Published in final edited form as:

Percept Mot Skills. 2009 February ; 108(1): 181–195.

Psychosocial Predictors, Higher Body Mass Index, and Aspects of Neurocognitive Dysfunction

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Abstract

This longitudinal (22-year) study examined several psychosocial predictors of higher than normal recommended BMI and aspects of neurocognitive dysfunction in a community-based sample of 470 participants interviewed in private during childhood, adolescence, emerging adulthood, and adulthood. We included five psychosocial measures; Internalizing Behaviors (i.e., symptoms of internal distress), Educational Expectations and Aspirations (i.e., components of cognitive functioning), Impulsivity (i.e., emotional control), BMI (a measure of weight by height), and Aspects of Neurocognitive Dysfunction (e.g., memory). Results, based on Structural Equation Modeling, indicated that earlier Internalizing Behaviors, Low Educational Expectations and Aspirations, and Impulsivity predict greater BMI. Greater than normal BMI in the early thirties is associated with later Aspects of Neurocognitive Dysfunction in the middle thirties. Adolescent Internalizing Behaviors are also associated with Aspects of Neurocognitive Dysfunction in the middle thirties. Public health implications suggest increasing education about diet, health, and exercise in order to prevent aspects of neurocognitive dysfunction. Clinical implications suggest the importance of providing appropriate prevention and intervention for people with internalizing behaviors, impulsivity, and greater BMI.

Keywords

Adolescent; Young Adult; Personality; Cognition

INTRODUCTION

Obesity and over overweight, as defined by the Center for Disease Control (2006c), are important health concerns that continue to escalate in scope and severity. Globally, more than 300 million adults are obese (World Health Organization, 2006; United States Department of Health & Human Services, 2007a). Obesity is a major problem in the United States (U.S.). After being relatively stable since 1960, the prevalence of obesity has increased significantly during the past 20 years, and this upward trend appears to be continuing (Flegal, Carroll, Ogden, & Johnson, 2002). Approximately a third of U.S. adults 20 years of age and older (over 60 million people) are obese (Sturm, 2002; Center for Disease Control and Prevention, 2006a, 2007).

Obesity increases the risk for many medical and psychiatric conditions such as coronary heart disease, stroke, certain types of cancers, and depression (Center for Disease Control and Prevention, 2006a, 2006b; United States Department of Health & Human Services, 2007b). Obesity has become a national priority; for example, one of the national health objectives for 2010 is to reduce adult obesity to less than 15% (Center for Disease Control and Prevention, 2006a, 2007; United States Department of Health & Human Services, 2007a, 2007b). Obesity

and being overweight may be assessed by use of the Body Mass Index (BMI), a measure of body weight adjusted for height (Mujahid, Roux, Borrell, & Nieto, 2005; Bigal, Liberman, & Lipton, 2006).

This is the first longitudinal study to examine the psychosocial antecedents of an increased BMI, as well its effects on aspects of neurocognitive dysfunction. Such knowledge should aid in developing a quantitative baseline from which prevention and treatment programs can be formulated (Mujahid, Roux, Borrell, & Nieto, 2005; Bigal, Liberman, & Lipton, 2006).

Based on Family Interactional Theory (FIT) (Brook, Brook, Gordon, Whiteman, & Cohen, 1990), the current research study assesses certain aspects of personality, behavior, and educational expectations in adolescence and the early and mid-twenties (i.e., internalizing behaviors, low educational expectations and aspirations, and impulsivity) and aspects of neurocognitive functioning later in life (See Figure 1). More specifically, internalizing behaviors, low educational expectations and aspirations, and impulsivity are related to different components of psychological functioning (substance abuse, psychological well-being, and psychopathology) (e.g., Brook, Brook, Zhang, Whiteman, Cohen, & Finch, 2008). Similarly, individuals who have difficulty in controlling their impulses may not be able to refrain from overeating. Moreover, these three components of psychological functioning noted above appear to be related to aspects of neurocognitive dysfunction (e.g., Brook, Brook, & Pahl, 2006). We extend FIT by further hypothesizing that these components of psychological functioning are related to physiological functioning. BMI is one measure of physiological functioning. BMI is related to aspects of neurocognitive dysfunction (Friedman & Booth-Kewley, 1987; Friedman, Tucker, Tomlinson-Keasey, Schwartz, Wingard, & Criqui, 1993; Friedman, Tucker, Schwartz, Martin, Tomlinson-Keasey, Wingard, et al., 1995; Brook, Brook, & Pahl, 2006). From a developmental perspective, FIT also postulates that there is both stability and change in psychological functioning over time. Therefore, in this study we propose that adolescent internalizing behaviors will be correlated with aspects of later neurocognitive dysfunction in adults in their thirties.

Two types of potential psychosocial antecedents of increased BMI are investigated in this study: internalizing behaviors (i.e., anxiety, depression, and interpersonal difficulties) and impulsivity. Increased anxiety and depression are associated with higher levels of impulsivity (Wapner & Connor, 1986; Corruble, Benyamina, Bayle, Falissard, & Hardy, 2003). Based on these cross-sectional findings, we hypothesize that internalizing behaviors in early adolescence should predict impulsive behavior in the early twenties. Internalizing behaviors and impulsivity may be learned methods of emotional response and should persist or become habitual.

We postulate that low educational expectations and aspirations are related to an increased BMI through two pathways (See Figure 1). First, the literature suggests that low educational expectations and aspirations are correlated significantly and highly with the number of pounds overweight (Falkner, Neumark-Sztainer, Story, Jeffery, Beuhring, & Resnick, 2001; Crosnoe & Muller, 2004; Taras & Potts-Datema, 2005). Second, we hypothesize that low educational expectations and aspirations are related to impulsivity. This hypothesis is based on the finding that individuals who have low educational expectations and aspirations are likely to use substances (Brook, Brook, Zhang, Whiteman, Cohen, & Finch, 2008). The use of substances has been shown to interfere with the individuals' ability to control their emotions (Brook, Brook, Zhang, Whiteman, Cohen, & Finch, 2008). Third, we hypothesize that impulsivity is related to a later increased BMI (Ryden, Sullivan, Torgerson, Karlsson, Lindroos, & Taft, 2003, 2004; Lyke & Spinella, 2004).

To date, there are no longitudinal studies that examine the interrelationship among low educational expectations and aspirations, impulsivity, and the BMI. The present study extends

the literature by examining the interrelationship of these three dimensions. In addition, we hypothesize a relationship between low educational expectations and aspirations and aspects of neurocognitive dysfunction. Although previous studies have found that low educational expectations and aspirations are associated with later difficulty in aspects of neurocognitive dysfunction, the present study also examines the mechanisms underlying this relationship (Scher, Stewart, Ricci, & Lipton, 2003; Kiegel, Zimprich, & Rott, 2004; Jeong, Nam, Son, Son, & Cho, 2005; Le Carte, Auriacombe, Letenneur, Bergua, Dartigues, & Fabrigoule, 2005). For example, two variables that we examine in this study are impulsivity and higher BMI.

Research supports a positive relationship between impulsivity and obesity, with impulsivity associated with a greater BMI (Ryden, Sullivan, Torgerson, Karlsson, Lindroos, & Taft, 2003, 2004; Lyke & Spinella, 2004). People who have difficulty controlling their impulses may have trouble controlling their food intake, which is reflected in higher caloric intake resulting in higher BMI. Based on the literature, we hypothesize a relationship between impulsivity and an increased BMI. In addition, the literature suggests that obesity is related to later impaired aspects of neurocognitive dysfunction; however, these studies have primarily concentrated on the elderly (Anderson & Milner, 2005; Jeong, Nam, Son, Son, & Cho, 2005; Ward, Carlsson, Trivdei, Sager, & Johnson, 2005). People who are overweight may have problems with self-image, which may result in difficulty concentrating (Jersild, Brook, & Brook, 1978).

The present investigation is the first longitudinal study to examine the relationship between early adolescent psychosocial factors and BMI during the early thirties, and aspects of neurocognitive dysfunction during the mid-thirties. The conceptual model derived from the above theoretical and empirical literature (i.e., Corruble, Benyamina, Bayle, Falissard, & Hardy, 2003; Lyke & Spinella, 2004) hypothesizes that an increased BMI and internalizing behaviors will be associated with later aspects of neurocognitive dysfunction. Therefore, we hypothesize that earlier psychosocial difficulties (internalizing behaviors, low educational expectations and aspirations) will be associated with a higher later BMI, and a higher BMI will be associated with later aspects of neurocognitive dysfunction.

METHOD

Participants

Sample Section—Albany County was identified as one of the poorest counties in the New York State and adjacent Saratoga County as one of the wealthiest. These two counties were chosen for study by means of a sample survey. Primary sampling units were created from enumeration districts and block groups, which, when taken together, comprised the entire area and population of the target counties. The primary sampling units in each county were stratified by urban/rural status, the proportion of Whites, and median income. A systematic sample of primary sampling units in each county was then drawn with probability proportional to the number of households, and probabilities equal for members of all strata. Segments of blocks were then selected with probability proportional to size (number of households), and each was surveyed in the field with a proportion of the households being selected according to the predetermined sampling ratio. Address lists were compiled in this process, and interviewers were sent to the selected addresses. Those households with at least one child between the ages of 1–10 years qualified for the study. In each qualified household, the interviewer, by use of a set of Kish Tables, randomly selected one child from those in the appropriate age range.

Participants' data were based on a randomly selected cohort (N = 975) in 1975 (mean age = 5.0) studied prospectively from 1983 to 2005. Follow-up data were collected in the participants' homes in 1983 (N=756), 1985–1986 (N=739), 1992 (N=750), 1997 (N=749), 2002 (N=673),

and 2005 (N=504). The mean ages (SDs) of the participants at the follow-up interviews were: 14.1 (2.8), 16.3 (2.8), 22.2 (2.8), 26.9 (2.8), 32.0 (2.8), and 35.1 (3.0), respectively. There was a close match of the study's participants in 1980 on family income, maternal education, and family structure with the 1980 survey data from the U.S. Bureau of Census, representing the Northeast region of the U.S. The families in this study were generally representative of the population of families living in Albany and Saratoga, the two New York counties which are noted above. For example, 75% of the study's participants in 1980 lived with married parents, and 19% lived with a mother who was not currently married while the census figures at that time were 79% and 17%, respectively.

We compared those who stayed in the sample from those who dropped out with adolescence to their mid-thirties. The findings indicated that there were no appreciable differences between the two groups, with one exception (Educational Aspirations (see below for the description of the measure), t -value = -2.12 ; $p < .05$). Those who remained in the sample had higher Educational Aspirations than those who dropped out.

Extensively trained and supervised lay interviewers administered the interviews in private. Written informed consent was obtained from the participants and their mothers in 1983, 1986, and 1992, and from the participants only in 1997, 2002, and 2005. Human subject approval for the study was given by the Institutional Review Board of the New York University School of Medicine. Additional details about the sampling procedures and the original sample have previously been published (Brook, Brook, Gordon, Whiteman, & Cohen, 1990; Cohen & Cohen, 1996). The measures described below (including Impulsivity) have predictive validity. More specifically, our measure of Impulsivity has been found to predict drug and alcohol use and psychological well-being (Brook, Whiteman, Peisach, & Deutsch, 1974; Pine, Cohen, Gurley, Brook, & Ma, 1998; Brook, Brook, Gordon, Whiteman, & Cohen; Johnson, Cohen, Gould, Kasen, Brown, & Brook, 2002; Lyke & Spinella, 2004; Brook, Brook, & Pahl, 2006).

The sample of 504 participants during their mid thirties who are a sub-group of the participants who took part in their early thirties. It is important to note that the actual attrition rate between the early and mid thirties is considerably lower than 25%, as we did not pursue the entire sample of 673 participants who participated in the study in their early thirties because of budgetary constraints. In order to be in the present analyses, the participants had to meet five criteria: 1) participation in the study during the participants' early and mid thirties; 2) participation in the study at least one time from adolescence through mid twenties; 3) not being pregnant during the early thirties; 4) no missing data for the BMI measure during the early thirties; and 5) no missing data for the health measures during the mid-thirties. After applying these five criteria, our final sample for analysis consisted of 470 participants. There were 63 participants in the final sample (13.4%) who had missing data at one or more time points between adolescence and the mid twenties. We used the SAS MI procedure to deal with missing data on a variable by variable basis. The SAS MI procedure calculates the maximum likelihood estimates of the missing values (i.e., Full Information Maximum Likelihood on a variable by variable basis).

Measures

Internalizing Behaviors During Adolescence—We hypothesized a latent variable of adolescent internalizing behavioral symptoms, which, during adolescence consisted of 5 items assessing depression (e.g., “Over the last few years, how much were you bothered by feeling low in energy or slowed down?” [(Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974)]), 4 items assessing anxiety (e.g., “Over the last few years, how much were you bothered by feeling fearful?” [(Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974)]), and 6 items assessing interpersonal difficulties (e.g., “Over the last few years, how much were you bothered by feeling easily annoyed or irritated with other people?” [(Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974)]). We calculated the mean of the participants at mean ages 14.1 and

16.3 between the two points of adolescence on the Depression scale. We followed the same procedure for Anxiety and Interpersonal Difficulties. For Anxiety, Depression, and Interpersonal Difficulties during adolescence, the values ranged from “Not at all” (1) to “Extremely” (5). The Cronbach’s alpha for Internalizing Behaviors was .84.

Educational Expectations and Aspirations During Adolescence—We calculated the mean score of the participants’ Educational Expectations and Aspirations during the two points of adolescence noted above (2 items: “How far do you expect you will go in school?”; “How far do you hope you will go in school?” [(Brook, Whiteman, Peisach, & Deutsch, 1974)]). For both educational expectations and aspirations during adolescence, the values ranged from “Finish high school only” (1) to “Obtain a doctoral degree” (6). The Cronbach’s alpha for Educational Expectations and Aspirations was .90.

Impulsivity During the Early and Mid Twenties—We calculated the mean scores of the participants’ Impulsivity during the early and mid twenties (6 items, e.g., “How often do you act on the spur of the moment without stopping to think?” [(Gough, 1957)]). The values ranged from “True” (1) to “False” (4). The Cronbach’s alpha for Impulsivity was .70.

BMI During the Early Thirties—BMI is a tool for indicating the relative weight status of adults, which also takes height into consideration. It may be used to assess nutritional status related to body fat and health risk. In this study, height and weight were assessed by self-report measures obtained during the early thirties. Although self-reported height and weight have some systematic biases, validation studies suggest that the magnitude of any bias is too small to affect conclusions about associations in large-scale epidemiological studies. We assessed BMI based on a self-report rather than on an objective measure. As noted by Jacobson and DeBock (2001), it would have been preferable to have both subjective and objective measures of BMI.

We calculated the BMI using weight in pounds and height in inches with the following equation:

$$\text{BMI} = \left(\frac{\text{Weight}}{\text{Height}^2} \right) \times 703$$

In the equation, 703 is a constant and is used to account for the conversion between metric and English measures. For example, a person who weighs 220 pounds and is 6 feet 3 inches tall (75 inches) has a BMI of 27.5 (Center for Disease Control and Prevention, 2006b).

Aspects of Neurocognitive Dysfunction During the Mid-Thirties—During the participants’ mid-thirties, we assessed their scores on our measure designed to assess Aspects of Neurocognitive Dysfunction, which consisted of: (a) headaches; (b) trouble remembering things; (c) difficulty thinking and concentrating; and (d) trouble learning new things (Johnston, O’Malley, Bachman, & Schulenberg, 2007). At the interview, each participant was asked how long a particular health symptom bothered him/her during the past year. Each symptom had a score coded as follows: not in the past year (0), 1–4 weeks (1), 1–3 months (2), and more than three months (3). The Cronbach’s alpha for our latent variable entitled Aspects of Neurocognitive Dysfunction was 0.71. These symptoms have been found to impact functional performance and early mental decline (McCall & Dunn, 2003; Rosano, Simonsick, Harris, Kritchevsky, Brach, Viser, et al., 2005).

Analysis

Latent variable structural equation modeling (SEM) using the SAS Proc CALIS, was employed to examine the empirical credibility of the proposed model (See Figure 1). In order to account for the influences of the participants' gender, age, and paternal educational level on the measurement and structural models, we used partial covariance matrices as the input matrices, which were created by statistically partialing out the effects of these demographic factors on each of the original manifest variables. We used a t-test to evaluate the significance of each path. For example, Internalizing Behaviors had a direct effect on Impulsivity, which had an effect on BMI, and ultimately Aspects of Neurocognitive Dysfunction. The correlations among the variables derived from the covariance matrices are available from the authors. Maximum likelihood estimates (MLE) of the model coefficients and the resulting $-2\ln(L_{MAX})$ were obtained, where L_{MAX} is the value of the likelihood function evaluated at the MLE values. The fit of the models was assessed with multiple indices: the goodness of fit index (GFI), the root mean square error of approximation (RMSEA), and the Bentler's comparative fit index (CFI). In this analysis, we focused on the psychosocial predictors of an increased BMI and its relationship with scores for Aspects of Neurocognitive Dysfunction during the mid thirties. We controlled for age, gender, and parental educational level in the analyses.

In addition, we examined whether each path that was not included in the model in Figure 1 should have been included using the modification index (MI). For example, there is no path from Impulsivity in the early-mid twenties to Aspects of Neurocognitive Dysfunction in the mid thirties, as noted in Figure 1. That is, the corresponding parameter in the model is set to zero. For each such parameter, the SAS CALIS procedure calculates the decrease in $-2\ln(L_{MAX})$ that occurs when the path is included. This value is the MI of the path. When the corresponding coefficient is zero, the asymptotic distribution of the MI is $\chi^2(1)$. That is, 95% of MIs of zero parameters will be less than 3.84, and 99% will be less than 6.64. In the event that the MI for a path is less than 3.84, we regard the data as suggesting that the path coefficient is zero.

RESULTS

Characteristics of the Sample and Descriptive Statistics

Demographic information indicated that 95% of the participants were White, 55% were female, and 93% had a parent with at least a high school education. During the mid thirties, 62% of these adults were married, 95% had at least a high school education, and the median annual income before taxes was \$25,000–\$34,999. Table 1 presents the duration of their symptoms on our latent variable entitled Aspects of Neurocognitive Dysfunction. Table 2 presents the descriptive statistics of the independent variables. The mean (SD) of the BMI of the participants during their mid-thirties was 26.82 (5.73). According to the Center for Disease Control and Prevention criteria, 21.5%, 36.5%, 40.9%, and 1.1% of the participants were obese, overweight, healthy weight, and underweight, respectively (Center for Disease Control and Prevention, 2006b,2006c).

Structural Equation Modeling

We tested the measurement model as well as our conceptual model using SEM. All standardized factor loadings were significant ($p < .001$), and all were $>.28$. The obtained path diagram along with the standardized regression weights are depicted in Figure 2. The GFI was 0.98, the RMSEA was 0.02, and the CFI was 0.99. These results reflect a satisfactory model fit. The MIs for the omitted paths in, as noted in Figure 1, were less than 2.36, confirming the hypothesized model. As noted in Figure 2, Adolescent Internalizing Behaviors and Educational Expectations and Aspirations were associated with Impulsivity in the 20s ($\beta = 0.27$; $t = 5.74$ and $\beta = 0.13$; $t = 3.02$, respectively). Impulsivity was associated with a greater BMI in the early

30s ($\beta = 0.13$; $t = 2.89$). Adolescent Internalizing Behaviors were also directly related to Aspects of Neurocognitive Dysfunction in the middle 30s ($\beta = 0.19$; $t = 3.22$). Adolescent low Educational Expectations and Aspirations were also directly related to a greater BMI in the early 30s ($\beta = 0.10$; $t = 2.24$). Finally, a greater BMI in the early 30s was associated with higher scores on Aspects of Neurocognitive Dysfunction in the middle 30s ($\beta = 0.14$; $t = 2.71$). In addition, all MIs of the omitted paths were less than 2.36, suggesting that the omitted path coefficients are zero.

DISCUSSION

This is the first longitudinal study designed to examine the association between BMI in the early thirties and aspects of neurocognitive dysfunction in the middle thirties, controlling for earlier adolescent factors. In addition, we tested the hypothesis that earlier adolescent and emerging adult psychosocial factors are associated with a greater BMI in the early thirties, and that a greater BMI in the early thirties is associated with later aspects of neurocognitive dysfunction in the middle thirties.

It is of great interest that 58% of this sample of 32 year olds are overweight or obese, both conditions commonly associated with a number of adverse health consequences (e.g., coronary heart disease, diabetes mellitus) (Center for Disease Control, 2006a).

The findings of the present study supported the hypothesized model. The results indicate that: 1) adolescent internalizing behaviors, low educational expectations and aspirations, and impulsivity in the twenties is associated with a higher BMI in the early thirties, and that a greater BMI in the early thirties predicts aspects of neurocognitive dysfunction in the middle thirties; 2) adolescent internalizing behaviors and low educational expectations and aspirations are associated with impulsivity in emerging adulthood, and that impulsivity in emerging adulthood correlates with a greater BMI in the early thirties; 3) adolescent internalizing behaviors is associated with aspects of neurocognitive dysfunction in the middle thirties (See Figure 2).

FIT postulates that the effects of problematic adolescent personality and behavioral attributes on adult adverse health outcomes are mediated in part by maladaptive health behaviors (e.g., those resulting in a greater BMI) (Brook, Brook, & Pahl, 2006). Some of these maladaptive health behaviors include limited physical activity and poor diet (Brook, Brook, Gordon, Whiteman, & Cohen, 1990). The influence of earlier adolescent internalizing behaviors and emerging adult impulsivity on later aspects of neurocognitive dysfunction was partially mediated by the BMI. These results provide support for FIT and point to mechanisms underlying developmental trajectories from adolescent psychosocial attributes to adult health outcomes. Furthermore, we found both direct and indirect effects of earlier internalizing behaviors on later aspects of neurocognitive dysfunction. The effects of internalizing behaviors emerged over two decades with many chances for other biological and psychosocial factors to influence aspects of neurocognitive dysfunction, morbidity, and mortality. Future research with this sample may offer the possibility to continue to study the participants over the next few decades when evaluations of other mechanisms affecting health (e.g., traditionality) will be possible.

Consistent with the findings of previous investigations in the literature (Anderson & Milner, 2005; Ward, Carlson, Trivdei, Sager, & Johnson, 2005), our results show a direct link between a higher BMI in the early thirties and aspects of neurocognitive dysfunction in the middle thirties. We add to the literature by using a community-based sample to examine this association in the fourth decade of life.

Our finding with respect to the association between adolescent internalizing behaviors and later impulsivity is supported by previous investigations (Wapner & Connor, 1986; Corruble, Benyamina, Bayle, Falissard, & Hardy, 2003). The association between low educational expectations and aspirations and a later higher BMI, as well as the association between impulsivity and a later higher BMI is also documented in the literature (Falkner, Neumark-Sztainer, story, Jeffery, Beuhring, & Resnick, 2001; Ryden, Sullivan, Torgerson, Karlsson, Lindroos, & Taft, 2003; Lyke & Spinella, 2004; Taras & Potts-Datema, 2005). However, this is the first study which demonstrates that impulsivity in the emerging adult may serve as a mediator between adolescent internalizing behaviors and low educational expectations and aspirations in adolescence and an a higher BMI in the early thirties. Our findings with respect to the direct adverse effect of adolescent internalizing behaviors on aspects of neurocognitive dysfunction in the middle thirties are supported by previous investigations (Friedman & Booth-Kewley, 1987; De Benedittis, Lorenzetti, & Pieri, 1990). Our study differs from the literature in that the analysis of data from our six-wave model spanned a relatively long period of time (22 years).

The present study has several limitations. First, we can only present the temporal relationships among the sets of variables in our model, but cannot prove causality. Second, the measurements of aspects of neurocognitive dysfunction in the middle thirties are based on self-reports. Objective measurements would allow for more precise and thorough assessments. Third, we assessed the BMI based on responses to self-report measures rather than on objective measures. However, Stewart, Jackson, Ford, & Beaglehole (1987) found high accuracy in subjective measures of BMI among the obese. Moreover, Amrosi-Randig & Bulian (2007) found a high correlation between self-reported and measured values of weight and height. Kawada and Suzuki (2005) found that self-reported values for BMI were valid. As noted earlier, we would have preferred to use both subjective and objective measures of BMI. As a result of relying solely on subjective measures, an added degree of caution must be used in interpreting and generalizing the results of this study. Nevertheless, a higher BMI was related to aspects of neurocognitive dysfunction and the predictors were related to the BMI in the expected direction. Future research should attempt to validate the BMI data. Fourth, we did not assess earlier neurological, psychiatric, or medical health, all of which may be related to the later BMI. Fifth, some variables were not measured at all time periods. For example, the BMI was not controlled for in adolescence. Therefore, it is possible that the relationship between the BMI in the thirties and aspects of neurocognitive dysfunction in the thirties is due to the association between the earlier adolescent BMI and later aspects of neurocognitive dysfunction.

Despite these limitations, the results of this investigation provide important new evidence regarding the relationship between a higher BMI in the early thirties and aspects of neurocognitive dysfunction in the middle thirties. The findings point to the possibility that an intervention to bring about a reduction of the BMI in the early thirties may be associated with an improvement in neurocognitive health in the middle thirties. The findings of our data based on a six-wave model spanning 22 years also suggests that there is a long-term relationship between adolescent internalizing behaviors, low educational expectations and aspirations, impulsivity, the BMI, and aspects of neurocognitive dysfunction in the middle thirties.

Public Health and Clinical Implications

This research has public health and clinical implications. From a public health perspective, increasing educational opportunities and expectations early in life may result in improved adult neurocognitive health. Publicizing the adverse effects of an increase in the BMI may help decrease or prevent impaired neurocognitive health later on in life.

From a clinical perspective, reducing internalizing behaviors, impulsivity, and the BMI may prevent and/or reduce impaired neurocognitive health. The provision of treatment for people with anxiety, depression, interpersonal difficulties, and impulsivity may help decrease the BMI, and indirectly may mitigate the adverse effects of overweight and obesity on adult neurocognitive health. In addition, the provision of treatment for people who are overweight or obese as measured by the BMI may help reduce or minimize the adverse effects of overweight or obesity on later neurocognitive health.

Acknowledgments

This study was supported by grants from the National Institute on Drug Abuse and the National Cancer Institute: #2R01DA03188, #K05DA00244, and #CA94845. We thank Dr. Martin Whiteman for his helpful comments.

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Figure 1.
Hypothesized Model: Adolescent/Young Adult Psychosocial Factors and Higher BMI as Related to Adult Aspects of Neurocognitive Dysfunction.
Note: BMI denotes the Body Mass Index.

Figure 2.

Obtained Model: Adolescent/Young Adult Psychosocial Factors and Higher BMI as Related to Adult Aspects of Neurocognitive Dysfunction (N=470).

Note:

1. GFI = 0.98; RMSEA=0.02; CFI=0.99
2. Parental education, age, and gender were statistically controlled
3. Pregnant participants in their early thirties were excluded from the analyses
4. β =standardized path coefficient; t =t statistic
5. All β values are significant at $p \leq 0.05$ (two-tailed test)
6. BMI denotes the Body Mass Index.

Table 1

Duration and Percent of Dysfunction of Participants on Measures of Aspects of Neurocognitive Dysfunction (N=470)

<u>Dysfunction</u>	<u>Duration and Percent of Dysfunction^a</u>			
	<u>0</u> <u>%</u>	<u>1</u> <u>%</u>	<u>2</u> <u>%</u>	<u>3</u> <u>%</u>
Headache	43.4	39.6	8.9	8.1
Trouble Remembering Things	80.4	11.5	3.0	5.1
Difficulty Thinking or Concentrating	75.5	17.0	4.1	3.4
Trouble Learning New Things	93.6	2.9	1.1	2.4

^a0=Not in the Past Year; 1=1–4 Weeks; 2=1–3 Months; 3=More Than 3 Months

Table 2
Descriptive Statistics of Independent Variables (N=470).

Variables	Mean (SD)
BMI (Early Thirties)	26.82 (5.73)
Impulsivity (Early-Mid Twenties)	13.48 (2.50)
Educational Expectations and Aspirations (Adolescence)	2.95 (1.06)
Depression (Adolescence)	10.34 (2.71)
Anxiety (Adolescence)	8.84 (2.35)
Internalizing Behaviors (Adolescence)	13.00 (3.26)

Note: BMI denotes the Body Mass Index.