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Research report

# Food reinforcement and parental obesity predict future weight gain in non-obese adolescents ☆

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ABSTRACT

*Background:* Food reinforcement, the extent to which people are willing to work to earn a preferred snack food, and parental obesity are risk factors for weight gain, but there is no research comparing the predictive effects of these factors for adolescent weight gain. *Methods:* 130 non-obese adolescents (M age = 15.2 ± 1.0; M BMI = 20.7 ± 2.0; M zBMI = 0.16 ± 0.64) at differential risk for weight gain based on parental obesity completed baseline food and money reinforcement tasks, and provided zBMI data over a 2-year follow-up. *Results:* The number of obese (BMI ≥ 30) parents ($p = 0.007$) and high food reinforcement ($p = 0.046$) were both significant independent predictors of greater zBMI increases, controlling for age, sex, parent education and minority status. Having no obese parents or being low or average in food reinforcement was associated with reductions in zBMI, but those high in food reinforcement showed larger zBMI increases (0.102) than having one obese parent (0.025) but less than having two obese parents (0.177). *Discussion:* Food reinforcement and parental obesity independently predict future weight gain among adolescents. It might be fruitful for obesity prevention programs to target both high risk groups.


## Introduction

Adolescence may be one of the critical periods for weight gain (Dietz, 1994). Adolescence is associated with hormonal changes that favor adipose tissue increase in girls (Biro, 2008), and genetic and familial predispositions to excess weight gain may be expressed more strongly during adolescence than during preadolescent periods (Stice, Presnell, Shaw, & Rohde, 2005). For this reason, examining parental obesity as a risk factor for weight gain in adolescence is particularly relevant. Adolescent children of obese versus lean parents have shown a fourfold increase in risk for obesity onset (Epstein et al., 2007; Magarey, Daniels, Boulton, & Cockington, 2003; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997), but the effects of this risk factor may vary across development, as some studies have shown parental obesity exerts an influence on weight gain throughout development (Crossman, Sullivan, & Benin, 2006), while other studies have shown parental obesity is important only for young children (Epstein et al., 2007; Whitaker et al., 1997). Parental obesity may be a risk factor for adolescent weight gain due to genetic predisposition (Wardle, Carnell, Haworth, & Plomin, 2008; Warrington et al., 2014), or due to behavioral factors within families (Birch & Fisher, 1998; Crossman et al., 2006; Francis, Lee, & Birch, 2003), such as the shared eating and activity environment, modeling, and support for healthy or unhealthy behaviors.

Another risk factor for weight gain is the motivation to eat, or food reinforcement. Food reinforcement is related to energy intake in the laboratory and natural environment assessed by dietary recalls and food frequency questionnaires (Epstein, Carr, Lin, Fletcher, & Roemmich, 2012) and cross-sectional data show that obese children (Temple, Legierski, Giacomelli, Salvy, & Epstein, 2008) and adults (Epstein et al., 2007, 2012) find highly palatable food more reinforcing and are more motivated to eat than leaner peers. In addition, prospective data show the reinforcing value of food predicts future body fat gain in children (Hill, Saxton, Webber, Blundell, & Wardle, 2009) and weight gain in adults (Carr, Lin, Fletcher, & Epstein, 2014).

The primary aim of this study is to assess the independent effects of food reinforcement and parental obesity on weight gain for adolescents in the healthy weight range, and to quantify the degree of risk associated with food reinforcement in terms of the well-established risk of parental obesity. In addition, the relationship

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between parental obesity and child food reinforcement will be assessed. While there is no research on the relation between these risk factors, research suggests that food reinforcement is correlated in parents and their children (Epstein, Dearing, Temple, & Cavanaugh, 2008), which may be in part responsible for the relation between parental and adolescent offspring obesity status (Crossman et al., 2006). If parents became obese due to their excessive motivation to eat (Carr et al., 2014), then parental obesity may be related to child food reinforcement. In addition, parental obesity may increase risk of weight gain for youth high in food reinforcement. Since obesity is related to greater consumption of high energy dense foods (Mendoza, Drewnowski, Cheadle, & Christakis, 2006; Mendoza, Drewnowski, & Christakis, 2007), healthy weight teens who are high in food reinforcement and who reside in homes with obese parents with access to high-fat/high-sugar foods may be at a higher risk of weight gain.

## Methods and materials

### *Participants*

Participants were 160 adolescent males and females (M age = 15.3 ± 1.07, zBMI = 0.2 ± 0.6, BMI = 20.8 ± 1.90); 4.1% Hispanic, 0.6% Native American, 0.6% Asian/Pacific Islanders, 76.5% European Americans, and 17.9% mixed racial heritage. Adolescents had to have an age-adjusted BMI >18 and < 25. Those who reported binge eating or compensatory behaviors in the past 3 months, any use of psychotropic medications or illicit drugs, head injury with a loss of consciousness, or current Axis I psychiatric disorder per *Diagnostic and Statistical Manual of Mental Disorders*, 4th Edition criteria (American Psychiatric Association, 1994) were excluded. Informed consent was obtained from parents and assent from adolescents. For the present investigation, analyses were performed on the 130 participants (M age = 15.2 years ± 1.0; 70 females) who met the inclusion criteria, with complete food and monetary reinforcement, who were not obese (<95th BMI percentile) at baseline, and for whom we collected objective height and weight data at 2-year follow-up. Participants were asked to refrain from eating or drinking caffeinated beverages 2 hours prior to their assessment.

Recruitment occurred between June 2009 and June 2011. The study was approved by the Oregon Research Institute Institutional Review Board. Participants were paid $75 for completing the 2-hour baseline assessment/behavioral test, and $30 for completing each annual follow-up assessment. Characteristics of adolescents and parents as a function of the number of obese parents are shown in Table 1.

### *Measures*

#### *Height and weight*

Height was measured to the nearest millimeter using a portable direct reading stadiometer. Weight was assessed to the nearest 0.1 kg using digital scales with participants wearing light clothing without shoes or coats. Two measures of height and weight were obtained and averaged. Parental BMI values are based on parental self-report. Although self-report may underestimate actual BMI, this is a conservative method for identifying obese parents. On the basis of height and weight data, BMI was calculated according to the following formula: BMI = kg/m$^2$. Parental obesity was defined as BMI greater than 30 (NHLBI Obesity Education Initiative Expert Panel, 1998), and risk was assessed in terms of the number of obese parents. Adolescent BMI values were standardized for age and sex, and converted to BMI percentiles and zBMI values for analyses (Kuczmarski et al., 2002).

**Table 1**
Characteristics of adolescents based on number of obese parents.

| Variable | Number of obese parents | | | |
|---|---|---|---|---|
| | 0 (N = 58) | 1 (N = 54) | 2 (N = 18) | *p* |
| Age (years) | 15.4 ± 1.1 | 15.0 ± 0.9 | 15.0 ± 1.1 | 0.043 |
| Tanner stage | 4.3 ± 0.8 | 4.3 ± 0.6 | 4.4 ± 0.7 | 0.643 |
| Baseline BMI | 20.7 ± 2.1 | 20.6 ± 1.8 | 21.1 ± 2.0 | 0.562 |
| Baseline zBMI | 0.09 ± 0.7 | 0.17 ± 0.6 | 0.36 ± 0.6 | 0.289 |
| Mother BMI | 24.2 ± 3.2 | 29.5 ± 6.5 | 39.4 ± 6.4 | <0.0001 |
| Father BMI | 25.3 ± 2.3 | 31.6 ± 5.0 | 37.9 ± 5.8 | <0.0001 |
| Sex (M/F) | 23/35 | 28/26 | 9/9 | 0.413 |
| Minority (minority/non-minority) | 11/47 | 11/43 | 5/13 | 0.725 |
| Highest parent education (years) | 15.8 ± 2.7 | 16.2 ± 2.7 | 14.7 ± 2.8 | 0.107 |
| Reinforcing value tasks | | | | |
| Food reinforcement (log $P_{max}$) | 3.01 ± 1.0 | 3.08 ± 1.1 | 3.04 ± 1.1 | 0.945 |
| Monetary reinforcement (log $P_{max}$) | 4.04 ± 1.3 | 3.94 ± 1.6 | 3.97 ± 1.2 | 0.935 |

*Note:* Data are mean ± SD. *p*-values are based on ANOVA or chi-square tests comparing between groups based on the number of obese (BMI > 30) parents. N = 53 for tanner staging for adolescents with one obese parent; N = 57 for father BMI and money $P_{max}$ for adolescents with no obese parents.

#### *Pubertal development*

Youth reported their current pubertal development using a series of sex-specific line drawings of youth at various stages of pubertal development (Bonat, Pathomvanich, Keil, Field, & Yanovski, 2002). Girls were given line drawings of the 5 stages of breast and female pubic hair development with appropriate written descriptions of each stage. Boys were given line drawings of boys showing the 5 stages of pubic hair development and appropriate written descriptions of each stage. The description of each stage were read to the participants and they indicated which best captures their present stage of pubertal development. Self-rated pubertal development correlates with Tanner ratings made by physicians ($r$ = 0.86) (Bonat et al., 2002).

#### *Food reinforcement task*

Behavioral choice methods, adapted from Epstein et al. (2007), were used to assess the reinforcing value of favorite snack foods or money. Money was chosen as the alternative reinforcer since it is a generalized conditioned reinforcer, is a strong reinforcer for most people, and can be used to purchase a wide variety of alternatives to food. In the reinforcement task, participants worked toward a snack food reward of their choice (e.g., small standard snack size bags/servings of salted peanuts, potato chips, Reeses' peanut butter cups, M&M's, chocolate cookies, and gummy bears) and for money. Participants were first asked to perform a taste test of 1g of each food and rate the pleasantness and intensity of each taste and how much they crave each food on cross-modal visual analogue scales. Participants earned the snack food that they rated the most pleasant. The reinforcement task is similar to a slot machine with shapes that rotate on the screen and a point is earned each time the three shapes match in shape and color. Reinforcers are first earned on a variable ratio 4 (VR4) schedule, which means that on the average of every four responses, a point is earned. The progressive ratios double each time the participant earned five points. Participants were told that it would get progressively harder to earn points. A total of 10 points was worth 1 standard serving of the food. In the monetary reinforcement task, participants completed the same task to earn $1 each time schedule requirements were met. The monetary reinforcement task was implemented first for all participants. Participants were told to do the task as long as they liked. They received the food and monetary rewards as they earned them.