Parent-Perceived Stress and Its Association with Children's BMI and Obesity-Related Behaviors

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Scholarly Report submitted in partial fulfillment of the MD Degree at Harvard Medical School

Date: 6 February 2018

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Scholarly Report Title: Parent-Perceived Stress and Its Association with Children's BMI and Obesity-Related Behaviors

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Abstract:

Background: Stress is associated with greater rates of obesity in adult and pediatric populations. Few studies have examined the relationship between parent stress and child obesity and related behaviors.

Methods: We studied 689 pairs of parents and children ages 2-12 years with body mass index (BMI)≥85th percentile in eastern Massachusetts. We asked parents a single question about their perceived stress and categorized responses into low, moderate and high levels. We examined associations of parent's stress with children's BMI z-scores and obesity-related behaviors using multivariable regression models adjusted for child/parent characteristics and stratified results by child age, race/ethnicity and household income.

Results: In fully-adjusted models, the association we observed between high (vs. low) parent-reported stress and children's age/sex-adjusted BMI z-scores only remained significant for children in lower-income households (β=0.22 [95% CI 0.08, 0.37]) and of Non-Hispanic Black race/ethnicity (0.29 [0.10, 0.47]). Parents with high or moderate (vs. low) stress were less likely to report that their children met recommendations for fast-food consumption (Prevalence Ratio=0.79 [0.65, 0.96] and 0.70 [0.59, 0.82]), but parents with high vs. low stress were more likely to endorse daily physically activity (1.21 [1.01, 1.45]). Parent-perceived stress was not associated with other obesity-related behaviors.

Conclusion: Among children with overweight/obesity, parent-perceived stress was associated with greater fast-food consumption and physical activity, and with higher child BMI among children in low-income households and of Non-Hispanic Black race/ethnicity. Obesity interventions should consider parent-perceived stress and potential differences in the nature of stress experienced by parents of different racial/ethnic and socioeconomic backgrounds.

Student Contribution:

I started working as a research assistant for the Connect for Health Trial in September 2015. I was trained to conduct follow-up surveys over the phone, clean data, and input the data into the software system. While conducting the surveys I became interested in the potential association between parent stress and pediatric obesity, and met with Dr. Taveras to craft a study question. I completed a literature review and created an analysis plan with input from Dr. Taveras and her colleagues. With the help of the team's statistician, we analyzed the data, made adjustments, and re-analyzed the data. I prepared an abstract, reviewed and revised by the members of the team, which was accepted by The Obesity Society for their Annual Meeting in November 2016. After the conference, I prepared the first draft of the manuscript, and then organized revisions from other authors prior to submission for publication. With each submission to different journals, I have worked with my colleagues to make changes based on peer reviewer comments, and taken ownership over the resubmission process.

This was a collaborative project, and I am extremely grateful for the mentorship received as I worked to complete my first significant research experience. All authors played different roles over the course of this project, but all reviewed, revised, and approved the final manuscript. Dr. Taveras, my primary SIM mentor, was the Principal Investigator of the Connect for Health Randomized Control Trial, from which the data analyzed was generated. She served as an overall project mentor and provided advice as I created the analysis plan for the study. I primarily worked with Monica Gerber to complete the statistical analysis of the study, and she wrote the corresponding section of the manuscript. Dr. Fiechtner helped conceptualize the data analysis plan, while Chrissy Horan coordinated survey administration, data collection and storage. Dr. Sharifi helped to conceptualize the design of the study, prepare the analysis plan and the first draft of the manuscript, and helped revise drafts of the manuscript based on peer reviews.

Appendix:

INTRODUCTION

Higher levels of psychosocial stress are associated with greater rates of obesity in adult and pediatric populations.[1-7] However, fewer studies have reported on the relationship between stress among parents and their children's risk of obesity.[8-10] Plausible behavioral, biological, and developmental mechanisms support such an association. Parents with greater stress may have less time to supervise their children, take them to organized physical activities, or shop for food and cook.[6,7,10-12] They may exercise less and eat less healthy diets, increasing the likelihood that their children will do the same.[13,14] High levels of stress among mothers may affect their children's hypothalamic-pituitary-adrenal axis or disrupt the formation of secure attachment and self-regulation skills.[15]

Studies examining the health impacts of stress most commonly use various objective measures to define stress, asking questions about physical and mental health,[10] parenting, home and family life,[16-19] finances[20,21] and racial discrimination.[22] While objective measures have advantages, they fail to take into account the important personal and contextual factors that modify how potential stressful life events are experienced, which may be an important mediator of health outcomes. Studies comparing objective and subjective measures of stress, such as the Perceived Stress Scale,[23] have demonstrated that they capture different information.[10] Yet, subjective measures of stress are infrequently used, and few studies have examined the relationship and potential intergenerational effects between perceived stress and obesity. Even fewer studies have examined single-item measures of perceived stress that could feasibly be used as a screening tool in primary care settings. While a shortened version of the Perceived Stress Scale exists, the four questions required are still likely prohibitive for routine use, as reflected by

recent recommendations from an Institute of Medicine committee to include a single-item measure of stress in the electronic health record as part of a "psychosocial vital sign".[24]

In this study, we examined the extent to which parent's responses to a single-question measure of stress was associated with BMI and weight-related behaviors among children with overweight and obesity. The ultimate goal is to inform feasible screening for psychosocial mediators of childhood obesity and guide the development of more effective, family-centered pediatric obesity interventions. We hypothesized that higher parent-perceived stress would be associated with higher child BMI and adversely associated weight-related behaviors, including screen time, sleep, physical activity, consumption of fast food, sugar-sweetened beverages, and fruits and vegetables.

METHODS

Participants and Setting: We studied 689 parent-child pairs from 6 pediatric primary care practices in eastern Massachusetts participating in the Connect for Health study - a two-arm randomized control trial studying an obesity intervention that leverages clinical and community resources and addresses socio-contextual factors.[25] During a well-child visit, pediatricians received an alert in the electronic health record to refer patients to the study if they were between the ages of 2-12 years and had a BMI $\geq 85^{th}$ percentile. Research assistants then called parents of referred children to establish eligibility, answer questions about the study, obtain verbal consent and complete the baseline survey. Participants were eligible for enrollment in Connect for Health if children were between the ages of 2-12.9 years, had a BMI $\geq 85^{th}$ percentile for age/sex, and had at least one parent with an active email address and comfortable reading and speaking in

English. Participants were ineligible if the child did not have at least one parent/guardian able to follow study procedures for 1 year, the family planned to leave the pediatric practice, the child's primary care provider thought the intervention was inappropriate for the family (e.g. due to emotional or cognitive difficulties), there was already a sibling enrolled, the child or parents were members of the study's family advisory group, or if the child had a chronic condition or was on medications that substantially interfered with growth or participation in physical activities. Of the 1752 children referred by their providers for recruitment, 267 did not meet inclusion criteria; 721 of the remaining parent-child pairs consented to participate in the study. We analyzed data from 689 parents who completed the study's baseline survey, excluding parent-child pairs with incomplete survey responses. BMI and age/sex-adjusted BMI z-scores were calculated from the children's height and weight as measured by trained medical assistants, who entered values into the electronic health record as part of routine care during annual well-child visits. All Connect for Health study activities were approved by the Partners Human Research Committee, the Institutional Review Board of Partners HealthCare. During the Connect for Health trial, all baseline survey data with identifying information was stored by lock and key or as password-protected electronic files.

Measures:

Outcome measures: Dependent variables were children's BMI z-score, screen time, sleep duration, physical activity, and consumption of fruits and vegetables, fast food, and sugar sweetened beverages at baseline. The survey questions can be found in Table 1. We treated BMI z-score as a continuous variable and dichotomized all health behaviors based on the health

behavior goals of the Connect for Health study.[25,26] These goals were defined as ≤2 hours of screen time each day, ≥60 minutes of daily exercise 7 days a week, consumption of fruit and vegetable ≥5 times per day, fast food < once per week, and sugar-sweetened beverages zero times per day. The recommended hours of sleep per night varied by age, as defined by the National Heart, Lung, and Blood Institute.[27]

Main exposure variable: We asked parents a single question to assess their level of perceived stress, adopted from the Growing Up Today Study.[28] Parents were asked "How much stress do you feel in your life?" with 5 response options: "I never feel stress", "I sometimes feel a little stress, but it's no big deal", "I feel stress fairly often", "I sometimes feel a lot of stress" and "I feel a lot of stress most of the time." We collapsed these 5 variables into 3 categories: "never/sometimes a little" for low stress, "fairly often/sometimes a lot" for moderate stress, and "most of the time" for high stress.

Covariates: Multivariable models included child age, sex, and race/ethnicity, and annual household income and parent BMI as covariates.[8-10,17,29] Child race/ethnicity was categorized as Non-Hispanic White, Non-Hispanic Black, Hispanic/Latino or other. Parent BMI was calculated using parent-reported height and weight and dichotomized to < or ≥ 30 kg/m^2. Parent-reported household income was dichotomized to ≤ or >$50,000 per year. We selected this threshold given that the median household income for Massachusetts in 2015 was $68,563[30] and 40% of the median neighborhood household income for this population sample was ≥$70,000.

Statistical analysis: We first calculated means and standard deviations, or frequencies and percentages, for child, parent and household characteristics at baseline. To test the association between parent-perceived stress and age/sex-adjusted BMI z-score, we used robust regression with bisquare weighting, an alternative to least square regression which accounts for outlier observations that are part of the population under study. We adjusted for child race/ethnicity, parent BMI, and household income. To test the association between parent stress and children's health behavior, we used generalized linear models with the log-binomial distribution to calculate adjusted prevalence ratios (PR) and 95% confidence intervals (CI).[31] For the health behaviors, we additionally adjusted for child age/sex. All adjusted log-binomial models converged. To examine whether the effect of parent-reported stress on BMI z-score and the five obesity-related behaviors varied according to sociodemographic characteristics, we included interaction terms and developed stratified models for three participant characteristics: child race/ethnicity, household income, and child age (2 to <7 years and ≥7 years), as children have varying levels of autonomy with age, and school entry changes parent-child dynamics. Interaction terms were considered significant if p-values were less than 0.10, therefore up to six statistically significant interaction tests would be expected on the basis of chance alone.[32,33] All analyses were conducted in SAS version 9.4 (SAS Institute, Inc., Cary, North Carolina).

RESULTS

Descriptive characteristics for the participant sample are shown in Table 2. Of 689 parents, 43.7% reported low stress, 35.7% moderate stress and 20.6% high stress. The mean (SD) BMI z-score of children was 1.9 (0.5) and the mean BMI percentile was 95.4 (4.0). As a measure of

socioeconomic status, 44.1% of respondents had an annual household income ≤$50,000. With regard to race/ethnicity, 34.4% of children were Non-Hispanic White, 33.8% were Non-Hispanic Black and 22.1% were Hispanic/Latino. The proportion of children who met the health behavior goals at baseline ranged from 11.1% for fruit and vegetable consumption to 51.0% for fast food intake.

BMI z-score

In unadjusted models, parents reporting high versus low stress had children with higher BMI z-scores (β=0.11 [95% CI 0.01, 0.22]), but there was no significant difference in child BMI z-scores among parents reporting moderate versus low stress (β=0.03 [95% CI -0.06, 0.12]). The association between high parent stress and child BMI z-score persisted in models adjusted for child race/ethnicity, but as shown in Table 3, the association was no longer significant after adjusting for household income and parent BMI.

We then examined models that included interaction terms for high and moderate (vs. low) parent-reported stress and race/ethnicity, household income, and child age. The interaction terms for Non-Hispanic Black race/ethnicity and low household income were significant (interaction term p-values 0.01 and 0.08, respectively). Figure 1 displays fully adjusted stratified models. Parents reporting high versus low stress had children with higher child BMI z-scores in households with an annual income ≤$50,000 (β=0.22 [95% CI 0.08, 0.37]) and among children of Non-Hispanic Black race/ethnicity (β=0.28 [95% CI 0.10, 0.47]) but not in households with an annual income >$50,000 (β=-0.07 [95% CI -0.21, 0.08]) nor among children of other

racial/ethnic groups (Figure 1). There were no significant associations between moderate versus low parent-reported stress and children's BMI z-scores in these stratified groups. No significant association was found between parent stress and child BMI when the data were stratified by child age.

Obesity-related Behaviors

As shown in Table 3, based on their parents' reports, children were less likely to meet the health goal of consuming fast food less than once per week if parent-perceived stress was high versus low (PR= 0.79 [95% CI 0.65, 0.96]) or moderate versus low (PR= 0.70 [95% CI 0.59, 0.82]). High versus low parent stress was associated with a higher likelihood of parents reporting that their children were physically active for at least 60 minutes daily, 7 days per week (PR= 1.21 [95% CI 1.01, 1.45]), but moderate versus low parent stress was not (PR= 0.90 [95% CI 0.75, 1.08]). We observed no significant relationship between increased parent-reported stress and the likelihood of children meeting health goals for screen time, sleep duration and consumption of fruits/vegetables and sugar sweetened beverages (Table 3).

We found a significant interaction between moderate (vs. low) parent stress and Hispanic race/ethnicity in our model of fast food consumption (p=0.06), as well as for high (vs. low) parent stress and age 2-6 years (vs. 7-12 years) in our model of sugar sweetened beverage consumption (p=0.02). However, stratified models did not show any clear differences in the effect of parent stress on obesity-related behaviors between these groups with overlapping confidence intervals between stratified subgroups.

DISCUSSION

In fully-adjusted models, the association we observed between high vs. low parent-reported stress and children's age and sex-adjusted BMI z-scores only remained significant for children in lower-income households and of Non-Hispanic Black race/ethnicity. Of the six obesity-related health behaviors studied, only fast food consumption and physical activity were found to be significantly associated with higher levels of parent-perceived stress.

Our findings corroborate and expand on a prior cross-sectional study among children with and without elevated BMI that used a different single-item measure of perceived stress and similarly observed an association between parent-perceived stress and child obesity in crude models, but found no significant effect in models adjusted for child age, sex, race/ethnicity and health quality (excellent or poor), and parent sex, education level and BMI.[10] Another study looking at associations between the 4-item Perceived Stress Scale and child BMI used both cross-sectional and prospective data over a four-year period, and found that the association between parent-perceived stress and child BMI remained significant in both analyses after adjusting for age, sex, race/ethnicity and community of residence, with substantial attenuation after additionally adjusting for traffic-related pollution at home, extra-curricular exercise activity, residence in a "food desert" and parental education.[9] How a single-item measure of stress relates to longer, validated measures of perceived stress remains to be fully understood. However, these studies suggest that the relationship between parent-perceived stress and child obesity is confounded and modified by child, parent, community and household characteristics.

To our knowledge, this study is the first to examine and observe effect modification of the relationship between parent-perceived stress and child BMI by household income and Non-Hispanic Black race/ethnicity. A prior study observed significant interaction effects of Hispanic race/ethnicity on the association between parent-perceived stress and children's BMI.[9] We did not observe this interaction, which could be a result of our smaller sample size of Hispanic children or that relationships between parent stress and child BMI are context dependent. Overall, the drivers of the heterogeneity of the effect we observed among certain sub-groups in our sample are unclear. We did not find any evidence of effect modification by household income or race/ethnicity of the relationship between parent stress and the studied health behaviors. Depending on one's life circumstances the nature of a person's perceived-stress may have variable consequences, revealing an important limitation of a single-item screener. Discrimination affects health in numerous ways,[34] and is one category of stress that may disproportionately affect both low-income and Non-Hispanic Black families, with greater relative impact on health outcomes compared to other categories of stress. Perceived discrimination has been shown to be associated with higher rates of obesity,[35] and perceived racism has been separately linked to obesity and hypertension.[36,37] Higher levels of parent stress may change certain parenting behaviors unmeasured in this study that are related to child obesity or may result in a stressful home environment, and the same biologic mechanisms thought to link stress and obesity in adults and children may be translated across generations.[38-41]

Our finding that the children of parents with higher levels of stress were more likely to consume fast food once a week or more are consistent with the findings of prior research[10] and affirm our hypothesis. Parental stress may impact family meals, cooking and shopping behaviors. There is evidence that stress is related to an increased consumption of foods with high fat and

sugar content, which could lead to stressed parents purchasing less nutritious foods and setting an example that encourages similar dietary preferences in their children.[12,42-44] We did not observe evidence of effect modification of this relationship by household income, child race/ethnicity, or child age. As a modifiable risk factor of obesity, pragmatic strategies to reduce fast food consumption should consider parent stress.

The finding that children of parents with higher versus lower-levels of stress are more likely to engage in physical activity for more than 60 minutes per day, 7 days a week, was an unexpected finding and one that had not been observed in other studies.[10] In fact, a systemic review from 2017 found fairly consistent evidence for associations between higher maternal stress and lower child physical activity.[45] The results of our study may be specific to how the survey question was asked. Parents with greater stress may have less face-to-face time with their children and overestimate their level of physical activity. If our results represent a true association, this could be due to involvement in organized activities, leading to greater parent stress secondary to associated costs, time and organization required for participation. Notably the survey question on physical activity did not distinguish between structured and unstructured play.[12]

We found no significant associations between increased parent stress and other behaviors, and to our knowledge, this is the first study to look at the association between parent-perceived stress and child screen time, sleep duration and sugar sweetened beverage consumption. A recent qualitative study found that parents may use screen time with their kids as a way of decreasing their own stress,[12] but we found no association to support this hypothesis.

Beyond the inclusion of multiple obesity-related behaviors, a strength of this study is the use of a single question to measure perceived stress, adopted from the Growing Up Today Study.[28] Unlike longer, validated measures of perceived stress, a single question may feasibly be asked as a part of well child visits in routine pediatric primary care. Recently, an Institute of Medicine committee recommended a single-item measure of stress in the electronic health record as part of a new set of "psychosocial vital signs."[24,46]

Limitations of this study include its cross-sectional design, which limits conclusions about directionality or causality. Our analysis of effect modification using interaction terms was constrained by our sample size, particularly for the dichotomous variables used for health behaviors. With increased testing, we increased the risk of discovering significant results due to chance alone. We sought to address this concern by forming a priori hypotheses and by concurrently conducting stratified analyses to evaluate evidence of effect modification. The generalizability of our results may be limited by the study's sample representing children with overweight and obesity who are insured and seen in pediatric primary care. There are additional covariates we did not include in our analysis that may affect the observed relationships, such as the effect of household size or single-parent households[8,17,29,47], education, and employment status[48]. With the exception of child height and weight, all data points were self reported by parents. There is potential selection bias as providers alerted about a child eligible for this study could choose to not recommend it if they deemed the intervention inappropriate for the family. Response bias is also possible as parents with high stress may be more difficult to reach and less willing to participate. Finally, this study could also be limited by reporter bias, as parents may inaccurately or optimistically recall the health behaviors of their children or may provide more socially-desirable responses.

In summary, we found that higher parent stress is associated with greater child fast food consumption and physical activity, and that parent-perceived stress is variably associated with BMI among children depending on annual household income and race/ethnicity. Further understanding of the drivers of the heterogeneity in the effect of parent-perceived stress on children's BMI, particularly among parents from lower income households and with children of Non-Hispanic Black race/ethnicity, is needed to guide meaningful screening for psychosocial mediators of childhood obesity and the development of childhood obesity interventions that are responsive to family context. A single-item measure of stress may be an effective place to start, yet our results suggest a need for further questioning for those parents who screen positive for perceived stress.

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