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Abstract

Purpose: Schachter's externality theory posits a connection between the inability to eat according to internal cue and higher body mass index (BMI); however, related work has not investigated associations between body trust and the wide range of BMIs found in general samples. This study examined the association between body trust and BMI across levels of BMI to determine whether this relationship differed as a function of BMI level. **Methods:** Participants were 534 adults (55.4% female), mean age 36 years, BMIs 15.13-67.90 (*M* = 27.89, *SD* = 7.25), recruited via MTurk. They completed self-report assessments of body trust, height, and weight. Quantile regression was utilized to estimate effects of body trust on BMI at five equidistant quantiles of BMI. **Results:** Overall linear regression analyses indicated body trust was significantly negatively associated with BMI. Quantile regression revealed a significant negative relationship at each quantile of BMI, and Wald tests indicated the association was significantly stronger at the .7 and .9 quantiles than at the .1, .3, and .5 quantiles, which did not differ. **Conclusions:** Quantile regression identified a stronger relationship between body trust and BMI at .7 and .9 quantiles than at .1, .3, and .5 quantiles of BMI. Results align with the externality hypothesis, which suggests those at higher weights experience difficulty using internal cues to guide eating. A weaker-than-expected association between body trust and low BMI may be due to restricted range (few low-BMI participants). Replication in eating disorder samples is merited.

Level of Evidence: Level VI

Keywords: quantile regression; body mass index; weight; body trust; intuitive eating

Examining the Association between Body Trust and Body Mass Index with Quantile Regression

Body trust is a facet of interoception reflecting the extent to which one perceives the body as safe and trustworthy [1]. More broadly, interoception is the ability to perceive, integrate, and respond to visceral signs relating to body states [2]. It has implications for one's capacity to perceive the physical self, as well as to utilize information from the body to inform emotional processing and guide engagement in goal-oriented behaviors [3, 4]. Dietary restraint, obesity, and eating pathology influence individual differences in how internal sensations, including hunger and satiety, are integrated and used in relation to cognition and behavior [5]. Specifically, some individuals at higher weights report that their eating is unrelated to hunger and satiation cues [6]. Such individuals also exhibit reduced satiation in response to test meals, in comparison to average-weight controls [6, 7]. Evidence also suggests that those at very low weights who exhibit eating pathology, such as individuals with anorexia nervosa, may demonstrate impaired interoceptive abilities [8, 9]. Interoceptive dysfunction has been implicated in various forms of disordered eating, but findings have been mixed regarding which components of interoception are most, or at all, relevant [8, 10, 11]. As such, researchers have begun applying multidimensional assessments of interoception to the study of eating and weight to better clarify whether and how individual facets of interoception relate to these domains.

The body trust facet of interoception may be especially worthy of attention. Trusting the body's sensations of hunger and satiety, rather than external or cognitive cues, is essential in regulating intake effectively. For example, restrained eaters are more susceptible to external cues (i.e., food labels) than are non-restrained eaters, whose food intake is more strongly influenced by their nutritional status [12]. This orientation to external cues is theorized to increase susceptibility to binge eating [13], and the externality hypothesis suggests those of higher body weights are reliant on external, rather than internal, cues for eating [14, 15]. These links extend to those with eating disorders, in whom low body trust is related to various forms of eating disorder behaviors (i.e., bingeing, purging, dietary restraint) and cognitions (i.e., weight concerns, shape concerns) above and beyond other facets of interoception [8].

Good interoceptive function in general, and high body trust in particular, are required to engage in intuitive eating, which entails “trusting the body to determine how much to eat” [16]. In the general population, intuitive eating has been associated with the ability to stop eating when full, reduced disordered eating, and lower BMI [16]. Additionally, responsiveness to interoceptive cues partially accounts for the relationships among facets of intuitive eating: unconditional permission to eat, reliance on internal hunger and satiety cues, and eating for physical rather than emotional reasons [17]. In contrast, externally-oriented eaters will consume food according to cues such as ease of access to food, perceived time of day, and emotional state [14, 15]. Notably, intuitive eating has been associated with maintenance of a normative body weight, various non-weight-related indices of mental and physical health, interoceptive sensitivity, and reduced eating pathology, including both binge-eating and dietary restriction [18–23]. One may expect, therefore, that low body trust would be found in individuals at both extremes of BMI. Though there are many factors determining body weight, the externality hypothesis provides evidence that those least likely to rely on internal cues for eating are also most likely to be at a non-normative body weight [14].

Research, however, has yet to empirically examine the relationship between body trust and BMI. Instead, past work has evaluated related, but distinct, constructs and behavioral proxies such as intuitive eating, binge eating, and eating in response to external cues. We can intuit that body trust would follow similar patterns, but this has yet to be directly evaluated. Further, it may be important to assess these relationships across the BMI spectrum and in demographically-diverse samples. Most relevant work has focused on female undergraduate students, predominantly-female eating disorder samples, or categorical comparisons of high-weight versus average-weight individuals, potentially biasing our knowledge. It is essential to understand what these relationships look like in demographically-diverse community-based samples that may be more representative of the adult population as a whole. Furthermore, many extant studies of BMI rely on linear-regression approaches, which assess the strength of relationship between BMI and constructs of interest at the sample mean, producing findings that do not address the clinically important possibility of differences across levels of BMI. Given previous findings that externally-motivated eating is particularly relevant to those at high body weights and those whose weights are altered by disordered eating, we may expect body trust to be more strongly related to BMI at the extremes of BMI, rather than exhibiting a consistent relationship across the BMI spectrum.

In the current study, we sought to address these limitations by utilizing a quantile regression-based approach applied to an unselected general sample. Quantile regression determines whether relationships between a predictor and an outcome variable differ across levels of the outcome variable (i.e., the strength of the relationship depends on whether an individual is low, average, or high on the outcome variable). Thus, we intended to both evaluate a more demographically diverse sample than in past work and apply a rarely-used, but highly relevant, analytic technique. Consistent with the externality-hypothesis and research on intuitive and disordered eating, we hypothesized: (1) BMI and body trust would be significantly negatively associated in the overall sample, and (2) the relationship between BMI and body trust would be strongest at tails of the BMI distribution, with this strengthening emerging for a wider range of individuals at the high end of the BMI spectrum (i.e., relationship stronger at the .1, .7, and .9 quantiles compared to the .3 and .5 quantiles).

Methods

Participants and Procedures

Participants were 534 adults (44.4% male, 55.4% female, 0.2% transgender male), aged 18 to 71 years (*M* = 36.00, *SD* = 11.41), who were recruited via Amazon's Mechanical Turk (MTurk), a crowdsourcing website that provides quick, inexpensive access to a large and diverse sample of individuals [24, 25]. Evidence suggests that MTurk samples more closely resemble the general population than traditional convenience samples [26] and may be more socioeconomically and racially diverse than other Internet samples [27]. The current sample self-identified as White/European American (78.1%), Black/African American (9.0%), Asian (8.6%), Hispanic/Latino (6.4%), American Indian/Native American (1.3%), Pacific Islander (0.2%), and another ethnicity (0.4%). Participant BMIs ranged from 15.13 to 67.90 (*M* = 27.89, *SD* = 7.25).

The measures described below were part of a larger battery examining associations between diet, exercise, personality, and mental health. Prospective participants (i.e., MTurk users) were given a brief description of the study; those who elected to participate provided electronic informed consent and completed a battery of measures online. Individuals who completed the study were compensated $2.00 for their participation. Participants who completed all measures of interest and answered more than 50% of attention check items correctly (eight of which were dispersed throughout the survey) were included in the current analyses (eight participants were excluded from the original dataset). All procedures were approved by the Florida State University Institutional Review Board and were conducted in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Measures

Multidimensional Assessment of Interoceptive Awareness (MAIA) – Body Trust Subscale [1]**.** The MAIA is a 32-item self-report measure of interoceptive body awareness, comprising eight subscales (i.e., noticing, distracting, worrying, attention regulation, emotional awareness, self-regulation, body listening, and body trust). Items were rated on a 6-point scale ranging from 0 (*Never*) to 5 (*Always*), with higher scores reflecting greater interoceptive awareness. In this study, the 3-item Body Trust subscale (e.g., "I trust my body sensations") was utilized to assess the degree to which one's perception of the body as safe and trustworthy was related to BMI, across varying quantiles of BMI. The Body Trust subscale has demonstrated strong internal consistency and concurrent validity in previous studies [1], as well as high internal consistency in the current sample (ω = .91).

BMI. Participants were asked to indicate their current height (in inches) and weight (in pounds). These indices were utilized to calculate participant BMI (kg/m^2). Importantly, previous work suggests self-reported height and weight yield relatively accurate estimates in both normal and high-weight adults [28, 29], supporting use of such data when direct, objective assessment of BMI is not feasible.

Data Analytic Strategy

The normality and interrelatedness of body trust and BMI were first examined using descriptive statistics and bivariate correlations. BMI was positively skewed and leptokurtic; however, consistent with recommendations for quantile regression analyses [30, 31], we did not conduct data transformations because quantile regression is semiparametric in nature (i.e., makes no assumptions about the distributions of errors and accordingly more robust to non-normal distributions and outliers) and invariant to monotonic transformations [30]. In order to examine the utility of quantile regression over ordinary least squares (OLS) regression in evaluating the question at hand, we began with a linear regression analysis with body trust as the independent variable and BMI as the outcome variable. Quantile regression [31, 32] was then used to estimate the effects of body trust on BMI across different quantiles of BMI, that is, incorporating estimates of this relationship both at the .5 quantile (i.e., the sample median, approximating the results of OLS regression) and at other quantiles of interest. Specifically, we made *a priori* determinations to examine five equidistant quantiles on the distribution of BMI (i.e., the .1, .3, .5, .7, and .9 quantiles); a Wald test was conducted to compare magnitudes of relationships between body trust and BMI at each quantile. We then calculated pseudo R-squared values for the model at each quantile. Pseudo R-squared is a local measure of goodness of fit as compared to the intercept-only model and is preferred in quantile regression analyses to effect size estimates such as R^2 [33]. In our sample, BMI values at each quantile were as follows: 20.88 (.1 quantile), 23.52 (.3 quantile), 26.11 (.5 quantile), 29.76 (.7 quantile), and 37.11 (.9 quantile). For ease of comparison to past work on the externality hypothesis, BMI quantiles in our sample roughly corresponded to the designations of normal (.1 and .3 quantiles), overweight (.5 quantile), and Class 1 (.7 quantile) and Class 2 obesity (.9 quantile). Missing data were minimal (0.7%) and handled via listwise deletion. All analyses were conducted in R using the *quantreg* package [34].

Results

Descriptive statistics and bivariate correlations are presented in Table 1. Body trust and BMI were slightly negatively correlated (r = -.18, p < .001). Results of an initial OLS regression indicated that body trust was significantly negatively associated with BMI (B = -.99, SE = .24, p < .001) at mean levels of BMI.

Quantile regression analyses (see Table 2) then examined the relation between body trust and BMI across quantiles of BMI. Estimated relations between body trust and BMI were dependent upon levels of BMI, such that the association between body trust and BMI was strongest at the high end of the distribution (i.e., .1 quantile: *B* = -.59, *SE* = .17; .3 quantile: *B* = -.48, *SE* = .17; .5 quantile: *B* = -.73, *SE* = .24; .7 quantile: *B* = -1.26, *SE* = .35; .9 quantile: *B* = -2.30, *SE* = .54). Specifically, results of Wald tests indicated that the association between body trust and BMI was significantly stronger at the .9 quantile than at the .5 (F = 6.48, p = .011), .3 (F = 8.17, p = .004), and .1 (F = 6.91, p = .009) quantiles, as well as being stronger at the .7 quantile than at the .5 (F = 4.44, p = .035), .3 (F = 6.89, p = .009) and .1 (F = 4.30, p = .038) quantiles. In contrast, there were no differences in slopes among the .1, .3, and .5 quantiles or between the .7 and .9 quantiles (*Fs* = .31-3.44, *ps* = .064-.579). Notably, the quantile regression results suggest a stronger relationship between body trust and BMI at the .7 and .9 quantiles than at the .1, .3, and .5 quantiles of BMI. Pseudo R-squared values at each quantile were as follows: .037 (.1 quantile), .028 (.3 quantile), .031 (.5 quantile), .039 (.7 quantile), .066 (.9 quantile).

Discussion

This study sought to examine the relationship between body trust and BMI across quantiles of BMI. As expected, we found that body trust was negatively associated with BMI in the overall sample, and the strength of this relationship varied across quantiles of BMI. Results only partially aligned with our hypothesis that body trust and BMI would exhibit the strongest association at the tails of the BMI distribution. Specifically, the association was significantly stronger at higher (.7 and .9 quantiles) levels of BMI in comparison to average (.5 quantile) and lower (.1 and .3 quantiles) levels, which did not differ from one another.

The current investigation was the first, to our knowledge, to specifically assess body trust and BMI. In addition, we utilized quantile regression, a novel analytic technique and evaluated a more demographically diverse sample than previous work on related constructs. Our finding that body trust was most strongly, and *negatively*, associated with BMI at the .7 and .9 BMI quantiles extends previous literature that illustrated a negative association between intuitive eating and BMI [23], and provides support the externality hypothesis, which suggests those at high body weights are less likely to respond to internal than external cues [14]. In addition, individuals of higher body weight are often encouraged to restrict their caloric intake in order to reduce adiposity [35]. This attention to rules for when to eat and what to eat could further reduce attention, awareness, and trust in interoceptive cues of hunger and fullness. Further, individuals with greater BMIs disproportionately experience weight stigma relative to those at lower weights [36], which could lead to perceptions of the body as a threat. Notably, body trust encapsulates not only trusting bodily sensations, but also feeling safe and at home in one's body [1]. Thus, low body trust may be a consequence as well as a contributor to high BMI. Future work may further investigate possible bi-directional associations between these constructs in multi-wave cross-lagged designs, as well as examine dieting and internalization of weight stigma as potential mediators of these relationships.

Our hypothesis that those at the lower end of BMI (i.e., .1 quantile) would also exhibit a stronger relationship with body trust than those at the .3 and .5 quantiles was not supported. It is possible that, for some individuals with lower weights, the association between low body trust and low BMI may be accounted for by distortions in how the body is perceived and over-control of the body that is often characterized in anorexia nervosa [37]. Our sample, however, was an unselected sample with limited representation of individuals at lower ends of the BMI spectrum, such that the .1 quantile still fell within the “normal” weight BMI designation. Our lowest BMI was 15.13, and few individuals had BMIs below 18.5. Thus, work in samples including more underweight individuals is needed. If the relationship of BMI and body trust does not strengthen as body trust decreases, it may be because some at low weights feel they are in control of their body and weight, or have a lower set point to which their body naturally gravitates, and so do not feel threatened by or distrustful of their bodily signals, whereas others may fear weight gain and so feel a need to remain vigilant in order to maintain their weight. This sort of variability would make it difficult to find a reliable association between body trust and BMI in those at lower weights. Still, these same dynamics could be at play in those of other weight classes as well. Greater representation of low weight individuals would clarify whether current findings were limited by restricted range versus the association simply being less strong at the lower end of the BMI spectrum.

As body trust has been linked to various forms of eating pathology [8], the results here suggest it may have implications for eating disorder research and treatment. Subsequent studies in samples with clinically significant eating pathology are merited, particularly in transdiagnostic eating disorder samples, in order to determine whether associations between body trust and BMI vary across eating disorder diagnosis and severity. Of note, BMI is not a direct indicator of health or eating behavior [38], and clinically significant disordered eating can occur at any BMI. Similarly, there are high and low BMI individuals who are physically and psychologically healthy. There may be subsets of individuals at either extreme of BMI, as well as mid-range BMI, with more or less body trust. Indeed, the current study sample contained examples of such individuals. Attention to other explanatory variables and potential interaction effects could lend greater nuance to findings in this area. In this effort, it would be useful to integrate measures of intuitive eating, weight- and eating-related cognitions and behaviors, and weight suppression in order to evaluate whether body trust is related to BMI specifically, or to other related constructs. We drew from extant work on related constructs to derive our hypotheses, but replication and extension of findings specific to body trust is needed. This work could also prospectively examine the role of BMI and body trust in psychological and behavioral outcomes.

Despite some limitations, this study is novel and breaks new ground in our understanding of how body trust relates to BMI, providing theoretical basis for its association with intuitive versus externally-oriented eating, as well as body weight. The study is strengthened by its use of a sample representing a broad range of BMIs and the full range of body trust scores, as well as more demographic diversity than previous work. We also utilized quantile regression, an innovative method rarely applied to eating-related research (see Rogers, Kennedy, Duffy, Keel, & Joiner, under review), that is robust to non-normal variable distributions (as seen with BMI) and provides a more nuanced interpretation of between-variable associations than linear regression-based techniques. Overall, this work suggests a need for more attention to the construct of body trust in the eating and weight-related field in order to clarify our understanding of if, when, and how it relates to BMI and, by extension, eating behavior.

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Conflict of Interest: The authors declare that they have no conflict of interest.

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39. Rogers ML, Kennedy GA, Duffy ME, et al Application of quantile regression to examine the association between body mass index and eating pathology

Table 1

Descriptive Statistics and Bivariate Correlations between Body Trust and BMI

	Body Trust	BMI
Pearson's *r* (BMI)	-.18***	--
Mean	3.10	27.89
SD	1.31	7.25
Range	0-5	15.13-67.90
Median	3.17	26.11
Interquartile Range	2.00-4.00	23.04-30.70
Skewness	-.40	1.73
Kurtosis	-.49	4.55

Note: *** $p < .001$; SD = Standard Deviation; BMI = Body Mass Index

Table 2

Quantile Regression of Body Trust Predicting BMI at the .1, .5, and .9 Quantiles of BMI

Quantile	**Parameter**	***B***	***SE***	***t***	**95% CI [B]**	**R^1**
.1	Intercept	22.95	.64	35.75***	21.55, 23.44	.037
	Body Trust	-.59	.17	-3.46***	-.74, -.21	
.3	Intercept	25.18	.56	44.98***	24.07, 26.17	.028
	Body Trust	-.48	.17	-2.85*	-.73, -.20	
.5	Intercept	28.48	.87	26.90***	26.97, 29.97	.031
	Body Trust	-.73	.24	-2.77*	-1.20, -.40	
.7	Intercept	33.89	1.38	24.51***	31.12-35.09	.039
	Body Trust	-1.26	.35	-3.56***	-1.59, -.46	
.9	Intercept	43.90	1.88	23.39***	41.36, 45.30	.066
	Body Trust	-2.30	.54	-4.26***	-2.60, -1.58	

Note: * $p < .05$, *** $p < .001$; R^1 = pseudo R-squared

Figure Captions

Fig. 1 Quantile process plots for BMI on Body Trust, including (A) BMI intercept; and (B) Body Trust slope. The horizontal solid line represents the linear regression intercept and slope coefficients, with associated 95% confidence intervals