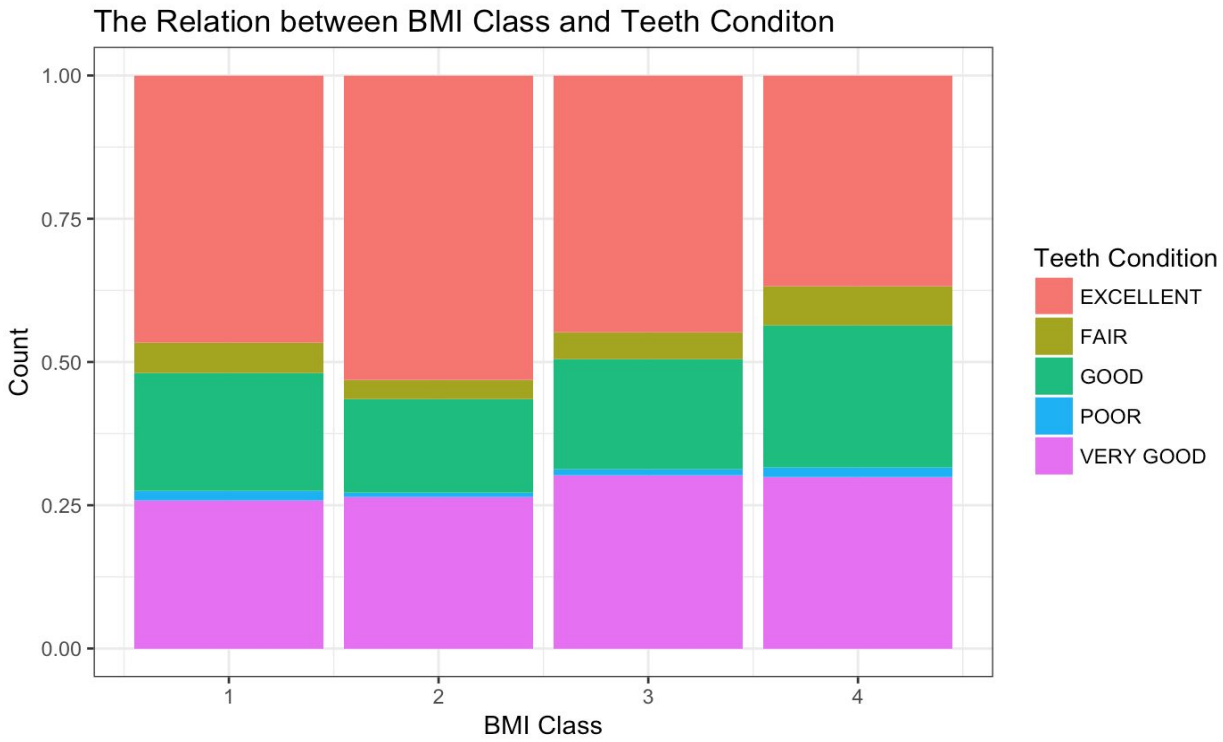
[12] Bimstein, Enrique, and Joseph Katz. "Obesity in Children: A Challenge that Pediatric Dentistry Should not Ignore – Review of the Literature." *Journal of Clinical Pediatric Dentistry*, vol. 34, no. 2, 2009, pp. 103–106., doi:10.17796/jcpd.34.2.65q424243n468452.

As illustrated in our plot, a higher percentage of individuals suffer from anxiety in BMI Classes 3 and 4 (OV and OB, respectively) as compared to those without OV/OB status. However, a larger percentage of individuals BMI Class 2 (Normal) do not suffer from anxiety.

Our plot is further supported by the result from the Fisher Test. We decided to use Fisher test because of the categorical nature of our data that we are analyzing. Due to the size of the dataset, we had run the Fisher test on smaller sample sizes of 10,000 to protect the system from overwhelming amounts of data. Our final p-value was obtained from taking the average of the 5 sampled p-values. The p-value that we obtained was 0.000486745 which is significant so we reject our null hypothesis that the proportion of individuals with and without anxiety are equal for each BMI Classes.

Analysis (Part 2)

We hypothesized that children with abnormal BMI status (*BMICLASS* = 1 (Underweight) ,3 (overweight), 4 (obese)) have a larger possibility of having poorer conditions of dental health (4 (Fair) and 5 (Poor)).



Since both variables in our hypothesis are categorical, we used a Chi Square test to evaluate the relationship. We also chose Chi Square test as the variables BMI Class and Teeth Condition have more than 2 categories.

To visualize our assumption, we used a stacked bar plot to see if the percentage of children having ‘Fair’ and ‘Poor’ Teeth Condition is larger in the BMI classes 1,3 and 4. As we can see from the plot the percentage of children having ‘Fair’ and ‘Poor’ Teeth health is marginally higher in the BMI categories 1,3 and 4 than it is in the normal BMI category 2.

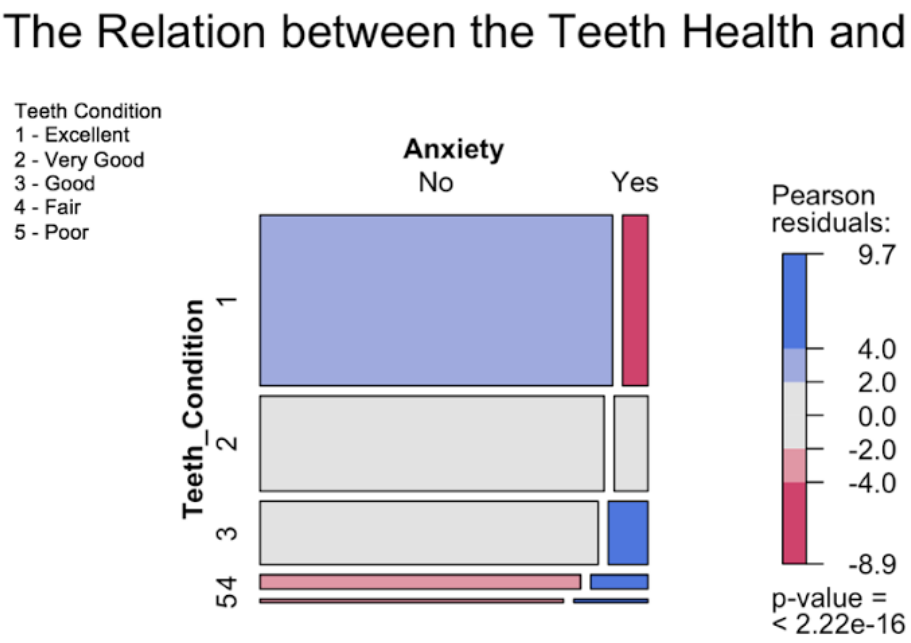
For the Chi-Square test, we combined the three categories 1, 3 and 4 into one single category. We then formed a table containing the combined category and the normal category

along with the proportion of children in each teeth condition. We then passed this table to the chisq test.

Our Null Hypothesis is that the proportion of children having Poor and Fair Teeth Conditions is equal in all the BMI categories. As the value of p(obtained 2.2 e-16) is less than 0.05, we reject the Null Hypothesis and believe that there is a positive correlation between the teeth health of the child and his/her BMI.

Analysis (Part 3)

We hypothesised that children with Anxiety have a higher chance of having 'Fair' or 'Poor' teeth health.



We ran a Population Proportion statistical test to evaluate the relationship between teeth condition of the child and anxiety.

We chose a mosaic plot to show how the proportion of children with Fair and Poor teeth health changes due to anxiety as both the variables are categorical. Mosaic plot is also a good way to visualize the overview of the data and makes it possible to recognize relationships between different variables. We chose to perform a prop test due to the fact that both the variables are categorical with each column having data greater than 20.

We can clearly see that there is a higher incidence of poor and fair teeth health among children with anxiety. The Pearson residuals also point towards the change in percentages of Good, Fair and Poor teeth conditions are the biggest contributors to the p value. The Prop test returned a p value of 2.2e-16 which is < 0.05. From this test we can reject the NULL hypothesis that there is no relation between anxiety and teeth health of the child.

There is a correlation between the teeth condition of the child and their anxiety and BMI class.

Limitations

There are some unfavorable aspects of this survey data. First, it is a cross-sectional study, which was conducted within a certain period of time (02/2011- 11/2012). Therefore, it is difficult to ascertain whether the outcome (BMI status) occurred before or after the exposure (MEB disorders). In addition, there could be a number of other confounding variables either in or outside of this dataset that we did not include in our analysis.

Furthermore, the quality of the data is also a limitation to our inquiry. The data was reported by parents in a telephone survey. Parental perception can be deeply biased and is not an accurate source of medical information that is gained from PHI. Hence, recall bias is of particular concern. Also, medical care providers were not directly involved in the data collection and visualization processes to ensure internal and external validity.

Another area of potential bias in our analysis includes self-reporting bias from parents rather than medical professionals. Lead time bias is also a potential concern because we are unaware of the progression model of the disease as it pertains to the pediatric patient because it is a cross-sectional study.

Conclusions

Our health-related question, **how diagnosis of anxiety and related indicators of mental health align with the BMI (Body Mass Index) status of the child**, also took into account potential confounder of dental health. From our analysis, we reject the null hypothesis that there is an equal proportion in BMI between children who suffer from MEB disorders and those who do not suffer from MEB disorders such as Anxiety. The p-value is very low, and thus, state that the result is significant.

In regard to potential confounders, Dental Health has a potentially significant role to play in the determination of a child's BMI status, according to our statistical analyses. Indeed, increasing the quality of pediatric patient care depends on a collaborative approach between multiple healthcare providers (pediatricians, dentists, mental health care providers) to create evidence-based clinical care guidelines for a holistic and efficient treatment approach to the pediatric obesity epidemic.

An interesting corollary observation we noticed was that a larger proportion of individuals in the BMI 1 category (Underweight) suffered from anxiety than those who were in BMI 2 category (Normal). In addition, the proportion of those who had 'Poor' Dental Health category was higher in BMI 1.

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Jin Xiu Lu: Background and Analysis Part 1
Nalingna Yuan: Limitations, Data Set Description

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