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Characteristics of Monozygotic Male and Female Twins Discordant for Overweight: A Descriptive Study

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Abstract

Objectives—BMI is highly heritable. Yet, trends in obesity highlight environmental influences on body weight. Monozygotic (MZ) twins discordant for overweight offer a unique opportunity to examine these factors.

Methods—MZ male ($n = 8$ pairs) and female twins ($n = 10$ pairs) discordant for overweight (defined as the BMI of one twin being at least 24.5, and the BMI of his/her co-twin being below 24.5 and at least three points lower) were identified from the Mid-Atlantic Twin Registry. Variables were assessed via self-report questionnaires.

Results—One overweight and two non-overweight females met criteria for bulimia nervosa. Rates of dieting and binge eating were high among all males and females. Hunger scores were higher among non-overweight females; disinhibition scores were higher among overweight males. Only one non-overweight and three overweight males smoked; 90% of non-overweight and 40% of overweight females smoked.

Conclusions—Assessing tobacco use and eating disorders may be important when sampling on the basis of family members who are discordant for BMI. Finally, results suggest possibilities for interventions in individuals at-risk for overweight.

Keywords

BMI discordance; twins; eating disorders; smoking

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Body mass index (BMI) is a highly heritable trait, with twin studies estimating that 50–90% of its variance is due to genetic factors (Maes, Neale, & Eaves, 1997). However, the rapid increase in obesity rates in the U.S. (Ogden et al., 2006) is attributed to an “obesogenic” environment, in which high-sugar, high-fat foods are readily accessible, and much of the population is sedentary (e.g., Brownell, 2002). These environmental factors appear to play an important role in the obesity epidemic. Investigations of monozygotic (MZ) twins whose members are discordant for BMI (i.e., one overweight, one non-overweight) can provide information regarding environmental contributions to overweight. As overweight discordance among MZ twins is relatively rare, few such studies have been published; extant research has found support for the roles of birth weight, smoking, dietary disinhibition, and susceptibility to hunger in BMI discrepancies among MZ twins (Hakala, Rissanen, Koskenvuo, Kaprio, & Rönnemaa, 1999; Pietiläinen et al., 2004; Rissanen et al., 2002). To our knowledge, no previous study has assessed eating disorder (ED) diagnoses or personality traits among twins discordant for overweight. In the current study, we assessed the relationships between several variables thought to influence BMI, including birthweight, smoking, EDs, dietary restraint, hunger, disinhibition, hunger, and personality variables, and BMI discordance among MZ twins.

Methods

Participants meeting criteria for overweight discordance were 18 pairs of MZ twins (10 female and eight male) from two related projects utilizing twins from the population-based Virginia Twin Registry (Kendler & Prescott, 1999), which is now the Mid-Atlantic Twin Registry (MATR). Discordance was defined as the BMI of one twin being at least 24.5 (based on the World Health Organization’s definition of overweight as BMI > 25.0; WHO, 2005), and the BMI of his/her co-twin being below 24.5 and at least three points lower than that of his/her co-twin (see Table 1 and Table 2 for mean BMI values). The approximate mean age for female twins was 37.77 ($SD = 6.42$); the approximate mean age for male twins was 36.92 ($SD = 10.48$).

Measures used included birth weight, obtained via self-report, and the personality traits of dependence, novelty seeking, self-esteem, extraversion, and neuroticism (Kendler, Neale, Kessler, Heath, & Eaves, 1994; Mazzeo, Slof, Tozzi, Kendler, & Bulik, 2004), which were measured in previous waves of data collection. Smoking status was dichotomized to represent individuals who had not smoked in the past year and those who had smoked at least one cigarette per day in the past year. A modified version of the Eating Inventory (EI; see Mazzeo, Aggen, Anderson, Tozzi, & Bulik, 2003) assessed dietary Restraint, Disinhibition, and Hunger. Finally, diagnoses of anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED) were based on responses to symptom-level items, (see Mazzeo et al., 2006, for a description).

Analyses were conducted separately for males and females. McNemar’s tests were performed to control for the paired nature of twin data, to assess differences between overweight and non-overweight twins on the categorical variables. Exact p values were computed, as these are more reliable in small samples. Paired sample t -tests were performed for continuous variables. P values less than .10 were considered to represent a significant trend.

Results

Female Twins

Three out of 19 (15.8%; one individual was missing data on the eating disorder items) female twins met criteria for BN narrow ($p = .07$). Two of these were non-overweight twins. No females met criteria for AN or BED broad or narrow. All 20 reported dieting. Seven females reported binge eating (four non-overweight, three overweight); however, this difference was nonsignificant ($p = .55$). One overweight and one non-overweight female reported receiving

treatment for an ED. A total of 65% of female twins reported smoking, including nine of the 10 non-overweight and four overweight twins ($p = .61$). Results of t-tests for continuous variables and means for the overweight and non-overweight female twins are presented in Table 1. Mean Hunger scores for overweight and non-overweight female twins differed significantly; non-overweight twins had higher scores. However, no significant differences were found for the EI Restraint or Disinhibition scores or personality measures.

Male Twins

No males met criteria for broad or narrow eating disorders. One overweight and one non-overweight male reported binge eating; 68.75% of males reported dieting, including five of the eight overweight male twins and six of the eight non-overweight twins ($p = .45$). No males reported receiving treatment for an ED. There were no significant differences in smoking in the past year between overweight and non-overweight male co-twins ($p = .22$). However, three of the four twins who reported smoking were overweight. T-tests for continuous variables and mean scores for the males are presented in Table 2. Disinhibition scores were higher among overweight than non-overweight male co-twins, although this difference was nonsignificant. No significant differences were found on measures of Restraint, Hunger or personality variables.

Discussion

Despite the highly heritable nature of BMI, rates of overweight and obesity are increasing rapidly among the U.S. population, much more so than would be expected from genetic selection alone. Lifestyle changes may be responsible for these changes (e.g., Hewitt, 1997). The current study attempted to provide additional insight into the influence of environmental factors on BMI, by examining this trait in MZ twins discordant for overweight. Non-overweight females in the study evidenced much higher rates of smoking than their co-twins; these smoking rates are also higher than those found in the general population (e.g., approximately 25% of U.S. women; CDC, 2005), suggesting non-overweight female twins may smoke as a means of weight-control. Female MZ twins discordant for overweight may be at greater risk for eating disordered behaviors, given their relatively high rates of BN. For example, research has suggested that individuals with BN may experience weight suppression, which is a discrepancy between one's highest adult weight and current weight (Lowe, 1993). In fact, these women may have a tendency toward overweight (Fairburn et al., 1997), which they suppress by engaging in unhealthy methods of weight control. Rates of dieting were high among both men and women in each weight group (i.e., 100% of female twins and 68.75% of male twins) and are higher than those observed in the general population (e.g., approximately 28.8% of men and 43.6% of women; Serdula et al., 1999). However, there were no significant differences in EI Restraint scores between discordant twins. As previous twin research has found that dieting behaviors are influenced by environmental factors (Neale et al., 2003), these discordant twins may have been raised in an environment that emphasized dieting as effective weight management. BMI discordance may also reflect cross-sectional differences in individuals who experience many weight fluctuations throughout their lives.

Disinhibition scores among male twins discordant for BMI were somewhat discrepant. As previous research has demonstrated that this trait is moderately heritable, it is possible that leaner co-twins actively modify their behaviors, and possibly their environments, in order to maintain lower body weights. Thus, individuals who are genetically predisposed to overweight and obesity may change in their eating habits in order to achieve healthier BMIs.

Although these results provide some insight into environmental factors associated with twin overweight discordance, several limitations should be noted, including the small sample (given the rarity of BMI discordance among MZ twins), the cross-sectional assessment of BMI, and

the exclusive use of self-report measures. The small sample size likely limited our power to detect significant differences. Lastly, the sample was comprised of White, middle-class adults. Future research should attempt to replicate these results in larger and more diverse samples. Moreover, use of different methods, including qualitative procedures or interviews, could provide more in-depth information on environmental contributions to overweight and obesity.

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Table 1

T-test results for MZ females.

Measure	Mean for Overweight Twins	Mean for Non-Overweight Twins	T-test	P-value
BMI	28.26	20.79	3.19	.01
EI-Hunger	19.75	25.00	-2.04	.09
EI-Restraint	24.63	27.33	-1.11	.31
EI-Disinhibition	25.88	28.89	-.64	.55
Dependence	17.67	15.60	.87	.41
Novelty-Seeking	7.38	8.63	-1.38	.23
Self-Esteem	22.50	22.10	.19	.85
Extraversion	3.56	4.40	-.38	.72
Neuroticism	4.00	2.50	1.12	.29

Table 2

T-test results for MZ males.

Measure	Mean for Overweight Twins	Mean for Non-Overweight Twins	T-test	P-value
BMI	28.57	21.86	5.33	.00
EI-Hunger	17.60	15.00	1.32	.23
EI-Restraint	22.75	25.67	-1.47	.19
EI-Disinhibition	23.63	17.88	1.81	.11
Dependence	16.25	17.75	-.78	.46
Novelty-Seeking	7.75	7.50	.17	.87
Self-Esteem	21.75	21.88	-.09	.93
Extraversion	4.88	4.63	.33	.75
Neuroticism	5.13	4.50	.60	.56