Introduction

The modern food supply and sedentary lifestyle contribute significantly to the high prevalence of excess weight and obesity, but it is estimated that as much as 40-70% of the variability in body mass index (BMI) and adiposity is explained by genetics. One of the most robust genetic associations predicting BMI is the FTO gene, as confirmed by experimental studies, yet mechanistic questions remain. Additionally, the broader polygenic architecture of BMI also implicates genes expressed in the central nervous system, suggesting mechanisms beyond individual differences in metabolism.

Indeed, psychological processes may partially explain the relationship between genetics and BMI. Both positive and negative emotional states have been shown to influence when and how much we eat. Several studies have found that overweight individuals are more likely to overeat in response to negative emotions as compared to normal to underweight individuals. Here, we examine the relationship between eating behavior, BMI, and genetics.

Methods

The study population includes 354,787 survey respondents who were genotyped as part of the 23andMe Personal Genome Service and consented for research. The population characteristics are described in Table 1. Respondents completed a 21-item eating behavior questionnaire, which addressed various aspects of emotional eating, restrictive eating, situational eating, social eating, overeating, and passive screen-time eating. Only responses with non-missing data for age, sex, body mass index, race/ethnicity, and all 21-items in the questionnaire were included in analyses.

To evaluate the relationship between each behavior surveyed and body mass index, bivariate correlations were explored on a per-item basis (Figure 1). Next, we used principal components analysis to explore the dimensionality of eating behaviors constructs and to identify eating behavior endophenotypes (Figure 2). Finally, the genetic architectures of the two first principal components were explored in genome wide association studies (GWAS) (Figures 3, 4).

For the first two principle component GWAS shown in Figures 3 and 4, the sample was restricted to unrelated people of European descent, and was adjusted for age, sex, genotyping platform, and the first 5 genetic ancestry principal components—with and without adjusting for BMI. Statistical analyses were conducted in R.

Results

Table 1. Population characteristics, by BMI category.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Full sample</th>
<th>BMI &lt;18.5</th>
<th>BMI 18.5-24.9</th>
<th>BMI 25.0-29.9</th>
<th>BMI ≥30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>49.2±18.7</td>
<td>47.7±17.6</td>
<td>50.6±15.0</td>
<td>50.0±16.4</td>
<td>48.7±16.2</td>
</tr>
<tr>
<td>Sex (%)</td>
<td>51.6%</td>
<td>52.5%</td>
<td>50.6%</td>
<td>51.2%</td>
<td>50.9%</td>
</tr>
<tr>
<td>Body mass index (BMI) (kg/m²)</td>
<td>24.7±5.6</td>
<td>23.3±4.0</td>
<td>25.5±4.5</td>
<td>27.7±5.0</td>
<td>31.2±5.6</td>
</tr>
<tr>
<td>% European</td>
<td>82.6%</td>
<td>82.1%</td>
<td>83.1%</td>
<td>82.5%</td>
<td>81.9%</td>
</tr>
<tr>
<td>% Asian</td>
<td>9.6%</td>
<td>9.2%</td>
<td>10.5%</td>
<td>9.5%</td>
<td>9.7%</td>
</tr>
<tr>
<td>% Hispanic</td>
<td>3.8%</td>
<td>5.3%</td>
<td>2.6%</td>
<td>2.9%</td>
<td>2.5%</td>
</tr>
<tr>
<td>% Other</td>
<td>3.9%</td>
<td>3.9%</td>
<td>3.7%</td>
<td>3.2%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

GWAS of PC1: Emotional and situational eating

For the first two principle component GWAS shown in Figures 3 and 4, the sample was restricted to unrelated people of European descent, and was adjusted for age, sex, genotyping platform, and the first 5 genetic ancestry principal components—with and without adjusting for BMI. Statistical analyses were conducted in R.

Results (cont.)

GWAS of PC2: Avoidant eating

Discussion

These findings support a long-standing body of research associating FTO with behaviors contributing to elevated weight. Furthermore, we extend previous analyses by examining the genetic architecture of emotional/situational and avoidant eating behavior that is independent of BMI. Indeed, FTO and several additional loci may play a role in the way we choose to eat or not eat in response to negative emotional states and situations as well as food avoidant behaviors independent of their direct effect on BMI.

Our results suggest that there may be genetic vulnerability to emotional/situational and avoidant eating that may enhance the feedback loop between BMI and these constructs. In light of the limited success of dietary and exercise interventions to control weight, and the strong feedback cycles associated negative emotional states (e.g., sadness, anxiety, and loneliness) with increased food intake behaviors, cognitive and behavioral strategies specifically designed to aid emotional and situational eating should be explored to minimize the health impacts of these common emotional states. Individuals with enhanced genetic vulnerability to situational eating may especially benefit from such interventions.

Acknowledgments

We thank 23andMe customers who consented to participate in research for enabling this study. We also thank employees of 23andMe who contributed to the development of the infrastructure that made this research possible.

References

1.  [Reference 1]
2.  [Reference 2]
3.  [Reference 3]
4.  [Reference 4]
5.  [Reference 5]
6.  [Reference 6]
7.  [Reference 7]
8.  [Reference 8]
9.  [Reference 9]
10. [Reference 10]
11. [Reference 11]