Emotion Awareness Predicts Body Mass Index Percentile Trajectories in Youth

Diana J. Whalen, PhD[1], Andy C. Belden, PhD[1], Deanna Barch, PhD[1,2], and Joan Luby, MD[1]

Objective To examine the rate of change in body mass index (BMI) percentile across 3 years in relation to emotion identification ability and brain-based reactivity in emotional processing regions.

Study design A longitudinal sample of 202 youths completed 3 functional magnetic resonance imaging–based facial processing tasks and behavioral emotion differentiation tasks. We examined the rate of change in the youth's BMI percentile as a function of reactivity in emotional processing brain regions and behavioral emotion identification tasks using multilevel modeling.

Results Lower correct identification of both happiness and sadness measured behaviorally predicted increases in BMI percentile across development, whereas higher correct identification of both happiness and sadness predicted decreases in BMI percentile, while controlling for children's pubertal status, sex, ethnicity, IQ score, exposure to antipsychotic medication, family income-to-needs ratio, and externalizing, internalizing, and depressive symptoms. Greater neural activation in emotional reactivity regions to sad faces also predicted increases in BMI percentile during development, also controlling for the aforementioned covariates.

Conclusion Our findings provide longitudinal developmental data demonstrating links between both emotion identification ability and greater neural reactivity in emotional processing regions with trajectories of BMI percentiles across childhood. *(J Pediatr 2015;167:821-8)*.

Obesity plagues our nation's youths, with 31.7% of youths classified as overweight or obese.[1] Obesity during childhood and adolescence represents a significant pathway toward premature mortality and physical morbidity in adulthood.[2] As such, a better understanding of the psychological and related neurobiological correlates that may contribute to elevated body mass index (BMI) in youth is needed.

Emotion dysregulation,[3] the inability to effectively recognize and control intense emotional responses, has been hypothesized to contribute to the development of obesity in youth. Impaired emotional awareness, a component of emotion dysregulation, may be evidenced by an inability to correctly label and identify emotions in oneself and others, leading to distressing and emotionally dysregulated psychological states. Emotional reactivity, another component of emotion dysregulation, may be evidenced by increased activation in emotion-related brain regions, such as the amygdala. Excessive or impulsive eating may become a maladaptive mechanism through which children relieve their distress or attempt to self-regulate, leading to lack of attention to satiety[4] and weight gain. Decreased emotional awareness, still another component of emotion dysregulation, has been related to obesity in youth and adults[5-7] In a sample of Italian youth, a decreased ability to label others' emotions was associated with obesity status.[5] In a sample of female adolescents, the relationship between increased self-reported negative affect and overeating was mediated by poor emotional awareness.[4] Previous work has demonstrated a reduced ability to label visual and verbal signs of emotion in film clips in both obese children and their mothers.[6] Obese women also have been shown to exhibit deficits in emotional awareness and to more often report using eating as a strategy to regulate negative emotions compared with nonobese women.[7]

The foregoing findings suggest that obesity is related to difficulty in accurately identifying facial expressions of emotion; however, there is no published evidence linking poor emotional awareness to changes in BMI or obesity across time. The aforementioned studies support the hypothesis that poor emotional awareness would predict increases in BMI across time, eventually leading to obesity.

Another component of emotion dysregulation, emotional reactivity, has yet to be studied as a potential contributor to obesity in childhood. Emotional reactivity, which may present as an intense experience of negative emotions, could

BMI	Body mass index
BOLD	Blood oxygen level dependent
CAPA	Child and Adolescent Psychiatric Assessment
fMRI	Functional magnetic resonance imaging
MLM	Multilevel model
PAPA	Preschool Age Psychiatric Assessment
PDS	Preschool Depression Study

From the [1]Department of Psychiatry, Washington University School of Medicine; and [2]Department of Psychology, Washington University, St Louis, MO

Supported by the National Institutes of Health (NIH; R01 MH064769-06A1). D.W. supported by NIH (T32 MH100019 [PIs: D.B. and J.L.]). D.B. serves as a consultant for Pfizer, Amgen, and Roche on psychosis-related work. J.L. obtains royalties from Guilford Press. The other authors declare no conflicts of interest.

http://dx.doi.org/10.1016/j.jpeds.2015.06.053

lead to maladaptive regulation strategies, such as increased or loss of control eating. Functional magnetic resonance imaging (fMRI) studies in this area have primarily investigated reactivity in reward circuitry to images of food.[8] Findings from a recent meta-analysis indicate increased reactivity to food images in areas associated with explicit memory, such as the right parahippocampal gyrus, and reduced reactivity in regions linked to cognitive control, such as the dorsolateral prefrontal cortex, in individuals who are overweight or obese.[9]

To date, there have been few attempts to connect emotional reactivity to nonfood-related imagery to obesity or overweight status in childhood, however. In one study, overweight and obese girls with loss of control eating demonstrated a failure to engage brain regions associated with emotion regulation in response to a peer social rejection task.[10] Furthermore, heightened activation in the fusiform face area (associated with emotional processing) in overweight and obese girls with loss of control eating following a simulated peer rejection predicted subsequent food intake.

Given these preliminary findings of heightened activation to socially salient stimuli, investigating additional neural responses to faces (a different type of socially salient stimuli) in overweight and obese children is particularly important. Previous work has documented that brain regions involved in emotional reactivity, such as the amygdala, appear to be critical for the detection and processing of emotional faces.[11] Alterations in activity in these brain areas among youth at risk for becoming obese may suggest unique emotional processing characteristics related to high BMI.

In the present study, we investigated the relationship between neural reactivity to emotional faces during an emotional face processing task and BMI percentile trajectory in youths. We also examined the relationships between behaviorally based emotion identification abilities and the trajectory of BMI percentiles across childhood and early adolescence. We hypothesized that youths with poor emotion identification ability and greater neural activation to emotional faces in brain regions within an emotional reactivity brain network would evidence steeper increases in BMI across time, given that both factors are hypothesized to be indicators of greater emotion dysregulation. In this context, increased eating may serve as a maladaptive method of regulating the intense experiences of negative emotion (eg, emotional reactivity) and/or decreased ability to label and process emotions (eg, emotion recognition).

Methods

Participants were drawn from the Preschool Depression Study (PDS), a prospective longitudinal investigation of preschoolers and their families conducted at the Washington University School of Medicine.[12] The present study reports on 202 children from the PDS (n = 305 at baseline) who, across a 7-year period, completed annual behavioral assessments and at least 1 (out of a possible 3) fMRI scans proximal to these annual assessments. Parental written consent and child assent were obtained before participation, and the Washington University School of Medicine's Institutional Review Board approved all procedures.

Children who did not complete an fMRI scan reported more externalizing and internalizing symptoms compared with those who did complete an fMRI scan. There were no between-group differences in terms of BMI percentile, sex, puberty, ethnicity, IQ, family income-to-needs ratio, and major depressive disorder (MDD) symptoms.

Details of recruitment have been reported previously.[12,13] In brief, between 2003 and 2005, 3- to 6-year-old children were recruited from primary care practices and preschools/daycare centers throughout the St Louis metropolitan region using a screening checklist to oversample preschoolers with symptoms of depression. The final sample consisted of preschoolers with varying levels of depressive symptoms and healthy control preschoolers without psychiatric symptoms. In 2010, additional children (aged 10-15 years) with no previous psychiatric diagnosis were recruited from local schools to enhance the sample of healthy subjects. Children with neurologic or chronic medical problems or those with significant developmental delays were excluded. All PDS participants without contraindication for fMRI were eligible for an fMRI scan session. In the present study, 157 children (77%) were participants in the original PDS and 45 (23%) were recruited as additional healthy subjects in 2010.

Measures

Mothers reported family income at each annual assessment. The income-to-needs ratio was computed as the total family income at baseline divided by the federal poverty level, based on family size, at the time of data collection.[14]

The Kaufman Brief Intelligence test[15] was used to assess verbal and nonverbal intelligence at the behavioral assessment wave closest to scan 2. This test has a mean score of 100 (SD $\pm$ 15), and has proven to be a reliable and valid measure of IQ in youths.[16]

Exposure to medications was ascertained at each behavioral assessment closest to each scan using the MacArthur Health and Behavior Questionnaire.[17] The child's lifetime exposure to antipsychotic medications was deemed particularly important, given the known association between these medications and weight gain.[18] For the purpose of the present study, exposure to medication was coded as 0 for "no" and 1 for "yes."

Dimensional scores for externalizing (including attention deficit disorder, conduct disorder, and oppositional defiant disorder), internalizing (including generalized anxiety disorder, separation anxiety disorder, and posttraumatic stress disorder), and depressive symptoms were calculated at each behavioral assessment closest to each scan using the Preschool Age Psychiatric Assessment (PAPA)[19,20] and the Child