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Short communication

Parental perception of child weight and inflammation: Perceived overweight is associated with higher child c-reactive protein

Angelina R. Sutin[a,*], George Rust[a], Eric Robinson[b], Michael Daly[c,d], Antonio Terracciano[a]

[a] Florida State University College of Medicine, United States
[b] Institute of Psychology, Health & Society, University of Liverpool, United States
[c] Behavioural Science Centre, University of Stirling, United States
[d] UCD Geary Institute, University College Dublin, United States

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ABSTRACT

Self-perceived overweight and weight discrimination are associated with inflammation in adulthood. We test whether there is an intergenerational association of parent perception of child overweight on higher levels of child c-reactive protein (CRP), a marker of inflammation implicated in stress. Data were from the National Health and Nutrition Examination Survey 2005–2014 (N = 4988). Parents reported their perception of their child's weight; CRP was assayed from children's blood samples. Children whose parents perceived them as overweight had higher CRP levels than children who were perceived about the right weight; perceived underweight was also associated with higher CRP ($F(2,4977) = 9.23$, $p < .001$). These associations were independent of the child's objective weight status and waist circumference and held when the sample was limited to children with objective overweight and obesity. These results suggest an intergenerational transfer of the psychological perception of body weight from parents to the inflammatory health of their child.

Many parents perceive their children to be normal weight when the child objectively measures in the overweight or obese category of body mass index (BMI) (Lundahl, Kidwell, & Nelson, 2014). This misperception is considered problematic because it is assumed that parents must first accurately perceive their child as overweight to be able to intervene successfully for weight loss (Moore, Harris, & Bradlyn, 2012). Recent evidence, however, suggests that parent perception of their child as overweight may be harmful rather than beneficial for the child's weight gain trajectory. Parent perception of overweight at age 4, for example, is associated with greater child weight gain up to age 12 (Robinson & Sutin, 2016), even after controlling for baseline weight; a finding that has replicated (Robinson & Sutin, 2017; Gerards et al., 2014). A quasi-experimental study on BMI report cards came to a similar conclusion (Almond, Lee, & Schwartz, 2016): adolescent girls who had a BMI just over the threshold of overweight were classified as "outside a healthy weight" and subsequently gained more weight than girls who had a BMI just under this threshold (a similar effect was not found for adolescent boys). These findings suggest that accurate knowledge and labeling of a child's weight category may have the opposite of the intended effect.

In addition to greater weight gain, there may be other physiological correlates of parent weight perceptions. C-reactive protein (CRP), in particular, is a common inflammatory marker implicated in stress (Steptoe, Hamer, & Chida, 2007) as well as greater adiposity (Brooks, Blaha, & Blumenthal, 2010). In adulthood, the stress and stigma of overweight is associated with greater inflammation, independent of the individual's adiposity (Sutin, Stephan, Luchetti, & Terracciano, 2014; Daly, Sutin, & Robinson, 2017). Parental perception of the child's weight may likewise be stressful and thus apparent in the child's level of inflammation. The present research addresses whether this association between the psychological experience of weight and greater inflammation is intergenerational. Specifically, we test the hypothesis that children perceived overweight by their parents have higher CRP than children perceived to be about the right weight by their parents. We test whether this association holds controlling for the child's adiposity to account for the greater inflammation that occurs at higher body weight (Brooks et al., 2010). We also test whether the association holds for children whose BMI measures ≥85th percentile because these are the children most at risk for the label of overweight and thus its negative correlates. We examine these cross-sectional differences using data from the National Health and Nutrition Examination Survey (NHANES).

* Corresponding author at: Florida State University College of Medicine, 1115 W. Call Street, Tallahassee, FL 32306, United States.
E-mail address: angelina.sutin@med.fsu.edu (A.R. Sutin).

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Table 1
Descriptive Statistics for all Study Variables.

Variable	Percentage or Mean (SD)
Child gender (female)	48.7%
Child age (years)	9.25 (4.06)
Maximum household education[a]	3.37 (1.27)
Ethnicity (African American)	24.3%
Ethnicity (Hispanic)	39.7%
Ethnicity (other)	6.5%
Ethnicity (Non-Hispanic white)	29.5%
BMI-for-age percentile	64.33 (29.62)
Waist circumference (cm)	67.28 (15.73
C-reactive protein (mg/L)	.90 (1.50)
Parent perception	
About the right weight (yes)	77.2%
Overweight (yes)	15.6%
Underweight (yes)	7.2%
Measured Weight Category	
Normal weight (yes)	63.2%
Overweight/obese (yes)	33.8%
Underweight (yes)	3.0%

N = 4988. SD = standard deviation. [a]Education is a 5-point scale from 1 (less than 9th grade) to 5 (college graduate or above); 3 corresponds to high school graduate or GED equivalent.

1. Methods

1.1. Participants and procedure

Participants were drawn from NHANES 2005–2014 (Centers for Disease Control and Prevention National Center for Health Statistics, 2016). These years were selected because the questionnaire in these cycles included an item on how parents perceived the weight of their child. Descriptive statistics are shown in Table 1. The Research Ethics Review Board at the National Center for Health Statistics approved the NHANES protocol. Informed consent was documented from parents for their child to participate in the NHANES assessment and children aged 11 and older provided assent prior to participation.

1.2. Measures

1.2.1. Perceived weight

The parents of children between the ages of 2 and 15 were asked, "Do you consider [SP] now to be…" Responses options were "overweight," "underweight," and "about the right weight."

1.2.2. C-reactive protein

A blood sample was taken from the children who took part in the in-person assessment at the mobile examination center. Standard procedures and quality controls were used in the assay of CRP from these blood samples (Hutchinson & Wener, 2007).

1.2.3. Adiposity

Participants were weighed on a digital scale wearing only underwear, disposable paper gowns, and foam slippers. Height was measured with a stadiometer. BMI-for-age percentile was calculated based on the Centers for Disease Control and Prevention (CDC) growth charts (Kuczmarski et al., 2000). Waist circumference was measured with a steel measuring tape as the circumference of the waist just above the iliac crest.

1.3. Analytic strategy

Analysis of covariance was used to test for differences in CRP by parent perception of child's weight: CRP was entered as the dependent variable, weight perception (about the right weight, overweight, underweight) was entered as the independent variable, and child gender, child age, maximum household education, child race/ethnicity (three dummy-coded variables that contrasted African American, Hispanic, and other race/ethnicity against non-Hispanic white), and child BMI percentile-for-age and waist circumference were entered as covariates. Per NHANES instructions, exam sampling weights were used in the analysis (Centers for Disease Control and Prevention National Center for Health Statistics, 2016). Parent perceived overweight and perceived underweight were compared to perceived about the right weight. Child gender, child age, and child BMI percentile-for-age were tested as moderators of this association. Follow-up analyses focused specifically on children who measured in the overweight and obese BMI categories (BMI ≥85th percentile). In this sub-sample of children with objective overweight, we re-ran the analysis to examine whether children whose parents perceived them as overweight had higher CRP than children whose parents perceived them as normal weight, controlling for the same covariates.

2. Results

A total of 5176 children had parent report of perceived weight, CRP, and the covariates. Of these participants, 188 were excluded from the main analysis due to elevated CRP (≥10.00 mg/L) indicative of acute infection (Pearson et al., 2003). Thus, the total analytic sample was 4988. The sample was 48.7% female, the average age was 9.25 years (SD = 4.06; range 2–15), 36.8% were overweight or obese, and 15.6% were perceived overweight by their parents (Table 1). Bivariate correlations among all study variables are shown in Table 2.

There were mean-level differences in CRP by parent perception of

Table 2
Bivariate Correlations Among All Study Variables.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Gender (female)	–										
2. Age (years)	.00	–									
3. Education[a]	−.02	.02	–								
4. Ethnicity (African American)[b]	.01	.04*	.03*	–							
5. Ethnicity (Hispanic)[b]	.01	−.01	−.38*	−.46*	–						
6. Ethnicity (Other)[b]	−.01	−.03*	.09*	−.15*	−.21*	–					
7. BMI Percentile	.05*	.10*	−.10*	.02	.09*	−.06*	–				
8. Waist Circumference (cm)	.03*	.71*	−.06*	−.02	.08*	−.06*	.57*	–			
9. Perceived Overweight[c]	.04*	.17*	−.06*	−.01	.10*	−.05*	.44*	.57*	–		
10. Perceived Underweight[c]	−.08*	−.02	.01	−.01	−.02	.01	−.34*	−.17*	−.12*	–	
11. C-Reactive Protein (mg/L)	.04*	.06*	−.13*	−.01	.13*	−.04*	.33*	.36*	.35*	−.09*	–

N = 4988.
[a] Education is a 5-point scale from 1 (less than 9th grade) to 5 (college graduate or above).
[b] Compared to non-Hispanic white.
[c] Compared to perceived about the right weight.

Table 3
Mean-Level Differences in Child C-Reactive Protein (mg/L) by Parent Perception of Weight.

Model	Parent Perception			*df*	*F*
	About the right weight	Overweight	Underweight		
Fully-adjusted Model[a]	.80 (.02)	1.10 (.07)*	.90 (.07)*	2, 4977	9.23*
Unadjusted Model[a]	.70 (.02)	1.70 (.05)*	.70 (.07)	2, 4985	169.01*
All participants[b]	1.40 (.10)	2.40 (.30)*	2.10 (.30)	2, 5165	6.02*
BMI ≥ 85th percentile[c]	1.20 (.05)	1.40 (.07)*	–	1, 1670	5.95*

Values are estimated marginal means for child c-reactive protein (mg/L) from Analysis of Covariance. The fully-adjusted model controls for child gender, child age, maximum household education, child race/ethnicity, child BMI percentile-for-age, and waist circumference. The unadjusted model does not include any covariates. The model with all participants includes children with evidence of acute infection (≥10.00 mg/L) and adjusts for the same covariates as in the fully-adjusted model. The BMI ≥ 85th percentile model limits the sample to children with measured overweight or obesity and adjusts for the same covariates as the fully-adjusted model.

*$p < .05$.

[a] $N = 4988$.

[b] $N = 5176$.

[c] $N = 1680$.

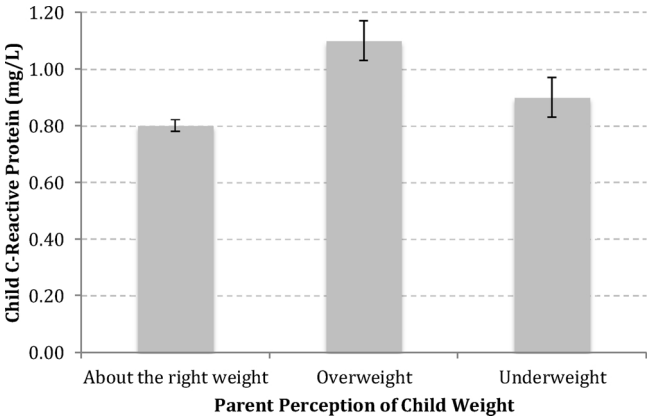

Fig. 1. Mean-level differences in child c-reactive protein by parent perception of body weight.

weight (Table 3): Children perceived to be overweight had higher CRP compared to children perceived about the right weight (Fig. 1); Cohen's *d* for this difference was .20. This difference was significant in the unadjusted model that did not control for the covariates and when participants with evidence of acute infection were included in the analysis (Table 3). Children perceived as underweight also had higher CRP levels compared to children perceived about the right weight, but this difference was only apparent in the fully-adjusted model. The association between perceived weight and CRP was not moderated by child gender, child age, or BMI percentile, which indicated the mean-level difference in CRP by parent perception was similar for boys and girls, across age, and across the BMI spectrum (all *ps ns*).

In the subsample of children with objective overweight/obesity ($n = 1680$), 57% of parents perceived their children about the right weight and 43% of parents perceived their children overweight. Similar to the analysis of the entire sample, children whose parents perceived them as overweight had higher CRP than children whose parents perceived them about the right weight (Table 3).

3. Discussion

The present research indicated that children perceived overweight by their parents had higher inflammation than children perceived about the right weight. This association was independent of BMI and waist circumference, which could both shape parents' perceptions and increase risk of physiological dysregulation, and was similar when the sample was limited to children who objectively measured in the overweight/obese weight categories.

Although counterintuitive, accurate parent perception of overweight has previously been associated with the trajectory of the child's weight gain: Children perceived as overweight by parents gained more weight over time than children perceived as normal weight (Robinson & Sutin, 2016). In previous research, this association was mediated, in part, by the child's own weight perception and dieting-related behavior (Robinson & Sutin, 2017). Physiological factors, such as inflammation, may also contribute to this association (Duncan et al., 2000). Although the current research is cross-sectional, and thus we could not test how these associations unfold over time, the findings establish an association between parent perception of overweight and child inflammation.

Likewise, with the available data, we could not test the mechanisms that explain why parent perception is associated with child CRP. Still, there are several possible mechanisms that we speculate are responsible for this relation. First, parents who perceive their child as overweight might pressure the child to lose weight or at least watch what they are eating; such pressure is stressful for the child (Wansink, Latimer, & Pope, 2016). Second, previous research has shown that parent perception of child overweight is associated longitudinally with the child's self-perception of weight (Robinson & Sutin, 2017), and this weight self-perception is associated with subsequent physiological dysregulation (Daly et al., 2017). Parent perception may thus contribute to child CRP by shaping the child's self-perceptions of their weight over time. Third, frequently commenting on a child's weight was associated with more depressive symptoms, use of extreme weight control behaviors (e.g., laxatives), and binge eating (Bauer, Bucchianeri, & Neumark-Sztainer, 2013), and could lead to greater weight gain and inflammation (Sonneville et al., 2012). Although extreme weight control behaviors are more likely among adolescents than young children, children internalize messages about weight early: children as young as three have been shown to already held negative attitudes about body weight (Spiel, Paxton, & Yager, 2012) and previous work shows that children as young as six expressed dissatisfaction with their own bodies and knowledge of and participation in dieting behavior (Lowes & Tiggemann, 2003). The label of overweight may activate dissatisfaction and behavior (even if not extreme) that may ultimately lead to higher inflammation. Longitudinal and experimental studies are now needed to test these hypothesized mechanisms.

Of note, the results in the current study held when controlling for both BMI and waist circumference and when the sample was limited to children who objectively measured as overweight/obese. This pattern suggests that the higher CRP associated with parent perception is not due only to the fact that CRP is related positively to body weight. In addition, given the greater societal pressure for girls to be thin, being perceived as overweight might be more detrimental for girls than for boys (Blowers, Loxton, Grady-Flesser, Occhipinti, & Dawe, 2003). It was thus surprising that the association between parent perception and child CRP was not moderated by child gender.

The higher inflammation associated with parent perceived overweight may have long-term implications for the child's health. Previous studies have found that CRP, for example, was associated with risk for cardiovascular disease, independent of other cardiometabolic risk factors (Kaptoge et al., 2012) and might impair cardiac health as early as adolescence (Kuo & Gore, 2015). Parent perception of overweight may set children on a trajectory for poor health outcomes in adulthood. The finding that parent perception was associated with higher CRP

independent of the child's measured adiposity suggests that, similar to other health outcomes (Sutin, Stephan, & Terracciano, 2015), the psychological experience of weight may be associated with this trajectory.

The present research had several strengths, including a large national sample, parent-reported perception, staff-assessed weight, and CRP assayed from the child's blood. Future research could address this association with longitudinal data to help disentangle the temporal direction of the association. In addition, although we speculated on why parent perception is associated with higher CRP, we did not have the data to empirically test for mediators of this association. Despite the limitations, the present research indicates that high child inflammation is an additional negative correlate of parent perception of body weight.

Conflict of interest

The authors declare no conflict of interest.

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