

The Role of BMI in Predicting Emotion-Driven Impulsivity and Sensitivity to Reward/Punishment in Over-Obese Adolescents

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ABSTRACT

Adolescent obesity is a complex condition affected by neuro-biological, psychological, socio-cultural and environmental factors. The role of brain reward mechanisms and associated personality traits are of growing interest in eating behavior and obesity literature. However, the findings are inconsistent. The present study aimed to examine the link between body mass index (BMI) and personality factors including sensitivity to reward/punishment (SR/SP) and impulsivity in over-obese adolescents. Ninety-two adolescents, aged 12–18 years, classified as over-obese (n = 46) and normal weight (n = 46) participated in the study. Their sensitivity to reward/punishment and the trait impulsivity was assessed using Sensitivity to Punishment and Reward Questionnaire (SPSRQ) and UPPS-P Scale, respectively. Multistep hierarchical regression models were used to investigate the relative contribution of age, BMI and SR/SP on estimates of impulsivity. The BMI significantly predicted elevations in emotion-driven impulsivity (positive and negative urgency) in over-obese adolescents and SR was the main predictor of elevations in positive and negative urgency, and sensation seeking. Our findings demonstrate that increases in BMI are specifically associated with elevations in emotion-driven impulsivity.

Key words: Adolescent Obesity, Body Mass Index, Reward/Punishment Sensitivity, Trait Impulsivity.

INTRODUCTION

The prevalence of childhood and adolescence overweight and obesity has been increasing worldwide recently¹. Childhood obesity is associated with different disorders such as early stages of coronary heart disease, diabetes, and various cancers². Approximately, 50% of children and adolescents in the United States are considered overweight or obese, and up to 80% of overweight adolescents will become obese as adults³. Adolescents who are overweight are almost 18 times more likely than healthy-weight adolescents to be obese as an adult⁴.

Identifying behavioral styles associated with obesity especially during adolescence is a

crucial step in developing prevention and treatment methods for this population.

Previous studies have shown that obese people are more prone to give in to temptations and are less effective in inhibiting their impulses⁵⁻⁷.

Impulsivity describes the tendency to act with less forethought, and predisposes an individual towards rash, unplanned reactions without regard to negative consequences and with a disregard to more rational long-term choices for success (International Society for Research on Impulsivity, 2011; ISRI; <http://www.impulsivity.org>). It is a multidimensional construct, which can be conceptualized as a failure of attention (inattention), a failure to inhibit responses (inhibition), and a

failure to consider the probable negative long term consequences of behavior (delay discounting or decision making)⁸. This construct is often associated with various forms of addiction (Reynolds, 2006) and several other clinical disorders⁹⁻¹¹. It can be measured with both self-report and laboratory-behavioral procedures^{12, 13}. Studies on utilizing self-report measures have indicated links between impulsivity and body mass index (BMI) in adults^{14, 15} and children¹⁶⁻²⁰.

Findings of the relevant studies showed that impulsivity, or the lack of self-control, may contribute to the onset and maintenance of obesity¹⁶. Whereby obese adolescents display greater levels of impulsivity compared to healthy-weight peers²¹. With in a subset of obese children, those who participated in binge eating were more impulsive than obese children who did not binge eat²².

Several studies have shown that personality variables such as impulsivity are associated with food intake^{23, 24}, relative body weight and obesity^{6, 25}.

However, the link between obesity and impulsivity depends on age indicating that high impulsivity is linked to higher body weight among young kids (8–10 years old), whereas in adolescents (12–14 years old) this association is less significant and even is inversed²⁶. Such findings suggest interaction may reflect age-related maturation of inhibitory processes²⁷.

According to Whiteside and Lynam's work²⁸, impulsivity must be considered as a multifaceted construct, made up of four separate components, which are the basis for the creation of a scale called the UPPS Impulsive Behavior Scale:

Urgency, defined as "the tendency to experience strong impulses, frequently under conditions of negative affect"; Urgency may contribute to an obese person's problem controlling eating in situations of strong emotion. Guerrieri *et al.* found that difficulty suppressing an automatic response (as measured by stop signal reaction time) predicted heightened food intake²⁹.

Lack of perseverance, defined as "the difficulty to remain focused on a task that may be boring or difficult";

- (1) Lack of premeditation, defined as "the difficulty to think and reflect on the consequences of an act before engaging in the act";
- (2) Sensation Seeking, defined as "a tendency to enjoy and pursue activities that are exciting, and openness for new experiences.

Previous studies have shown that obese persons choose immediate rewards even when future long-term negative consequences are associated with them. Overweight persons with binge eating disorders have enhanced sensitivity to rewards³⁰. The tendency to seek rewards (e.g. food) is associated with food intake, overeating and subsequent weight gain, as well as difficulty maintaining or losing weight³¹. This tendency affects food intake, especially when varied food (food that varies in color, form, taste, and texture) is offered³². It may be related to a heightened selective attention to food stimuli and may make it difficult to regulate eating, particularly in obese individuals who have impaired sensitivity to the hunger and satiety signals that normally regulate eating³³.

Studies have employed the construct of impulsivity as an index of reward sensitivity to be linked to eating behaviors^{23, 24, 34}. These studies found a positive relation between impulsivity and overeating, which would be in accordance with the reinforcement sensitivity theory (RST) of Gray (1987). The RST is one of the leading biological based models of personality that might explain individual differences in food consumption.

The RST is based on two hypothesized brain systems that control behavior. The sub-cortical brain does not likely differentiate among rewards provoked by natural reinforcers like food, illicit drugs like cocaine, or behaviors like gambling³⁵.

Some studies investigating the relationship between reward sensitivity, eating behaviors, and body weight have indicated positive relation between these variables³⁶⁻³⁸. Franken and Muris (2005) found that young women with higher

sensitivity to reward reported stronger food cravings and had a higher BMI³⁷).

Recent studies have indicated that the ways people perceive food and regulate food intake, are increasingly modulated by external reward cues rather than physiological cues of hunger³⁹.

Stice *et al.* (2011) showed that high-risk adolescents for obesity have heightened activation of the reward system in response to receipt of palatable food⁴⁰.

Psychometric studies indicate that personality factors of sensitivity to reward (SR) and sensitivity to punishment (SP) are related to neuropsychological deficits in adolescent with overweight and obesity: SR positively correlates with trait impulsivity, whereas SP positively correlates with compulsivity^{19, 41}.

Davis *et al.* (2004) demonstrated that SR significantly predicted higher scores on a measure of emotional eating— overeating when under strong negative states, and they proposed a meditational path between SR, negative emotion-driven eating, and BMI³⁶. This result is fitting with evidence showing that both SR and SP correlate with negative urgency (the tendency to experience strong impulses under conditions of negative affect) in obese adults⁴². However, further dissociation of the differential role of SR against SP, and of their relative impact on inhibitory control against

inflexibility is needed to investigate to what extent and how personality affects neuropsychological profiles in obese adolescents.

In this study, we aimed to examine the link between personality factors (sensitivity to reward and sensitivity to punishment), BMI, and outcome measures of impulsivity vs. flexibility in over-obese adolescents. According to previous evidence, we predicted that BMI and SR would significantly predict higher scores on emotion-driven impulsivity among adolescents with excess weight.

MATERIALS AND METHODS

Participants

Ninety-two adolescents (age range 12–18) participated in this study. Participants were classified as normal weight (n = 46, 18 boys and 28 girls) and over-obese (n=46, 18 boys and 28 girls).The normal weight group had BMI among 18 to 25, where as the over-obese group were consisted of adolescents with the BMI of 35 and upper. The over-obese group consisted of the patients referred to bariatric gastrectomy surgery clinics and the normal group consisted of age- and sex-matched counterparts to the over-obese group.

The inclusion criteria include: (i) age range between 12 and 18 years old, (ii) BMI values 18-25 for normal weight group and 35 and higher for the over-obese group, (iii) absence of past/current evidence of medical or psychological disorders.

Table 1: Group comparisons for measures of impulsivity (UPPS-P) and sensitivity to punishment/reward (SPSRQ)

| | Mean (S.D) | | t | Cohen's d |
|-------------------------------|--------------|---------------|--------|-----------|
| | Over-obese | Normal Weight | | |
| UPPS-PNegativeurgency | 26.34 (7.52) | 27.64 (7.13) | -0.614 | 0.13 |
| UPPS-PLack of premeditation | 26.41 (5.17) | 26.03 (5.21) | 0.814 | 0.29 |
| UPPS-PLack of perseverance | 24.01 (4.95) | 22.51 (4.70) | 1.60 | 0.31 |
| UPPS-PSensationseeking | 34.13 (7.25) | 28.42 (6.98) | 2.049 | 0.54 * |
| UPPS-PPositiveUrgency | 24.23 (5.93) | 25.01 (6.44) | -0.417 | 0.12 |
| SPSRQSensitivity toReward | 11.91 (4.98) | 9.20 (4.53) | 2.050 | 0.55 * |
| SPSRQSensitivity toPunishment | 11.03 (5.01) | 10.33 (4.48) | 0.499 | 0.15 |

*Significant differences between the groups.

Measures

BMI

BMI was calculated for each participant as the ratio of weight in kilograms divided by the square of height in meters (weight [kg]/height [metres²]) with the participant wearing indoor clothing and standing in stocking feet.

SR and SP

Sensitivity to Punishment and Reward Questionnaire (SPSRQ)(43). The SPSRQ is a 48 yes–no response item questionnaire aimed to measure two neuropsychological systems driving motivated behavior: the behavioral activation system (SR) and the behavioral inhibition system (SP). It reflects the respondent's approach responses under various conditions of reward. The scale items reflect both the anticipation of reward (e.g. Does the good prospect of obtaining money motivate you strongly to do some things?) and pleasure experienced from rewarding activities (e.g. Does your attention easily stray from your work in the presence of an attractive stranger?). The total scores from each scale (SP and SR) were obtained for the analysis.

Impulsivity: UPPS-P Scale(28)

This is a 59-item inventory designed to measure five distinct personality pathways to impulsive behavior: sensation seeking, (lack of) perseverance, (lack of) premeditation, negative urgency, and positive urgency. The first four dimensions were included in the original version of the UPPS scale: the fifth dimension was included based on the recent study of Cyders *et al.* (2007) and Smith *et al.* (2007)(44, 45). Sensation seeking (12 items) incorporates two aspects: (i) a tendency to enjoy and pursue activities that are exciting, and (ii) an openness to trying new experiences that may or may not be dangerous; (lack of) perseverance (10 items) refers to the individual's ability to remain focused on a task that may be boring or difficult; (lack of) pre- meditation (11 items) refers to the tendency to think and reflect on the consequences of an act before engaging in that act; and finally, urgency (12 items) refers to the tendency to experience strong impulses under conditions of negative affect (negative urgency - 12 items) or positive affect (positive urgency - 14 items). Each

item on the UPPS is rated on a 4-point scale ranging from 1 (strongly disagree) to 4 (strongly agree). We obtained the total scores of each of these five UPPS-P dimensions for analyses.

Statistical Analyses

Independent-sample t-tests were used to examine differences between groups on demographic, personality, and outcome variables. We examined inter-correlations among these variables by group using Pearson correlation coefficients. To test the main study hypotheses, we conducted three-step level hierarchical multiple regression models to examine the influence of (i) age, (ii) BMI, and (iii) SR and SP personality traits, on the outcome measures of impulsivity (UPPS). We computed the changes in R² associated with the inclusion of each of these steps on the prediction model in order to estimate their separate (and aggregated) contribution to prediction of outcome variables.

RESULTS

Group Comparisons

Over-obese and normal weight adolescents did not significantly differ on UPPS dimensions of positive and negative urgency, lack of premeditation and perseverance, and sensitivity to punishment (Table 1). Over-obese adolescents showed increased sensitivity to reward (SPSRQ), while normal weight adolescents showed elevated sensation seeking (UPPS-P) (Table 1).

The results of correlation assessments are presented in Table 2. According to the correlation assessments, in the over-obese group, SR was positively correlated with BMI, negative urgency and positive urgency, sensation seeking and premeditation. SP was only positively correlated with negative urgency. In addition, BMI was positively correlated to negative and positive urgency. Other correlations were among the tests subscales.

In the normal weight group, SR was significantly positively correlated with negative urgency, positive urgency, lack of perseverance and sensation seeking. BMI had no correlation with any

Table 2: Correlations between age, BMI, UPPS-P and SPSRQ variables for normal weight and over-obese group

| Normal Weight | BMI | Negative Urgency | Premeditation | Perseverance | Sensation Seeking | Positive Urgency | Sensitivity Punishment | Sensitivity Reward |
|------------------------|------------|-------------------------|----------------------|---------------------|--------------------------|-------------------------|-------------------------------|---------------------------|
| Age | 0.266 | 0.012 | -0.099 | -0.031 | -0.010 | 0.314 | 0.107 | 0.252 |
| BMI | | 0.00 | 0.011 | 0.125 | -0.198 | 0.066 | 0.041 | -0.118 |
| Negative Urgency | | | 0.444* | 0.512* | 0.391* | 0.902* | 0.141 | 0.596* |
| Lack of Premeditation | | | | 0.441* | 0.502* | 0.411 | -0.317 | 0.303 |
| Lack of Perseverance | | | | | 0.443* | 0.443 | 0.561* | 0.801* |
| Sensation Seeking | | | | | | 0.493* | -0.088 | 0.574* |
| Positive Urgency | | | | | | | 0.301 | 0.673* |
| Sensitivity Punishment | | | | | | | | 0.312 |
| Over Obese | BMI | Negative Urgency | Premeditation | Perseverance | Sensation Seeking | Positive Urgency | Sensitivity Punishment | Sensitivity Reward |
| Age | 0.216 | 0.099 | 0.111 | 0.502* | 0.173 | 0.198 | 0.117 | 0.222 |
| BMI | | 0.512* | 0.527 | 0.271 | 0.213 | 0.347* | 0.198 | 0.365* |
| Negative Urgency | | | 0.407* | 0.056 | 0.509* | 0.791* | 0.462* | 0.522* |
| Lack of Premeditation | | | | 0.014 | 0.241 | 0.312* | -0.258 | 0.325* |
| Lack of Perseverance | | | | | -0.117 | 0.115 | 0.171 | -0.101 |
| Sensation Seeking | | | | | | 0.441* | 0.019 | 0.555* |
| Positive Urgency | | | | | | | 0.214 | 0.618* |
| Sensitivity Punishment | | | | | | | | 0.297 |

* $p < 0.05$

of the items. The other variables with significant correlations with the items were among the tests subscales.

Regression Models

The regression results are presented in Table 3. Age did not predict any of personality traits in impulsivity or reward/punishment sensitivity. The block including personality traits (SR) significantly predicted scores on the impulsivity dimensions of sensation seeking, positive and negative urgency. Inclusion of BMI significantly increased the predictive capacity of personality traits on the impulsivity dimensions of positive and negative urgency.

DISCUSSION

Our findings show that over-obese adolescents, compared with their normal weight peers, had very similar psychological concerns and personality characteristics. The main significant difference is shown by the traits of SR and sensation seeking; in both cases over-obese individuals had higher levels of these traits. So, our findings are supportive of the conception of adolescent obesity as a dysfunction characterized by hypersensitivity to reward^{36, 37, 46}. However, the only trait correlated with BMI within the over-obese group was sensitivity to punishment. This finding supports the findings of Davis & Fox (2008) that showed BMI and SR have a non-linear relationship⁴⁷. In consistent with their findings, our results showed a positive relationship between BMI and reward sensitivity in the normal and overweight range of BMI (18–30). Further increase in BMI, for moderate and extreme obesity, resulted in inverse relationship with reward sensitivity.

The results also show that BMI is significantly associated with increased impulsivity—but only under strong affective states (positive and negative urgency). Since sensitivity to punishment and urgency are psychometrically correlated in healthy youths⁴⁴, and both have shown significant associations with dysfunctional thought control and compulsivity^{41, 48}, our findings suggest that adolescent obesity is better characterized by negative reinforcing mechanisms triggering habitual behaviors. The overall relationship pattern of increased sensitivity with punishment is consistent with the findings indicating that adolescents with excess weight tend to be constrained (i.e., they are submissive and dependent) until they find themselves in very positive mood and also to those found in the whole spectrum of eating disorders⁴⁹.

Indeed, as far as our findings show, BMI positively predicts levels of positive and negative urgency in over-obese adolescents. Sensitivity to reward also, significantly predicts positive and negative urgency and sensation seeking. But neither BMI nor SR can significantly predict lack of perseverance and premeditation. These findings demonstrate that increases in BMI are specifically associated with elevations in emotion-driven impulsivity, which supports the idea that adolescents with excess weight increase their proneness to overindulge when under strong affective states⁴⁹.

CONCLUSION

In conclusion, our findings support a dimensional approach to adolescent obesity,

Table3: MultipleregressionmodelstestingtheassociationbetweenAge, BMI, UPPS-P and SPSRQ

| | Age R ² Change (p value) | BMI R ² Change (p value) | SR /SP R ² Change (p value) | Full Model R ² Adjusted (p value) | Significant Contributors |
|-----------------------|--|--|---|---|-----------------------------|
| Negative Urgency | 0.012 (0.377) | 0.133 (0.001) | 0.322 (0.000) | 0.391 (0.000) | BMI, SR |
| Positive Urgency | 0.033 (0.111) | 0.096 (0.017) | 0.299 (0.000) | 0.337 (0.000) | BMI, SR |
| Lack of Perseverance | 0.038 (0.081) | 0.009 (0.343) | 0.025 (0.092) | 0.019 (0.074) | --- |
| Lack of Premeditation | 0.003 (0.781) | 0.004 (0.644) | 0.073 (0.089) | 0.003 (0.437) | --- |
| Sensation Seeking | 0.014 (0.403) | 0.005 (0.509) | 0.307 (0.000) | 0.244 (0.000) | SR |

where increasing weight and adiposity decreases the ability to control impulses under strong affects.

These results suggest that obese and overweight persons have difficulty to inhibit automatic or dominant behaviors and intrusive thoughts. They also have a tendency to exaggerate the impact of rewards and punishments. The study confirmed and extended previous results regarding the relationship between impulsivity and overweight.

Our findings hold implications for work with overweight and obese adolescents. When considering prevention and treatment methods for weight, strategies involving specific ways to cope with impulsivity may increase the likelihood of success, either by individuals not becoming overweight or obese through prevention strategies or weight loss for those who are already overweight or obese.

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