Body Mass in Adolescence: The Role of Personality, Intelligence, and Socioeconomic Status

Abstract

With increasing rates of obesity among children and adolescents, it is important to understand the mechanisms behind the alarming number of individuals’ high body mass index. Personality may be an important factor linking low SES and high BMI. The purpose of this study was to investigate the association between SES personality traits, cognitive abilities and BMI. Data were drawn from a larger dataset personality. The study included 32,647 participants (11,856 males and 20,791 females). The results revealed that cognitive abilities and parental education levels remained significant predictors of BMI in males, even after accounting for demographic variables and other indicators of parental SES. In contrast, extraversion and parental education level were significant predictors of BMI in females. The findings that emerge from this study may have far-reaching implications in interventions by suggesting that psychological traits should be taken into account while designing weight-loss or weight-management interventions.

*Keywords:*adolescents, Body Mass Index, obesity, personality traits, socioeconomic status

**Introduction**

Obesity among children and adolescents is an international public health crisis. In the last 40 years, the prevalence of obesity has grown from 1 in 20 American adolescents to nearly 1 in 5 (Ogden, Carroll, Kit, & Flegal, 2014). Currently, an estimated 16.9% of children and adolescents under the age of 19 were obese in 2010 (Ogden, Carroll, Kit, & Flegal, 2012).

Efforts to reduce the prevalence of overweight and obesity have now been a high priority public health issue in the U.S. for several years (Frieden, Dietz, & Collins, 2010; HealthyPeople, 2010; HealthyPeople, 2020; US Department of Health and Human Services, 2001) and several of the prominent social programs focused on this issue consider children and adolescents as populations that are ripe for intervention (Dietz & Gortmaker, 2001; Frieden et al., 2010; Khan et al., 2009). Yet, there is little evidence that these efforts are working (Ogden, Carroll, Kit, & Flegal, 2014).

The Centers for Disease Control and Prevention defines childhood and adolescent obesity as having a BMI at or above the 95th percentile for children and teens of the same age and sex whereas overweight is defined as a BMI at or above the 85th percentile and below the 95th (CDC, 2015). Although there are some alternatives to the assessment of obesity in children and adolescents, BMI – as an estimate of body fat – is a widely accepted index to determine overweight status and obesity in children, adolescents, and adults (Dietz & Bellizzi, 1999). BMI is calculated by dividing a person’s weight in kg by the square of their height in meters (the same formula can be used with pounds and inches, though the result must be multiplied by a conversion factor of 703). The World Health Organization’s (WHO) defines overweight status, regardless of age and gender, as a BMI greater than or equal to 25 whereas a BMI greater than or equal to 30 qualifies as obese. The WHO furthers classifies overweight individuals (those with BMIs between 25 and 30) as “pre-obese” (WHO, 2011).

Adolescence is associated with considerable changes in body composition: all the main components of body composition (total body fat, lean body mass, bone mineral content) increase during this period (Siervogel et al., 2003), which typically begins between the ages of XX and XX years for females and between XY and XY years for males. Numerous studies (and anecdotal evidence from billions of former adolescents) suggest that this period is often psychologically challenging. Adolescents are more likely to be dissatisfied with their body (to the point of endorsing a profound dislike of one's own body), experience fear of weight gain, and have appearance and body shape concerns, and these concerns predispose them to the development of eating disorders (Killen et al., 1994; Story et al., 1991; Striegel-Moore, Silberstein, & Rodin, 1986).

The trend of increasing obesity prevalence among adolescents, coupled with its adverse health outcomes, underscores the need for obesity prevention efforts, especially those targeting adolescents. Adolescence is a vulnerable period for weight gain and most of the complications that are commonly associated with adult obesity are tied to health behaviors formed in childhood and adolescence [citation needed]. As such, a more informed understanding of relations among key constructs within this developmental period is crucial.

Numerous changes in body mass levels during adolescence are already well-documented, including several pointing to important sex differences. For example, developmentally appropriate increases in BMI occur at different ages for each sex, necessitating the use of age- and sex-specific reference values (Bibiloni, Pons, & Tur, 2013). Adolescent males and females differ substantially on average in terms of body fat percentages, with females typically having more body fat than males at the same BMI (Daniels, Khoury, & Morrison, 1997; Taylor, Gold, Manning, & Goulding, 1997). Similarly, substantial differences have been reported between the eating habits of males and females, even when controlling for differences in knowledge of healthy eating practices and benefits (Djordjevic-Nikic & Dopsaj, 2013). Given these and related findings, much of the research in this area (including the work reported here) is conducted on each of the sexes independently.

The primary aim of this work is to identify and evaluate the wide range of individual differences contributing to elevated BMI across both sexes. There is some evidence that socioeconomic status (Sherwood, Wall, Neumark-Sztainer, & Story, 2009; Smith, 2004), personality (Bogg & Roberts, 2004), and cognitive ability (Liang, Matheson, Kaye & Boutelle, 2014) are each protective factors for obesity, however, the unique (independent) and combined variance of these attributes has rarely been considered. Before describing the methods used to evaluate the associations among these variables and body mass in large samples of both male and female adolescents, it is first necessary to summarize prior findings within and across each domain.

**The relationship between SES and BMI**

The term “socioeconomic status” (SES) is an aggregate construct defined according to one’s level of resources or prestige in relation to others (Adler & Rehkopf, 2008; Krieger, Williams, & Moss, 1997; Lynch & Kaplan, 2000). While the operationalization and measurement of socioeconomic status is notably inconsistent, there is general consensus that SES includes education, income, and occupational prestige (Shanahan, Hill, Roberts, Eccles, & Friedman, 2014). Because children and adolescents are still in school and do not have income, researchers typically use measures of parental education, parental occupation, and/or household income as markers of childhood/adolescent SES (Shrewsbury & Wardle, 2008).

The relationship between SES and BMI has been widely investigated. Several studies have found that obesity among children and adults in industrialized countries is negatively associated with income and education (e.g., Booth et al., 1999; Bove & Olson, 2006; Molenar et al., 2004; Wang et al., 2007); the opposite relationship has been found in some (but not all developing countries), including urban India or Ghana (Fokeena & Jeewon, 2012). The list of proposed mechanisms placing low-income children at increased risk for obesity relative to higher-income children includes the consumption of less whole meal and brown bread and less fresh fruits and vegetables, but more fatty milk, eggs, and meats (Steele, Dobson, Alexander, Russell, 1991; Smith & Baghurst, 1992). It has also been proposed that the inverse relationship between SES and BMI is driven by sedentary behavior as low SES children have been found to be less physically active and spend more time watching television and using the computer (Brown, Halvorson, Cohen, Lazorick, & Skelton, 2015; Drenowatz et al., 2010; Morgenstern, Sargent, & Hanewinkel, 2009). Unfortunately, additional research has shown that SES is inversely related to sedentary behavior and to rates of overweight status in children over six years of age (Hanson & Chen, 2007; Inchley et al., 2005; Lioret et al. 2007) and adolescents (Lohman et al., 2006). Still other research points to sedentary behavior as a mediator of BMI in children of low SES status (O’Dea & Wilson, 2006), among more prominent main effects.

**SES and personality**

Personality traits have been widely linked to not only mental and physical health but also other criteria such as socioeconomic status. Considerable research suggests that individuals raised in low SES households have higher levels of neuroticism, lower openness to experience and maladaptive coping mechanisms, including external locus of control and lack of problem-focused coping (Bosma, van de Mheen, & Mackenbach, 1999; Korner, Geyer, Gunzelmann, Brahler, 2003). These individuals are also more likely to engage in risky health behaviors and have higher levels of hostility (Barefoot et al., 1991; Kubzansky, Kawachi, Sparrow, 1999) whereas children from families with higher SES are less impulsive on average (Delaney & Doyle, 2012), significantly less likely to be risk-seeking (Deckers et al., 2015), and more altruistic (Bauer, Chytilova, Pertold-Gebicka, 2015; Deckers at al., 2015).

It should be noted that associations between SES and personality are likely bidirectional.Certainly across the lifespan, there is strong evidence of the effects of personality on socioeconomic status in adulthood. Research shows children’s conscientiousness is a strong predictor of income and occupational status, even after controlling for IQ (Duckworth & Weir, 2010). Individuals high on conscientiousness tend to save more money and are more hardworking, dependable, persistent and goal-oriented (e.g., Barrick & Mount, 1991). In addition, they spend money more cautiously (e.g., Wilcox, Block & Eisenstein, 2011). Some studies have also shown empirical support for the influence of agreeableness on SES. Individuals high on agreeableness are more likely to choose professions that are paid less such as teaching, nursing or volunteer work (Larson, Rottinghaus, & Borgen, 2002; Lodi-Smith & Roberts, 2007). Findings on other personality traits are inconsistent (Sutin et al., 2015).

**SES and cognitive abilities**

A growing body of research has documented that socioeconomic status (SES) predicts a variety of children’s outcomes including physical and mental health, cognitive ability, and academic achievement (Adler & Rehkopf, 2008; Merikangas et al., 2010). Interestingly, the differences in cognitive abilities between children from families with high and low SES can be observed as early as infancy and persists, on average, throughout adolescence (Lipina et al., 2005). A number of studies have demonstrated that low-SES children performed worse in working memory or executive attention tasks in comparison to children from families with high SES (Blair et al., 2011; Hughes, Wilson, & Graham, 2010; Mezzacappa, 2004). Although cognitive ability has been shown to be highly heritable (e.g., Haworth et al., 2010), SES also seems to have an important influence on children’s school performance that is potentially independent of cognitive ability (Conger & Donnellan, 2007).

**BMI and personality**

Research has shown that certain personality traits are associated with behaviors that contribute to obesity such as unhealthy eating habits and physical inactivity. For example, individuals high on conscientiousness are likely to be more self-disciplined about their diet (see Bogg & Roberts, 2004; Terracciano et al., 2009) and are more physically active (Rhodes & Smith, 2006) whereas individuals with lower levels of conscientiousness tend to engage in emotional and external eating, which is a tendency to overeat in response to food-related cues like the smell or taste of food, regardless of the individual’s physical need for food (Evers et al., 2011; Heaven, Mulligan, Merrilees, Woods, & Fairooz, 2001). Findings regarding neuroticism are inconclusive. Some researchers found that high levels of neuroticism are related to disinhibition and susceptibility to hunger (Provencher et al., 2008). On the other hand, individuals who have higher scores on this trait tend to be underweight (Kakazaki et al., 2008; Terrecciano et al., 2009) and more likely to suffer from eating disorders (Bogg & Roberts, 2004). Sutin and colleagues (2011) suggested two possible explanations for this phenomenon: (1) there might be a curvilinear relationship between neuroticism and abnormal weight or (2) being overweight/underweight is associated with different aspects of neuroticism. Higher scores on extraversion have also been found to contribute to obesity (e.g., Kakizaki, 2008; Sutin, Ferrucci, Zonderman & Terracciano, 2011). Similarly, individuals with higher scores on openness to experience were found to be less successful at managing their body weight and indicated a stronger drive toward overeating (Sullivan, Cloninger, Przybeck, & Klein, 2007). In addition, higher scores on openness were negatively related to cognitive dietary restraint (van den Bree, Przybeck, & Robert, 2006). In summary, a growing body of research confirms that personality traits influence eating behavior and therefore moderate the association between personality and BMI.

**BMI and cognitive abilities**

Previous studies investigating the association between BMI and cognitive abilities found that individuals with lower levels of cognitive abilities have higher BMI (Cournot, Marquie, Ansiau, 2006; Hirshman et al., 2004; Li, 1995). Adolescents who are obese are more likely to suffer from deficits in multiple cognitive domains such as attention, memory, and executive function and as a result have worse school outcomes in comparison to non-obese peers (Elias et al., 2005; Lawlor et al., 2006; Mond et al., 2007; Sabia et al., 2009). This association remains significant even after controlling for important confounding factors, such as physical activity or maternal intelligence. The mechanisms through which cognitive abilities may adversely affect BMI remain unclear. One hypothesis of the underlying mechanism is that lower levels of cognitive abilities may result in poor control over neurological centers associated with impulsivity which can lead to impaired control over food intake (Veldwijk et al., 2011). Alternatively, obesity may negatively influence cognitive function via physiological changes in brain tissue (Veldwijk et al., 2011). Therefore, there might be a bi-directional interaction between cognitive abilities and BMI. Because there is a hereditary component to both cognitive abilities and BMI, a number of genetic factors may be involved in explaining this association (Teasdale, Sorensen, & Stunkard, 1992).

**The present study**

In this study, we use a large international sample to evaluate the associations between Body Mass Index (BMI), personality traits, cognitive ability, and SES as well as other demographic variables. A growing body of research on obesity has demonstrated that the relationship between race and BMI is complex. The racial/ethnic differences in overweight and obesity are well documented in many studies (Hedley et al. 2004; Flegal et al., 2002; Truong & Sturm, 2005). Specifically, the prevalence of obesity is higher in racial-ethnic minority populations, especially black women, than in whites (Cossrow & Falkner, 2004; National Institutes of Health and National Heart, Lung, and Blood Institute, 1998). In addition, these racial/ethnic disparities are more pronounced and consistent among women than among men (Ogden et al., 2006). Although black girls were more likely to be overweight than white girls, black boys were not more likely to be overweight than white boys (Caprio et al., 2008).

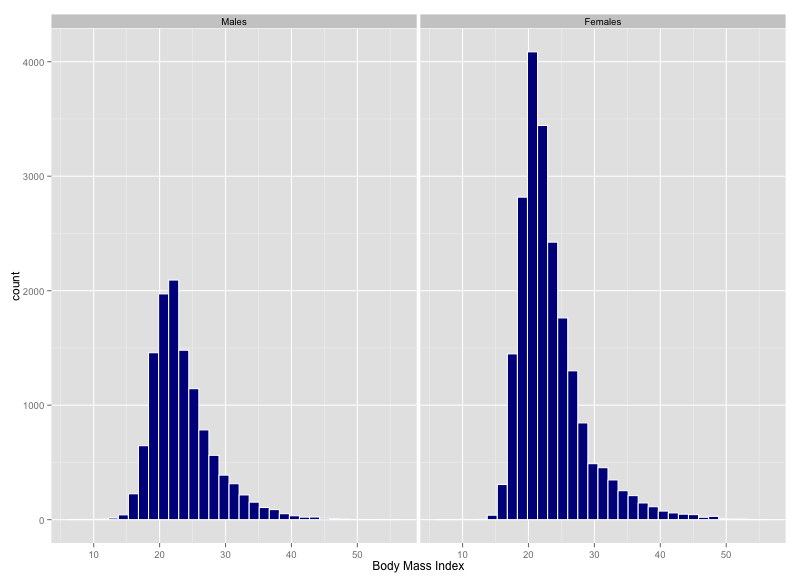
Gordon-Larsen and colleagues (2003) found an inverse relationship between overweight prevalence and SES for white adolescent females but overweight prevalence did not decrease with increased SES for either black or Hispanic teen girls. Based on this finding, in this study we will control for race. So far, no study explored the association between socioeconomic status, personality traits, cognitive ability, and BMI. Our key research questions are (a) what factors contribute to obesity; (b) whether personality traits are significant predictors of high BMI; (c) are there differences in the relationship between these variables in male and female adolescents.

**Methods**

**Participants**

199,516 (62% female) individuals participated in the personality survey at SAPA-Project.org between August 18, 2010 and October 15, 2015 in exchange for customized feedback about their personalities. From these, the sub-sample of individuals (*n* = 92,644) who provided both self-reported height and weight information (65% of the total) and were from the United States (69% of the total) was used to evaluate the internal consistency and structure of the measures in this study. Only the data from 13 to 19 year old adolescents in this sub-sample of U.S. participants were used for the full analyses; this included 11,856 males with a mean age of 17.3 years (*M* = 18; *SD* = 1.4) and 20,791 females with a mean age of 17.4 years (*M* = 18; *SD* = 1.4). Figure 1 shows the distribution of body mass index scores for both genders. 8,712 participants (27.9% of the adolescent males and 26.0% of the adolescent females) had BMI scores of 25 or more. More information about the characteristics of the sample is provided in the Supplementary Materials.

*Figure 1.* Distribution of body mass index scores by gender



**Procedures**

All data were self-reported and collected using the Synthetic Aperture Personality Assessment (SAPA) technique (Wilt, Condon, & Revelle, 2010), a variant of the matrix sampling procedures discussed by Lord (1955). These procedures produce data with substantial planned missingness and can be qualified as “missing completely at random” (Graham, 2009; Condon & Revelle, 2015). After accounting for missingness, the number of pairwise administrations among items was a mean of 1,120 (*SD* = 874) for the adolescent males and 1,988 (SD = 1,548) for the adolescent females.

**Measures**

**Parental SES.** Parental SES was measured by the assessment of educational attainment levels and occupation. For educational attainment, each participant was prompted to describe the education completed for up to two parents or guardians. When education was provided for more than one parent, mean education level was used. Education level was scored from 1 to 7 and the choices were coded as follows: “less than 12 years”, “high school graduate,” “currently in college/university,” “some college/university, but did not graduate,” “college/university degree,” “currently in graduate or professional school,” “graduate or professional school degree.”

For occupation, each participant was prompted to describe the occupational field for up to two parents if those parents worked outside of the home or were retired. The occupational field choices are based on the Occupational Information Network (O\*NET ®) taxonomy developed by the U.S. Department of Labor (DOL) and the National Center for O\*NET Development (National O\*NET Consortium, 2010; see onetcenter.org/taxonomy/2010/list.html). The occupational fields were then used to estimate the income for each parent based on the estimates provided by O\*NET (National O\*NET Consortium, 2010). Occupational fields were also used to estimate occupational prestige for each parent based on the mean ratings of each occupational field collected in an independent sample (*n* = 208). When the occupational field was described for more than one parent, the average was used for the estimate of parental income and parental occupational prestige. The index of parental SES was calculated from the equally weighted average of parental education level, estimated parental income, and parental occupational prestige.

**BMI.**Respondents reported their body weight (in pounds or kilograms) and height (in feet/inches or centimeters. Based on this information, a body mass index score was derived by dividing weight in kilograms by the square of height in meters (BMI = weight (kg) / [height (m)]2).

**Personality.** Personality was assessed using the IPIP Big-Five factor markers (Goldberg, 1999), a 100-item inventory consisting of 20 items for each of the Big-Five factors: Extraversion, Agreeableness, Conscientiousness, Emotional Stability, and Intellect. An additional 596 personality items were administered from 87 other personality scales in this sample (Condon, 2014; Condon & Revelle, 2015); data collected on these additional items were not included as part of the original hypotheses but were used for post-hoc analyses. All items were administered with a 6-point, Likert-type scale ranging from 1 (“very inaccurate”) to 6 (“very accurate”).

**Cognitive Ability.** Cognitive ability was assessed using a 60 item measure from the International Cognitive Ability Resource (“ICAR60”, Condon & Revelle, 2014). This included items of four different item types: Matrix Reasoning (11 items), Verbal Reasoning (16 items), Letter-Number Series (9 items), and Three-Dimensional Rotation items (24 items). Participants were administered random 16 item subsets of the measure; general cognitive ability scores across all item types were used.

**Results**

All analyses were conducted in R (R Development Core Team, 2015), primarily using the psych package (Revelle, 2015). Complete syntax for the analyses is provided in the Supplemental Materials.

**Evaluation of the measures and descriptive statistics**

Internal consistencies for the measures of personality and cognitive ability are presented in Table 1. All of the scales demonstrated high internal consistency ( = 0.89 - 0.96). The general factor saturation (hierarchical; Zinbarg, Yovel & Revelle, 2007; Zinbarg, Yovel, Revelle, & McDonald, 2006) was adequate for all measures but relatively low for Intellect (hierarchical = 0.59). Table 2 shows the relationship between the socioeconomic variables among the full sample (both male and female adolescents). All three were moderately-to-strongly correlated (*r* = 0.34 – 0.81, 95% CIs +/- 0.01) and were indexed for subsequent analyses.

Table 1. Internal consistencies for the measures of Big Five and cognitive ability

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | h | items |
| Agreeableness | 0.91 | 0.72 | 20 |
| Conscientiousness | 0.92 | 0.68 | 20 |
| Extraversion | 0.94 | 0.80 | 20 |
| Emotional Stability | 0.93 | 0.76 | 20 |
| Intellect | 0.89 | 0.59 | 20 |
| ICAR60 | 0.96 | 0.76 | 60 |
| Note: α = Cronbach’s alpha, ωh = omega hierarchical | | | |

Table 2. Correlations among the socioeconomic status variables for the full sample

|  |  |  |
| --- | --- | --- |
|  |  |  |
| 1. Parental education |  |  |
|  |  |  |
| 2. Parental occupational prestige | 0.46 |  |
|  | (0.46, 0.47) |  |
|  |  |  |
| 3. Parental estimated income | 0.34 | 0.81 |
|  | (0.34, 0.35) | (0.80, 0.81) |
| *Note. n* = 92,644; 95% confidence intervals in parentheses. | | |

Descriptive statistics for all variables by gender are presented in Table 3, along with standardized effect sizes for the differences across genders. All of the means were significantly different between males and females. All of the socioeconomic variables were significantly higher for males but the parental SES index had an overall small effect size difference in favor of males (*d* = 0.06). The largest effect size differences were for agreeableness (*d* = 0.37 in favor of females) and emotional stability (*d* = 0.45 in favor of males). Effect sizes were small for conscientiousness (*d* = 0.18 in favor of females), intellect (*d* = 0.19 in favor of males), and cognitive ability (*d* = 0.21 in favor of males).

Table 3. Descriptive statistics for BMI, SES, personality and cognitive ability.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Males | | Females | |  |  |  |
| *n* = 11,856 | | *n* = 20,791 | |  |  |  |
| Variable | *M* | *SD* | *M* | *SD* |  | *d1* | 95% CI |
| Body mass index | 23.53 | 4.83 | 23.32 | 5.05 |  | 0.04 | (0.02, 0.06) |
| Household Income | 60,349 | 19,337 | 59,777 | 19,238 |  | 0.03 | (0.01, 0.05) |
| Occupational Prestige | 59.25 | 13.16 | 58.77 | 13.19 |  | 0.04 | (0.01, 0.06) |
| Parental education | 4.33 | 1.75 | 4.19 | 1.76 |  | 0.08 | (0.06, 0.1) |
| Parental SES index | 0.14 | 0.84 | 0.08 | 0.84 |  | 0.06 | (0.04, 0.09) |
| Agreeableness | 4.34 | 0.98 | 4.69 | 0.91 |  | -0.37 | (-0.39, -0.35) |
| Extraversion | 3.74 | 1.25 | 3.79 | 1.24 |  | -0.04 | (-0.06, -0.01) |
| Emotional Stability | 3.77 | 1.23 | 3.22 | 1.20 |  | 0.45 | (0.43, 0.48) |
| Conscientiousness | 3.88 | 1.07 | 4.07 | 1.06 |  | -0.18 | (-0.2, -0.16) |
| Intellect | 4.52 | 0.95 | 4.34 | 0.96 |  | 0.19 | (0.17, 0.21) |
| Cognitive Ability | 0.29 | 0.26 | 0.24 | 0.23 |  | 0.21 | (0.19, 0.23) |
| 1 Standardized effect sizes for the differences in means | | | | | | | |

**Zero-Order Correlations Among the Variables**

Separate correlation analyses were conducted for male and female adolescents as shown in Tables 4 and 5, respectively. Estimates of the 95% confidence intervals for all correlations are based on bootstrapping procedures with 100 sampling iterations; these reflect that most of the correlations are statistically significant (*p* < .05) though small in magnitude. For both genders, the correlations of highest magnitude were among the personality variables; the most prominent of these were between Agreeableness and Extraversion (*r* = 0.39-0.40) and Agreeableness and Emotional Stability (*r* = 0.27-0.30). Notable correlations for both genders with parental SES included Intellect (*r* = 0.10-0.12) and cognitive ability (*r* = 0.10-0.12). Intellect and cognitive ability were also similarly correlated (*r* = 0.20-0.22) across genders. Correlations with age differed slightly across genders; age was more highly correlated with conscientiousness among adolescent females (*r* = 0.18 vs. *r* = 0.09) and age was more highly correlated with cognitive ability among adolescent males (*r* = 0.07 vs. *r* = 0.01). Both genders had similar correlations between age and BMI (*r* = 0.12-0.13). For body mass index, there were two notable differences across genders: (1) the correlation between BMI and parental SES was higher in magnitude for females (*r* = -0.16 vs *r* = -0.11); and (2) the correlation between BMI and cognitive ability was higher in magnitude for males (*r* = -0.09 vs *r* = -0.04).

Table 4. Zero-order correlations for male adolescents

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|  |  |  |  |  |  |  |  |  |
| 1. Body mass index |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 2. Age | .13 |  |  |  |  |  |  |  |
|  | (.11, .14) |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 3. Parental SES | -.11 | .00 |  |  |  |  |  |  |
|  | (-.11, -.10) | (.00, .01) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 4. Agreeableness | .06 | .11 | .02 |  |  |  |  |  |
|  | (.06, .08) | (.10, .12) | (.00, .03) |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 5. Extraversion | .03 | .03 | .04 | .40 |  |  |  |  |
|  | (.03, .06) | (.02, .04) | (.02, .04) | (.39, .41) |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 6. Emotional Stability | -.03 | .05 | .02 | .14 | .30 |  |  |  |
|  | (-.05, -.02) | (.04, .07) | (-.01, .03) | (.11, .15) | (.29, .32) |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 7. Conscientiousness | -.02 | .09 | -.04 | .20 | .20 | .22 |  |  |
|  | (-.04, -.02) | (.09, .10) | (-.05, -.04) | (.19, .21) | (.19, .22) | (.19, .24) |  |  |
|  |  |  |  |  |  |  |  |  |
| 8. Intellect | -.05 | .05 | .10 | .23 | .18 | .14 | .13 |  |
|  | (-.06, -.03) | (.04, .07) | (.07, .11) | (.21, .25) | (.15, .21) | (.11, .15) | (.13, .16) |  |
|  |  |  |  |  |  |  |  |  |
| 9. Cognitive ability | -.09 | .07 | .12 | -.07 | -.18 | -.07 | -.08 | .22 |
|  | (-.09, -.08) | (.06, .08) | (.10, .12) | (-.11, -.06) | (-.20, -.18) | (-.11, -.04) | (-.10, -.08) | (.22, .23) |
|  |  |  |  |  |  |  |  |  |
| *Note: n* = 11,856; 95% confidence intervals in parentheses. | | | | | | | | |

Table 5. Zero-order correlations for female adolescents

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. |
|  |  |  |  |  |  |  |  |  |
| 1. Body Mass Index |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 2. Age | .12 |  |  |  |  |  |  |  |
|  | (.11, .13) |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 3. Parental SES | -.16 | -.04 |  |  |  |  |  |  |
|  | (-.17, -.15) | (-.05, -.02) |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 4. Agreeableness | .02 | .15 | .04 |  |  |  |  |  |
|  | (.00, .03) | (.13, .17) | (.03, .06) |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 5. Extraversion | -.04 | .06 | .07 | .39 |  |  |  |  |
|  | (-.06, -.02) | (.04, .07) | (.06, .09) | (.36, .41) |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 6. Emotional Stability | -.04 | .09 | .06 | .17 | .27 |  |  |  |
|  | (-.07, -.03) | (.08, .11) | (.05, .08) | (.15, .20) | (.24, .30) |  |  |  |
|  |  |  |  |  |  |  |  |  |
| 7. Conscientiousness | -.06 | .18 | .00 | .25 | .15 | .18 |  |  |
|  | (-.07, -.04) | (.16, .20) | (-.02, .02) | (.23, .28) | (.12, .18) | (.16, .21) |  |  |
|  |  |  |  |  |  |  |  |  |
| 8. Intellect | -.02 | -.03 | .12 | .19 | .18 | .12 | .11 |  |
|  | (-.05, .00) | (-.05, -.01) | (.11, .14) | (.17, .22) | (.16, .21) | (.09, .14) | (.09, .13) |  |
|  |  |  |  |  |  |  |  |  |
| 9. Cognitive ability | -.04 | .01 | .10 | -.05 | -.16 | -.05 | -.08 | .20 |
|  | (-.05, -.03) | (-.01, .02) | (.09, .11) | (-.07, -.03) | (-.19, -.15) | (-.07, -.02) | (-.10, -.05) | (.18, .22) |
|  |  |  |  |  |  |  |  |  |
| *Note: n* = 20,791; 95% confidence intervals in parentheses. | | | | | | | | |

**Evaluation of Multiple Regression Models**

Several analyses were conducted using multiple regression with body mass index as the predicted outcome. Results of these analyses are shown for each gender in Table 6. The values in the first column for each gender show the standardized regression coefficients for each variable after controlling for age and race. All three components of parental SES were predictive of BMI for males and females; parental education was slightly more predictive for females (*β* = -0.16, *p* < .001). Among the personality and cognitive ability variables, conscientiousness was a significant predictor for females only (*β* = -0.08, *p* < .001) and cognitive ability was significant for males only (*β* = -0.10, *p* < .001). The second column for each gender in Table 6 shows the standardized regression coefficient for each variable when all of the variables in each domain (parental SES or personality or cognitive ability) were modeled as a group, controlling for age and race. These models show the extent to which each domain explained variance in BMI scores. Parental SES explained the most variance (*R*2 = .032 for males, .059 for females) followed by personality (*R*2 = .029 for males, .043 for females) and cognitive ability (*R*2 = .028 for males, .034 for females). The final column for each gender in Table 6 shows the standardized regression coefficients when all variables were modeled simultaneously, controlling for age and race. Parental education remains significant for both genders (*β* = -.08 for males, *p* < .01; *β* = -.14 for females, *p* < .001). Conscientiousness was significant for females (*β* = -.09, *p* < .001). Cognitive ability was significant for males (*β* = -.07, *p* < .05). The complete model explained more variance in BMI scores for females (*R*2 = .070) than for males (*R*2 = .046).

Table 6. Summary of regression analyses predicting BMI with demographics, parental socioeconomic status and personality

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *All males (n = 11,856)* | | | | | |  | *All females (n = 20,791)* | | | | | | | |
|  | *Number of Regression Models1* | | | | | |  | *Number of Regression Models1* | | | | | | | |
|  | *9* | | *3* | | *1* | |  | *9* | | *3* | | | *1* | | |
| Parental education level | -0.11 | \*\*\* | -0.09 | \*\* | -0.08 | \*\* |  | -0.16 | \*\*\* | | -0.14 | \*\*\* | -0.14 | \*\*\* |
| Parental occupational prestige | -0.08 | \*\* | -0.04 |  | -0.04 |  |  | -0.10 | \*\*\* | | -0.01 |  | -0.02 |  |
| Estimated parental income | -0.06 | \* | 0.00 |  | 0.00 |  |  | -0.09 | \*\*\* | | -0.04 |  | -0.04 |  |
| Parental SES combined *R*2 |  |  | 0.032 |  |  |  |  |  |  | | 0.059 |  |  |  |
|  |  |  |  |  |  |  |  |  |  | |  |  |  |  |
| Agreeableness | 0.05 |  | 0.06 | \* | 0.06 |  |  | 0.01 |  | | 0.05 |  | 0.05 |  |
| Extraversion | 0.02 |  | 0.03 |  | 0.02 |  |  | -0.05 | \* | | -0.05 |  | -0.05 |  |
| Emotional Stability | -0.04 |  | -0.04 |  | 0.02 |  |  | -0.05 | \* | | -0.03 |  | -0.03 |  |
| Conscientiousness | -0.03 |  | -0.04 |  | -0.05 |  |  | -0.08 | \*\*\* | | -0.08 | \*\*\* | -0.09 | \*\*\* |
| Intellect | -0.05 | \* | -0.06 | \* | -0.03 |  |  | -0.01 |  | | 0.00 |  | -0.03 |  |
| Personality combined *R*2 |  |  | 0.029 |  |  |  |  |  |  | | 0.043 |  |  |  |
|  |  |  |  |  |  |  |  |  |  | |  |  |  |  |
| Cognitive ability | -0.10 | \*\*\* | -0.10 | \*\*\* | -0.07 | \* |  | -0.03 |  | | -0.03 |  | -0.03 |  |
| Cognitive ability *R*2 |  |  | 0.028 |  |  |  |  |  |  | | 0.034 |  |  |  |
|  |  |  |  |  |  |  |  |  |  | |  |  |  |  |
| All variables – combined *R2* |  |  |  |  | 0.046 |  |  |  |  | |  |  | 0.070 |  |
| *1 Note: The values in the first column for each sample are the standardized βs from 9 separate regression analyses of BMI predicted by each variable independently, controlling for age and race. The values in the second column are the standardized βs and R2 from 3 separate regressions analyses of BMI predicted by the domains of (1) parental SES; (2) personality; and (3) cognitive ability. The values in the third column are the standardized βs and R2 from a single regression analysis of BMI predicted by all of the factors simultaneously.* | | | | | | | | | | | | | | | |
| \*\*\* *p* < .001, \*\* *p* < .01,\* *p* < .05 | | | | | | | | | | | | | | | |

**Post-hoc item level regression analyses**

After completing and interpreting the results of the planned regression analyses shown in Table 6, post-hoc item-level analyses were conducted using all available personality items in addition to age, parental SES and the cognitive ability items. The items that correlated most highly with BMI for each gender are shown in Table 7 for males and Table 8 for females. For males, the top 10 items included 9 personality items and the age variable. For females, the top 10 items included 8 personality variables, the age variable, and parental SES. The confidence intervals for the correlations shown in Tables 7 and 8 reflect the range of correlation values after 100 iterations of re-sampling from the adolescent male and female samples, respectively. These 10 items were then scored as empirical scales and correlated with BMI for both genders. For males, the 10 item empirical BMI scale had a correlation with BMI of .50 (95% CI = .41-.58). For females, the 10 item empirical BMI scale had a correlation with BMI of .32 (95% CI = .28-.36).

Table 7. Empirical BMI scale for adolescent males

|  |  |
| --- | --- |
| Item | *r* with BMI 1 |
| 1. Often eat too much | .33 (.26, .40) |
| 2. Have great stamina | -.20 (-.25, -.13) |
| 3. Enjoy thinking about things | -.16 (-.30, -.01) |
| 4. Seek adventure | -.16 (-.28, -.06) |
| 5. Get to work at once | .15 (.07, .22) |
| 6. Have an intense boisterous laugh | .15 (.09, .20) |
| 7. Worry about my health | .13 (.07, .22) |
| 8. Age | .13 (.11, .15) |
| 9. Love to eat | .13 (.02, .24) |
| 10. Love action | -.13 (-.24, -.02) |

Table 8. Empirical BMI scale for adolescent females

|  |  |
| --- | --- |
| Item | *r* with BMI 1 |
| 1. Often eat too much | .20 (.14, .28) |
| 2. Parental SES | -.16 (-.17, -.14) |
| 3. Have an intense boisterous laugh | .14 (.10, .19) |
| 4. Have great stamina | -.14 (-.18, -.09) |
| 5. Am able to control my cravings | -.13 (-.18, -.06) |
| 6. Have a slow pace to my life | .13 (.06, .20) |
| 7. Prefer to stick with things that I know | .13 (.07, .18) |
| 8. Feel healthy and vibrant most of the time | -.12 (-.16, -.07) |
| 9. Age | .12 (.10, .13) |
| 10. Love to eat | .12 (.06-.16) |

**Discussion**

Obesity is related to a wide range of physical and psychological problems, so addressing the problem in childhood and adolescence has the potential to improve many aspects of health and prevent chronic health conditions later in life. Because obesity tends to persist from childhood and adolescence into adulthood, it is important to identify associations that can help with treatment and prevention. The aim of this study was to examine the combined and independent influences of socioeconomic status, personality traits and cognitive abilities on BMI. Our findings suggest that BMI is associated with all three of these domains and that these associations differ across genders.

For both genders, BMI was negatively correlated with parental socioeconomic status and, particularly for females, this association was strongest for parental educational attainment levels. This association with parental education remained significant for both genders even after controlling for demographics, personality, and cognitive ability. These findings are consistent with prior research on BMI and socioeconomic status (Gordon-Larsen, Adair & Popkin, 2002; Lamerz et al., 2005; Parikka et al., 2015; Sobal & Stunkard, 1989) though we are not aware of prior research that disaggregates parental education from other aspects of SES. The mechanisms underlying the specific influence of parental education are not clear but one explanation may be that parental awareness about diet and exercise is more relevant to the body mass of children than the financial consequences that result from higher or lower income. It is also unclear why the influence of parental education is stronger for female adolescents than for males. If the magnitude of this difference is replicated in other samples, it would suggest that female adolescents are more strongly influenced than males by direct and indirect cues about body mass from their parents.

Higher scores in conscientiousness were negatively associated with BMI for adolescent females and this remained significant after controlling for demographics, cognitive ability, and the other personality factors. There was no evidence for an effect of conscientiousness in males. Similarly, cognitive ability was negatively associated with BMI for adolescent males, even after controlling for demographics and personality, though the effect of cognitive ability was not significant for females. Both of these results are consistent with prior findings on BMI regarding relationships with conscientiousness (Bogg & Roberts, 2004; Terracciano et al., 2009) and cognitive ability (e.g., Cournot, Marquie, Ansiau, 2006; Li, 1995), but we are not aware of prior findings that disambiguate the gender specificity of these effects.

The mechanisms for these gender differences are unclear but there are at least three possibilities that warrant further research. First, it may be that one or both of these effects is specific to the sample or data collection procedures used here; this should be evaluated by efforts to replicate the gender differences in independent samples and/or with alternative assessment methods. Second, it may be that distinct associations between BMI and individual differences across genders are an artifact of differences in the structure of personality. Evaluation of this possibility is beyond the scope of this study, but there is preliminary evidence to suggest that the nature of conscientiousness in adolescent males is distinct from that of females and older males (Condon, 2015). Third, it may be that the gender-specificity of these findings reflects fundamental differences in the construct of body mass across genders. In other words, the psychological correlates of BMI may differ because body mass itself has gender-specific qualities as a construct. We do not mean to suggest that the measurement of BMI is biased; male adolescents had significantly higher BMI scores but the shapes of the BMI score distributions were strikingly similar. Instead, it seems likely that the gender differences reflect different perceptions and expectations about body mass for females and males (Noh, Kim, Park, Oh, & Kwon, 2014).

In addition to the findings related to the primary aims, we also propose two empirically-derived scales that correlate more highly with BMI than parental SES, personality, and cognitive ability. Our rationale for the derivation of these scales followed from recognition of the fact that the predictive utility of personality may be limited by the aforementioned potential for inconsistencies in the structure of personality itself among this age group (particularly for males). We emphasize that these scales require further cross-validation to ascertain their replicability and utility, and acknowledge that they have limited value in cases where it is possible to collect height and weight information directly. That said, we have attempted to reduce the likelihood that these scales are capitalizing on chance correlations in this sample by confirming the stability of the confidence intervals based on bootstrapped estimates. It is also the case that height and weight data can be both sensitive and confidential (by virtue of being identifying), suggesting that there are circumstances in which these scales would be useful for future data collection. More importantly, the strength of the correlations between these scales and BMI scores suggest that the predictive power of stable individual differences may be understated by exclusive reliance on the Big Five measurement model. The Big Five scales used here (100 items) predict roughly 3% to 4% of the variance in BMI for males and females, respectively, when controlling for age and race. Other researchers have pointed out that values in this range compare favorably with other measures (Roberts, Kuncel, Shiner, Caspi, & Goldberg, 2007; Ozer & Benet-Martinez, 2006; Meyer et al., 2001), and this is supported by findings in this study for SES and cognitive ability. Yet, it should be acknowledged that the predictive power of personality can be substantially increased in cases where the outcome variables under study have been identified in advance.

**Limitations and strengths**

One of the strengths of this study is that we used a large dataset, which provided sufficient statistical power to conduct the required analyses. Furthermore, existing studies mostly focus on investigating the predictors of BMI for both genders together whereas we were able to evaluate the effects for both genders separately.

Several limitations of the present study should be considered when interpreting the results. The main limitation is that the data are cross-sectional. Therefore, the direction of the relationship between the studied variables and BMI is unclear. Future research should address this limitation by using longitudinal data which allow for evaluation of changes in BMI and the remaining variables over time.

A second limitation lies with use of the BMI measure. It has been reported that BMI alone may not be the best measure of obesity because it does not directly measure body fat or fat distribution levels. Therefore, individuals with high muscle mass may be classified as obese (Sach et al., 2007). This limitation could be addressed in future research by including additional measures, such as waist circumference.

Further limitations result from the fact that these are self-reported data from an online survey. The main disadvantage of self-reported data is that it can reflect self-presentation motives (Richter & Johnson, 2001), particularly socially-desirable responding. A related limitation is that data on parental education levels and parental occupation were collected from adolescents and not from their parents. It is possible that differences among adolescents in terms of awareness or accuracy about their parents’ education and occupation(s) are relevant to other variables in the study. Evaluation of data from both adolescents and their parents/guardians would provide a broader picture of the relationships among studied variables. Finally, it should be noted that this sample was limited to online survey participants from the U.S.

**Conclusions**

Our findings have important public health implications because they suggest that SES, personality, and cognitive ability are all relevant to the issue of body weight in adolescents and that the importance of each factor differs across genders. We hope that these will encourage further research on gender-specific mechanisms that influence body weight and obesity in adolescents and we suggest that the empirical measures we have described might improve this research by allowing for more efficient assessment of the individual differences that relate to BMI.

**References**

Adair, L. S., & Gordon-Larsen, P. (2001). Maturational timing and overweight prevalence in US adolescent girls. *American Journal of Public Health, 91*(4), 642–644.

Adler, N. E. & Rehkopf, D. H. (2008). U.S. Disparities in health: descriptions, causes, and mechanisms. *Annual Reviews of Public Health, 29*, 235-252. 10.1146/annurev.publhealth.29.020907.090852

Barefoot, J. C., Peterson, B.L, Dahlstrom, W. G, Siegler, I. C, Anderson, N. B., Williams, & R. B., Jr. (1991). Hostility patterns and health implications: correlates of Cook-Medley Hostility Scale scores in a national survey. *Health Psychology, 10*(1), 18–24. doi: 10.1037/0278-6133.10.1.18.

Barrick, M. R. & Mount, M. K. (1991). The big five personality dimensions and job performance: A meta-analysis. *Personnel Psychology, 44,* 1-26. doi: 10.1111/j.1744-6570.1991.tb00688.x.

Bauer, M., Chytilova, J., Pertold-Gebicka, B. (2014). Parental background and other-regarding preferences in children. *Experimental Economics, 17,* 24-46. doi: 10.1007/s10683-0139355-y.

Bibiloni, M. D., Pons, A., Tur, J. A. (2013). Prevalence of overweight and obesity in adolescents: a systematic review. *ISRN Obesity, 392747.* http://dx.doi.org/10.1155/2013/392747

Blair, C., Granger, D. A., Willoughby, M., Mills-Koonce, R., Cox, M., Greenberg, M. T., Kivlighan, K. T., & Fortunato, C. K. (2011). Salivary cortisol mediates effects of poverty and parenting on executive functions in early childhood. Child Development, 82(6), 1970-1984. doi: 10.1111/j.1467-8624.2011.01643.x.

Bogg, T., & Roberts, B. W. (2004). Conscientiousness and health behaviors: A meta analysis of the leading behavioral contributors to mortality. *Psychological Bulletin, 130,* 887–919. doi:10.1037/0033-2909.130.6.887.

Bove, C.F., & Olson, C. M. (2006). Obesity in low-income rural women: qualitative insights about physical activity and eating patterns. *Women & Health, 44*(1), 57-78. doi: 10.1300/J013v44n01\_04

Bosma, H., van de Mheen, H. D., & Mackenbach, J. P. (1999). Social class in childhood and general health in adulthood: questionnaire study of contribution of psychological attributes. *British Medical Journal, 318*(7175), 18–22. doi: 10.1136/bmj.318.7175.18.

Booth, M. L., Macaskill, P., Lazarus, R., & Baur, L. A. (1999). Sociodemographic distribution of measures of body fatness among children and adolescents in New South Wales, Australia. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 23*(5), 456-462.

Brown, C. L., Halvorson, E. E., Cohen, G. M., Lazorick, S., & Skelton, J. A. (2015). Addressing Childhood Obesity: Opportunities for Prevention. Pediatric clinics of North America, 62(5), 1241–1261. doi:10.1016/j.pcl.2015.05.013

Centers for Disease Control and Prevention (2015). About Child & Teen BMI. Retrieved from http://www.cdc.gov/healthyweight/assessing/bmi/childrens\_bmi/about\_childrens\_bmi.html.

Centers for Disease Control and Prevention (2011). National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, Atlanta, GA: U.S. Department of Health and Human Services. Retrieved from: https://www.cdc.gov/diabetes/pubs/pdf/ndfs\_2011.pdf

Conger, R. D., & Donnellan, M. B. (2007). An interactionist perspective on the socioeconomic context of human development. *Annual Review of Psychology, 58,* 175-199. doi: 10.1146/annurev.psych.58.110405.085551.

Condon, D. M. (2014). An organizational framework for the psychological individual differences: integrating the affective, cognitive, and conative domains. (Doctoral dissertation, Northwestern University).

Condon, D. M. (2015, July). Predicting health outcomes: Traditional personality measures and novel empirically-derived scales. Symposia at the biennial meeting of the International Society for the Study of Individual Differences, London, Ontario, Canada. Retrieved from https://sapa-project.org/dmc/docs/CondonISSID2015FINAL.pdf

Condon, D., & Revelle, W. (2014). The International Cognitive Ability Resource: Development and initial validation of a public-domain measure. *Intelligence, 43,* 52-64. doi: 10.1016/j.intell.2014.01.004.

Condon, D. M., & Revelle, W. (2015). Selected personality data from the SAPA-Project: On the structure of phrased self-report items. *Journal of Open Psychology Data, 3*(1). doi: 10.5334/jopd.al.

Cournot, M., Marquie, J. C, Ansiau, D., et al. (2006). Relation between body mass index and cognitive function in healthy middle-aged men and women. *Neurology, 67*, 1208–14.

Daniels, S. R., Khoury, P. R. & Morrison, J. A. (1997). The utility of body mass index as a measure of body fatness in children and adolescents: Differences by race and gender. *Pediatrics, 99*, 804-807. doi:10.1542/peds.99.6.804

Deckers, T., Falk, A., Kosse, F., & Schildberg-Hörisch (2015). How Does Socio-Economic Status Shape a Child’s Personality? IZA Discussion Paper No. 8977, 1-35.

Delaney, L., & Doyle, O. (2012). Socioeconomic differences in early childhood time preferences. *Journal of Economic Psychology, 33,* 237-247. doi: 10.1016/j.joep.2011.08.010.

Dietz, W. H. (2004). Overweight in childhood and adolescence. *New England Journal of Medicine, 350,* 855-857. doi: 10.1056/NEJMp048008

Dietz, W. H. & Bellizzi, M. C. (1999). Introduction: the use of body mass index to assess obesity in children. *The American Journal of Clinical Nutrition,* *70,* 123-125.

Dietz, W. H. (1998).Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics, 101,* 518–525.

Drenowatz, C., Eisenmann, J. C., Pfeiffer, K. A., Welk, G., Heelan, K., Gentile, D., & Walsh, D. (2010). Influence of socio-economic status on habitual physical activity and sedentary behavior in 8- to 11-year old children. *BMC Public Health, 10,* 214. doi: 10.1186/1471-2458-10-214

Duckworth, A.L. & Weir, D., Tsukayama, E., & Kwok, D. (2012). Who does well in life? Conscientious adults excel in both objective and subjective success. *Frontiers in Pyschology, 3,* 1-8. doi: 10.3389/fpsyg.2012.00356.

Elias, M. F., Elias, P. K., Sullivan, L. M, Wolf, P. A, & D'Agostino, R. B. (2005). Obesity, diabetes and cognitive deficit: The Framingham Heart Study. *Neurobiology of aging, 26,* 11–16.

Evers, C., Stok, M., Danner, U., Salmon, S., de Ridder D. & Adriaanse, M. (2011). The shaping role of hunger on self-reported external eating status. *Appetite, 57*(2), 318-320. doi: 10.1016/j.appet.2011.05.311.

Fokeena, W. B., & Jeewon, R., (2012). Is There an Association between Socioeconomic Status and Body Mass Index among Adolescents in Mauritius? *The Scientific World Journal*. 2012, 750659. doi:10.1100/2012/750659

Freedman, D. S., Zuguo, M., Srinivasan, S. R., Berenson, G. S., Dietz, W. H. (2007). Cardiovascular risk factors and excess adiposity among overweight children and adolescents: the Bogalusa Heart Study. *Journal of Pediatrics, 150*(1), 12–17.

Freedman, D. S., Kettel, L., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115,* 22–27.

French, S. A., Story, M. and Perry, C. L. (1995). Self-Esteem and obesity in children and adolescents: A literature review. *Obesity Research, 3,* 479–490. doi: 10.1002/j.15508528.1995.tb00179.x

Garn, S. M., LaVelle, M., Rosenberg, K. R., Hawthorn, V. M. (1986). Maturational timing as a factor in female fatness and obesity. *The American Journal of Clinical Nutrition, 43*, 879–883. <https://doi.org/10.1093/ajcn/43.6.879>

Garrow, J. (1991). Importance of obesity. *BMJ (Clinical research ed.), 303*(6804), 704–706. doi:10.1136/bmj.303.6804.704

Graham, J. W. (2009). Missing data analysis: making it work in the real world. *Annual Review of Psychology, 60*(1), 549–576, doi:10.1146/annurev.psych.58.110405.085530.

Goldberg, L. R. (1999). A broad-bandwith, public-domain, personality inventory measuring the lower-level facets of several Five-Factor models. In I. Mervielde, I. J. Deary, F. de Fruyt, & F. Ostendorf (Eds.). *Personality psychology in Europe* (Vol. 7, pp. 7–28). Tilburg: Tilburg University Press

Gordon-Larsen, P., Adair, L. S., Popkin, B. M. (2002). Ethnic differences in physical activity and inactivity patterns and overweight status. *Obesity research, 10*(3), 141-9.

Hanson, M. D., & Chen, E. (2007). Socioeconomic status and health behaviors in adolescence: A review of the literature. *Journal of Behavioral Medicine, 30,* 263-285. doi: 10.1007/s10865-007-9098-3.

Haworth, C., Wright, M., Luciano, M., Martin, N., de Geus, E., van Beijsterveldt, C., … Plomin, R. (2010). The heritability of general cognitive ability increases linearly from childhood to young adulthood. Molecular Psychiatry, 15(11), 1112–1120. doi: 10.1038/mp.2009.55.

Heaven, P. C., Mulligan, K., Merrilees, R., Woods, T., & Fairooz, Y. (2001). Neuroticism and conscientiousness as predictors of emotional, external, and restrained eating behaviors. *International Journal of Eating Disorders, 30*(2), 161-166. doi: 10.1002/eat.1068.

Hirshman, E., Merrit, P., Wang, C., Wierman, M., Budescu, D., Kohrt, W., Templin, J., Bhasin, S. (2004). Evidence than androgenic and estrogenic metabolites contribute to the effects of dehydroepiandrosterone on cognition in postmenopausal women. *Hormones and Behavior, 45,* 144–155.

Hughes, C., Ensor, R., Wilson, A., & Graham, A. (2010). Tracking executive function across the transition to school: A latent variable approach. Developmental Neuropsychology, 35(1), 20-36.

Inchley, J. C., Currie, D. B., Todd, J. M., Akhtar, P. C., & Currie, C. E. (2005). Persistent socio-demographic differences in physical activity among Scottish schoolchildren 1990-2002. *European Journal of Public Health 15*(4), 386-388.

Joinson, C., Heron, J., Lewis, G., Croudace, T., & Araya, R. (2011). "Timing of menarche and depressive symptoms in adolescent girls from a UK cohort": Correction. *The British Journal of Psychiatry, 198*(5), 410.

Kakizaki, M., Kuriyama, S., Sato, Y., Shimazu, T., Matsuda-Ohmori, K., Nakaya, N., et al. (2008). Personality and body mass index: A cross-sectional analysis from the Miyagi Cohort Study. *Journal of Psychosomatic Research, 64,* 71–80. doi: 10.1016/j.jpsychores.2007.07.008.

Khan, L. K., Sobush, K., Keener, D., Goodman, K., Lowry, A., Kakietek, J. … Centers for Disease Control and Prevention. (2009).Recommended community strategies and measurements to prevent obesity in the United States. *MMWR Recommendations and reports. Morbidity and Mortality Weekly Report, 58*(RR-7), 1–26.

Korner, A., Geyer, M., Gunzelmann, T., Brahler, E. (2003). The influence of socio-demographic factors on personality dimensions in the elderly. *Zeitschrift für Gerontologie und Geriatrie, 36*(2), 130–137. doi: 10.1007/s00391-003-0085-1.

Krieger, N., Williams, D. R., & Moss, N. E. (1997). Measuring Social Class in US Public Health Research: Concepts, Methodologies, and Guidelines. *Annual Review of Public Health, 18,* 341-78.

Kubzansky, L., Kawachi, I., Sparrow, D. (1999). Socioeconomic status, hostility, and risk factor clustering in the normative aging study: any help from the concept of allostatic load? *Annals of Behavioral Medicine, 21*(4), 330–338. doi: 10.1007/BF02895966.

Kushi, L. H., Byers, T., Doyle, C., Bandera, E. V., McCullough, M., Gansler, T., … American Cancer Society 2010 Nutrition and Physical Activity Guidelines Advisory Committee. (2012). American Cancer Society guidelines on nutrition and physical activity for cancer prevention: reducing the risk of cancer with healthy food choices and physical activity. *CA: A Cancer Journal for Clinicians, 56,* 254–281. doi: 10.3322/caac.20140.

Lamerz, A., Kuepper-Nybelen, J., Wehle, C., Bruning, N., Trost-Brinkhues, G., Brenner, H., Hebebrand, J., & Herpertz-Dahlmann, B. (2005). Social class, parental education, and obesity prevalence in a study of six-year-old children in Germany. *International Journal of Obesity, 29,* 373–380. doi:10.1038/sj.ijo.0802914

Larson, L.M., Rottinghaus, P.J., & Borgen, F.H. (2002). Meta-analyses of Big Six Interests and Big Five Personality Factors. *Journal of Vocational Behavior, 61,* 217-239. doi: 10.1006/jvbe.2001.1854.

Lawlor, D. A., Clark, H., Davey Smith, G., & Leon, D. A. (2006). Childhood intelligence, educational attainment and adult body mass index: findings from a prospective cohort and within sibling-pairs analysis. *International Journal of Obesity, 30,* 1758–1765. doi:10.1038/sj.ijo.0803330

Li, C., Ford, E. S., Zhao, G., Mokdad, A. H. (2009). Prevalence of pre-diabetes and its association with clustering of cardiometabolic risk factors and hyperinsulinemia among US adolescents: NHANES 2005–2006. *Diabetes Care, 32,* 342–347. https://doi.org/10.2337/dc08-1128

Li, X., (1995). A study of intelligence and personality in children with simple obesity. *International Journal of Obesity and Related Metabolic Disorders, 19*(5), 355–357.

Liang, J., Matheson, B., Kaye, W., & Boutelle, K. (2014). Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *International Journal of Obesity, 38*(4), 494–506. doi: 10.1038/ijo.2013.142

Lioret, S., Maire, B., Volatier, J. L., & Charles, M. A. (2007). Child overweight in France and its relationship with physical activity, sedentary behaviour and socioeconomic status. *European Journal of Clinical Nutrition, 61*(4), 509-516.

Lipina, S. J., Martelli, M. I., Vuelta, B. & Colombo, J. A. (2005). Performance on the A-not-B task of Argentinian infants from unsatisfied and satisfied basic needs homes. *International Journal of Psychology,* 39, 49–60.

Lodi-Smith, J. L. & Roberts, B. W. (2007). Social investment and personality: a meta-analytic analysis of the relationship of personality traits to investment in work, family, religion, and volunteerism. *Personality and Social Psychology Review, 11,* 68-86. doi: 10.1177/1088868306294590.

Lohman, T. G., Ring, K., Schmitz, K. H., Treuth, M. S., Loftin, M., Yang, S., Sothern, M. & Going, S. (2006). Associations of body size and composition with physical activity in adolescent girls. *Medicine and Science in Sports and Exercise, 38*(6): 1175-1181.

Lord, F. M. (1955). Estimating test reliability. *ETS Research Bulletin Series, 15*(1), 1–17. doi: 10.1002/j.2333-8504.1955.tb00054.x.

Lynch, J., & Kaplan, G. (2000). Socioeconomic Position. In: *Social Epidemiology* (Eds.) Lisa Berkman and Ichiro Kawachi (pp. 13-35). New York: Oxford University Press.

Merikangas, K. R., He, J. P., Brody, D., Fisher, P. W., Bourdon, K., & Koretz, D. S. (2010). Prevalence and treatment of mental disorders among US children in the 2001–2004 NHANES. *Pediatrics, 125*(1), 75-81. doi: 10.1542/peds.2008-2598.

Meyer, G. J., Finn, S. E., Eyde, L. D., Kay, G. G., Moreland, K. L., Dies, R. R., ... & Reed, G. M. (2001). Psychological testing and psychological assessment: A review of evidence and issues. *American psychologist, 56*(2), 128. doi: 10.1037/0003-066X.56.2.128

Mezzacappa, E. (2004). Alerting, orienting, and executive attention: developmental properties and sociodemographic correlates in an epidemiological sample of young, urban children. *Child Development, 75*(5), 1373-1386. Retrieved from http://www.jstor.org/stable/3696489.

Mond, J. M, Stich, H., Hay, P. J, Kraemer, A., Baune, B. T. (2007). Associations between obesity and developmental functioning in pre-school children: a population-based study. *International Journal of Obesity, 31,* 1068–1073. doi:10.1038/sj.ijo.0803644.

Molnar, B. E., Gortmaker, S. L., Bull, F. C., & Buka, S. L. (2004). Unsafe to play? Neighborhood disorder and lack of safety predict reduced physical activity among urban children and adolescents. *American Journal of Health Promotion, 18*(5), 378-386. doi: 10.4278/0890-1171-18.5.378.

Morgenstern, M., Sargent, J. D., & Hanewinkel, R. (2009). Relation between Socioeconomic Status and Body Mass Index: Evidence of an Indirect Path via Television Use. *Archives of Pediatrics & Adolescent Medicine, 163*(8), 731–738. http://doi.org/10.1001/archpediatrics.2009.78.

National O\*NET Consortium (2015). Occupational Listings. Retrieved from <http://www.onetcenter.org/taxonomy/2010/list.html>.

Nnoaham, K. E., Webster, P., Kumbang, J., Kennedy, S. H., & Zondervan, K. T. (2012). Is early age at menarche a risk factor for endometriosis? A systematic review and meta-analysis of case-control studies. *Fertility and Sterility, 98*(3), 702–712.e6. http://doi.org/10.1016/j.fertnstert.2012.05.035

O’Dea, J. A., & Wilson, R. (2006). Socio-cognitive and nutritional factors associated with body mass index in children and adolescents: possibilities for childhood obesity prevention. *Health Education Research, 21*(6), 796-805.

Office of the Surgeon General (US). The Surgeon General's Vision for a Healthy and Fit Nation. Rockville (MD): Office of the Surgeon General (US); 2010. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK44660/

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Journal of the American Medical Association, 311*(8), 806-814. doi: 10.1001/jama.2014.732.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *Journal of the American Medical Association, 307*(5), 483–490. doi:10.1001/jama.2012.40

Ogden, C. L, Carroll, M. D., Kit, B. K., Flegal, K. M. (2012). *Prevalence of obesity in the United States, 2009 - 2010.* NCHS data brief, no 82. Hyattsville, MD: National Center for Health Statistics.

Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. *Annual Review of Psychology, 57*, 401-421. doi: 10.1146/annurev.psych.57.102904.190127.

Parikka, S., Mäki, P., Levälahti, E., Lehtinen-Jacks, S., Martelin, T., & Laatikainen, T. (2015). Associations between parental BMI, socioeconomic factors, family structure and overweight in Finnish children: a path model approach. *BMC Public Health, 15,* 271. doi: 10.1186/s12889-015-1548-1.

Provencher, V., Bégin, C., Gagnon-Girouard, M. P., Tremblay, A., Boivin, S., Lemieux, S. (2008). Personality traits in overweight and obese women: Associations with BMI and eating behaviors. *Eating Behaviors, 9,* 294–302. doi: 10.1016/j.eatbeh.2007.10.004.

R Development Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>

Reilly, J., Methven, E., McDowell, Z., Hacking, B., Alexander, D., Stewart, L., & Kelnar, C. (2003). Health consequences of obesity. *Archives of Disease in Childhood, 88*(9), 748-752. doi: 10.1136/adc.88.9.748.

Revelle, W. (2015). psych: Procedures for psychological, psychometric, and personality research. Evanston, Illinois: Northwestern University.

Rhodes, R. E., & Smith, N. E. I. (2006). Personality correlates of physical activity: a review and meta‐analysis. *British Journal of Sports Medicine, 40*(12), 958–965. http://doi.org/10.1136/bjsm.2006.028860.

Richter, L., & Johnson, P. B. (2001). Current Methods of Assessing Substance Use: A Review of Strengths, Problems, and Developments. *Journal of Drug Issues, 31*, 809-832. doi: 10.1177/002204260103100401.

Roberts, B. W., Kuncel, N. R., Shiner, R., Caspi, A., & Goldberg, L. R. (2007). The power of personality: the comparative validity of personality traits, socioeconomic status, and cognitive ability for predicting important life outcomes. *Perspectives on Psychological Science 2*(313). doi: 10.1111/j.1745-6916.2007.00047.x.

Sabia, S., Kivimaki, M., Shipley, M. J. , Marmot, M. G., & Singh-Manoux, A. (2009). Body mass index over the adult life course and cognition in late midlife: the Whitehall II cohort study. *The American Journal of Clinical Nutrition; 89,* 601-607. doi: 10.3945/ajcn.2008.26482.

Sach, T. H., Barton, G. R., Doherty, M., Muir, K. R., Jenkinson, C., & Averyet, A. J. (2007). The relationship between body mass index and health-related quality of life: comparing the EQ-5D, EuroQol VAS and SF-6D. *International Journal of Obesity, 31,* 189–196. doi:10.1038/sj.ijo.0803365.

Shanahan, M. J., Hill, P. L., Roberts, B. W., Eccles, J., Friedman, H. S. (2014). Conscientiousness, health, and aging: The Life Course of Personality Model. *Developmental Psychology, 50*(5), 1407-1425. http://dx.doi.org/10.1037/a0031130.

Shrewsbury, V. & Wardle, J. (2008). Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity, 16*(2), 275-284. doi: 10.1038/oby.2007.35.

Sherwood, N. E., Wall, M., Neumark-Sztainer, D., & Story, M. (2009). Effect of socioeconomic status on weight change patterns in adolescents. *Preventing Chronic Disease, 6*(1), A19.

Siervogel, R. M., Demerath, E. W., Schubert, C., Remsberg, K. E., Chumlea, W. C., Sun, S., …Towne, B. (2003). Puberty and body composition. *Hormone Research in Pediatrics, 60*, 36-45. <https://doi.org/10.1159/000071224>

Sloboda, D. M., Hart, R., Doherty, D. A., Pennell, C. E., Hickey, M. (2007). Age at Menarche: Influences of Prenatal and Postnatal Growth. *The Journal of Clinical Endocrinology and Metabolism, 92*, 46–50. https://doi.org/10.1210/jc.2006-1378

Smith, J. (2004). Unraveling the SES health connection. Population and Development Review. *Aging, Health, and Public Policy: Demographic and Economic Perspectives,* *30,* 133–150. Retrieved from http://www.jstor.org/stable/3401465

Smith, A. M, & Baghurst, K. I. (1992). Public health implications of dietary differences between social status and occupational category groups. *Journal of Epidemiology and Community Health, 46,* 409–416. doi:10.1136/jech.46.4.409

Sobal, J., & Stunkard, A. J. (1989). Socioeconomic-status and obesity: A review of the literature. *Psychological Bulletin 105,* 260-275.

Steele, P., Dobson, A., Alexander, H., Russell, A. (1991). Who eats what? A comparison of dietary patterns among men and women in different occupational groups. *Australian and New Zealand Journal of Public Health, 15*, 286–295. doi: 10.1111/j.1753-6405.1991.tb00349.x.

Sullivan, S., Cloninger, C., Przybeck, T., & Klein, S. (2007). Personality characteristics in obesity and relationship with successful weight loss. *International Journal of Obesity, 31*(4), 669–674. http://doi.org/10.1038/sj.ijo.0803464.

Sutin, A. R., Stephan, Y., Wang, L., Gao, S., Wang, P, Terracciano, A. (2015). Personality traits and body mass index in Asian populations. *Journal of Research in Personality, 58,* 137–142. doi: 10.1016/j.jrp.2015.07.006.

Teasdale, T. W., Sorensen, T. I., Stunkard, A. J. (1992). Intelligence and educational level in relation to body mass index of adult males. *Human Biology, 64*(1), 99–106.

Terracciano, A., Sutin, A. R., McCrae, R. R., Deiana, B., Ferrucci, L., Schlessinger, D., … Costa, P. T. (2009). Facets of personality linked to underweight and overweight. *Psychosomatic Medicine, 71*(6), 682–689. <http://doi.org/10.1097/PSY.0b013e3181a2925b>.

US Department of Health and Human Services. The Surgeon General's call to action to prevent and decrease overweight and obesity. Report No. 2001. Retrieved from: http://www.surgeongeneral.gov/library/calls/obesity/CalltoAction.pdf.pdf.

van den Bree, M., Przybeck, T. R., Robert Cloninger, C. (2006). Diet and personality: associations in a population-based sample. *Appetite, 46*, 177–188.

Veldwijk, J., Scholtens, S., Hornstra, G., Bemelmans, W. J. (2011). Body mass index and cognitive ability of young children. *Obesity Facts, 4,* 264–269. doi: 10.1159/000331015.

Wang, Y., Liang, L., Tussing, C., Braunschweig, C. Caballero, & Flay, B. (2007). Obesity and related risk factors among low socio-economic status minority students in Chicago. *Public Health Nutrition, 10*(9), 927-938. doi: 10.1017/S1368980007658005.

Wellens, R., Malina, R. M., Roche, A. F., Chumlea, W. C, Guo, S., Siervogel, R. M. (1992). Body size and fatness in young adults in relation to age at menarche. *American Journal of Human Biology, 4*, 783–787. doi: 10.1002/ajhb.1310040610.

Wilt, J., Condon, D. M., & Revelle, W. (2012). Telemetrics and online data collection: Collecting data at a distance. In B. Laursen, T. D. Little, & N. A. Card (Eds.), *Handbook of developmental research methods* (pp. 163–180). New York: Guilford Press.

World Health Organization. (2011). Obesity and overweight. World Health Organization. 2011. Retrieved from http://www.who.int/mediacentre/factsheets/fs311/en/print.html.

Wilcox, K., Block, L. G. & Eisenstein, E. M. (2011). Leave home without it? The effects of credit card debt and available credit on spending. *Journal of Marketing Research. 48,* 78-90. doi: 10.1509/jmkr.48.SPL.S78.

Zinbarg, R., Yovel, I. & Revelle, W. (2007). Estimating omega for structures containing two group factors: Perils and prospects. *Applied Psychological Measurement. 31*(2), 135-157. doi: 10.1177/0146621606291558

Zinbarg, R., Yovel, I., Revelle, W. & McDonald, R. (2006). Estimating generalizability to a universe of indicators that all have one attribute in common: A comparison of estimators for omega. *Applied Psychological Measurement, 30*, 121-144. doi:10.1177/0146621605278814