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Adolescent Obesity and Future Substance Use: Incorporating the Psychosocial Context

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Abstract

A growing body of work has shown that obese adolescents are at risk of engaging in problematic substance use, but mixed findings highlight the complexity of the relationship. Incorporating the psychosocial context into this research may inform past discrepancies. The current study assessed whether obese adolescents had a higher likelihood of experiencing a psychosocial context that predicted problematic substance use in young adulthood. Latent class analysis on 10,637 adolescents from The National Longitudinal Study of Adolescent to Adult Health (Add Health) identified four psychosocial classes in adolescence: Adjusted, Deviant Peer/Victimization, Moderate Depression, and Maladjusted. Obese adolescents were more likely to belong to the Maladjusted class, characterized by higher levels of depression and deviant peer affiliation. Those in the Maladjusted class had the second highest levels of cigarette smoking and marijuana use in young adulthood. Obese adolescents' psychosocial context should be considered in future research linking obesity and substance use.

Keywords

cigarette smoking; latent class analysis; obesity; psychosocial adjustment; substance use; weight status

In the last few decades, child obesity has become one of the most significant global public health concerns. In the United States 16.9% of 2- to 19-year-olds currently meet obesity

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status (Ogden, Carroll, Kit, & Flegal, 2014). The high prevalence rate has been met with substantial empirical work focused on the prevention, intervention, and consequences of child obesity (Birch & Ventura, 2009; Hannon, Rao, & Arslanian, 2005; Johnston et al., 2013; Sweeting, Wright, & Minnis, 2005). These efforts have begun to link child obesity to other health-risk behaviors, such as problematic substance use (Farhat, Iannotti, & Morton-Simons, 2010; Huang, Lanza, Wright, & Anglin, 2013; Volkow & Wise, 2005). However, the relationship between child obesity and substance use remains unclear, which may be due to a lack of studies examining the underlying mechanisms linking child obesity and substance use. The current study aims to elucidate the relationship between obesity and substance use by considering whether obese adolescents are more likely to experience psychosocial contexts that are associated with problematic substance use in young adulthood.

Although there is a growing body of evidence demonstrating significant associations between adolescent obesity and substance use, mixed findings need to be addressed. Cross-sectional studies have generally not found a positive correlation between higher weight status and marijuana or other illicit drug use, but have shown that higher weight status is associated with greater cigarette smoking and alcohol use (Dhariwal, Rasmussen, & Holstein, 2010; Fonseca, Matos, Guerra, & Pedro, 2009; Farhat et al., 2010; Liu et al., 2010). Longitudinal studies, on the other hand, are less conclusive. Some studies have indicated that overweight and obese adolescents are more likely than non-overweight/obese adolescents to initiate smoking or become regular smokers (Caria, Bellocco, Zambon, Horton, & Galanti, 2009; Cawley, Markowitz, & Tauras, 2004; Hussaini, Nicholson, Shera, Stettler, & Kinsman, 2011; Lanza, Grella, & Chung, 2014). Conversely, other studies have shown that adolescent obesity is linked to lower risk of cigarette smoking initiation or generally not associated with future problematic substance use (Austin & Gortmaker, 2001; Mustillo, Worthman, Erkanli, Keeler, & Angold 2003; Pasch, Velazquez, Cance, Moe, & Lytle, 2012). Overall, the focus on cigarette smoking compared to other substance use behaviors highlights the need for additional prospective studies that include other types of problematic substance use, like binge drinking and marijuana use, in addition to cigarette smoking.

An ideal developmental period to examine the role of adolescent obesity on substance use behaviors is young adulthood, as substance use reaches its peak between 18–25 years. About a third of young adults report cigarette smoking (30.6%) and binge drinking (37.9%), and 19.1% report marijuana use (SAMHSA, 2014). However, beyond examining associations between adolescent obesity and future substance use, mixed findings from previous studies call into question why discrepancies exist. Potentially, mixed findings in the literature reflect a need to better incorporate the factors or processes that underlie associations between obesity and substance use. For instance, the psychosocial context is likely to be a key underlying mechanism linking adolescent obesity and substance use. Obese adolescents may be more vulnerable to problematic substance use in young adulthood as a result of experiencing particular negative psychosocial contexts in adolescence.

During a developmental period when achieving greater peer acceptance and popularity is a prominent goal (LaFontana & Cillessen, 2010), obese adolescents are significantly more

likely to experience social marginalization than non-obese youth (Falkner et al., 2001; Puhl & Latner, 2007; Puhl & Heuer, 2009; Strauss & Pollack, 2003). In an effort to boost their standing among peers, obese adolescents may be eager to seek out peer groups that will be accepting of them. Unfortunately, due to being on the periphery of the peer network, obese adolescents have fewer options for gaining social acceptance. The lack of options may drive them to affiliate with deviant peers, a group also on the fringe of the peer network, as they are likely to be accepting as long as new members engage in deviant acts (Dishion & Medici Skaggs, 2000; Kiesner & Pastore, 2005). Obese individuals may be especially vulnerable to the negative effects of a deviant peer group during the transition from adolescence to young adulthood, as adolescents' developing reasoning skills are dominated by a strong desire for peer acceptance (Steinberg, 2008; Chein, Albert, O'Brien, Uckert, & Steinberg, 2011). The motivation to gain social acceptance may ultimately drive obese adolescents to engage in risky behaviors.

In addition to the possibility that obese adolescents engage in problematic substance use as a way to increase social acceptance by peers, it is also possible that obese adolescents self-medicate with substances to decrease negative emotions related to social stigma and depression. The higher likelihood of victimization, rejection, and exclusion faced by obese youth (Lumeng et al., 2010; Pearce, Boergers, & Prinstein, 2002; Puhl, Luedicke, & Heuer, 2011) is likely to contribute to greater psychological distress, such as depressive symptoms (Bucchianeri, Eisenberg, Wall, Piran & Neumark-Sztainer, 2014; Storch et al., 2007). Indeed, there is robust evidence that obese adolescents are at greater risk of depressive symptoms than non-obese adolescents (Halfon, Larson, & Slusser, 2013; Needham & Crosnoe, 2005; Van Vlierberghe & Braet, 2007). With obese adolescents at greater risk of depressive symptoms, the self-medication hypothesis (Bolton, Robinson, & Sareen, 2009; Weiss, Griffin, & Mirin, 1992) posits that a significant number may engage in substance use in an attempt to mitigate and cope with negative emotions (Abrantes, Brown, & Tomlinson, 2004; Anderson, Ramo, & Brown, 2006; Bizzari et al., 2006). Although a form of maladaptive coping, obese adolescents may perceive substance use as a way to avoid negative feelings about themselves.

Taking into account that social stigma, victimization, depressive symptoms, and deviant peer affiliation may play a role in explaining why obese adolescents are at risk for future substance use, the current study assessed whether obese adolescents had a higher likelihood of experiencing a psychosocial context that would put them at risk for problematic substance use in young adulthood. Based on previous research, it was expected that obese adolescents would endorse a psychosocial context with higher levels of social marginalization, victimization, and depression, but the relationship between obesity status and deviant peer affiliation was unclear. A person-centered approach was chosen to identify underlying patterns of psychosocial context in adolescence. The identified psychosocial classes in adolescence were then used to predict problematic substance use behaviors in young adulthood, which included binge drinking, cigarette smoking, and marijuana use. It was hypothesized that adolescent obesity status would predict belonging to the most negative psychosocial class a year later, and membership in this psychosocial class would predict the highest levels of substance use in young adulthood.

Method

Participants

Study data was obtained from The National Longitudinal Study of Adolescent to Adult Health (Add Health), comprised of a nationally representative sample of U.S. adolescents in grades 7–12 during the 1994–95 school year. The Institutional Review Board of the University of North Carolina-Chapel Hill approved research design and data collection. Eighty high schools and 52 middle schools participated in the initial wave of the study. During the first wave, 20,745 adolescents in grades 7–12 (11–19 years) completed both a school survey and in-home interview between April and December 1995. Written informed consent was obtained from parent and adolescent. A year later (April–August 1996), participants were asked to complete a second wave of in-home interviews (12–20 years; $N=14,738$). A third wave of in-home interviews was conducted approximately 5 years later (July 2001–April 2002), which included 15,197 young adults (18–26 years). Throughout these assessments participants were asked questions about their psychosocial adjustment, health-risk behaviors, and various contextual factors related to family, peer, school, and neighborhood (Harris et al., 2009).

The current study included 10,637 participants that were enrolled in high school (grades 9–12) at Wave 2, which allowed for an analysis of the psychosocial context across a similar setting. The average age of participants at Wave 1 was 16.04 years $\pm$ 1.20, 16.95 years $\pm$ 1.20 at Wave 2, and 22.36 years $\pm$ 1.22 at Wave 3. At Wave 1, 91.6% of participants were between the ages of 14–17 years, 4.0% were under 14 years, and 4.4% were 18 years or older. Participants included 51.0% female; 50.7% White, 22.5% Black, 16.0% Latino; 8.0% Asian; and 2.8% other. At Wave 1, 94.8% of participants reported mother education, indicating 4.0% of mothers had no education or adolescents did not know; 13.8% of mothers received less than a high school education; 31.9% were high school graduates; 18.0% completed some college; and 27.2% completed college or beyond. Also at Wave 1, 76.7% of participants' parents provided annual household income: 21.7% reported less than \$25,000; 25.4% between \$25–49,999; 18.1% between \$50–74,999; 6.5% between \$75–99,999; and 5.0% \$100,000 or more. Obesity status at Wave 1 was not available for 2.4% of the sample. Substance use behaviors measured at Wave 3 (young adulthood) were missing for 22.5% of the sample. Those missing substance use data compared to those with available data were more likely to be male (54.8% vs. 47.2%), Black (25.2% vs. 21.6%), and Latino (18.6% vs. 15.2%).

Measures

Individual characteristics—Participants reported their sex (1 = *female*, 0 = *male*) and race/ethnicity at Wave 1. Race/ethnicity variables for African American, Asian, Latino, and White were dummy coded (e.g., 1 = *African-American*, 0 = *non-African-American*). Maternal education status at Wave 1 (1 = *less than a high school education*; 2 = *high school graduate*; 3 = *completed some college*; 4 = *completed college or beyond*) was used as a proxy for socioeconomic status, given that annual household income was only available for 76.7% of participants whose parents had completed in-home interviews at Wave 1.

Obesity status—Adolescent self-reported height and weight at Wave 1 was used to calculate obesity status. Self-reported height and weight data was found to be reliable for 96% of adolescents at Wave 1 (Goodwin, Hinden, & Khandewal, 2000). Age- and sex-specific body mass index [BMI; $\text{weight}(\text{lbs})/[\text{height}(\text{in})^2 \times 703]$ percentiles were estimated with self-reported height and weight using the Centers for Disease Prevention (CDC) 2000 growth charts (Kuczmarski et al. 2000). Obesity was defined as having a BMI percentile at or above the 95th percentile. A dummy variable was created to assess obese vs. non-obese adolescents (1 = *obese*, 0 = *non-obese*).

Psychosocial Context—At Wave 2, adolescents responded to various measures related to psychosocial experience, including depressive symptoms, social marginalization, deviant peer affiliation, and victimization

Depressive symptoms were measured with a ten-item version of the Center for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977). Adolescents were asked, “How often was each of the following things true during the past week?” Sample items include “You had trouble keeping your mind on what you were doing;” “You felt depressed;” “You felt that you were too tired to do things;” and “You felt sad.” Responses ranged from 0 (*never or rarely*) to 3 (*most of the time or all of the time*).

Social marginalization was assessed with two items asking participants whether they 1) felt socially accepted and 2) felt loved and wanted, with responses collapsed into 3 categories (1 = *strongly agree or agree*, 2 = *neither agree nor disagree*, and 3 = *disagree or strongly disagree*). Another item originally used in the CES-D (Radloff, 1977) asked participants to respond from 0 (*never or rarely*) to 3 (*most of the time or all of the time*) to the statement, “You felt that people disliked you” in the past week. Higher values for items indicated greater social marginalization.

Deviant peer affiliation was assessed with three questions that asked adolescents to state how many of their three closest friends smoked at least one cigarette each day, consumed alcohol at least once a month, and smoked marijuana at least once each month. Responses to each question were coded from 0 = *zero friends* to 3 = *three friends*.

Participants responded to four questions about their victimization experiences in the past 12 months, including whether they had been threatened with a knife, threatened with a gun, shot at, or “jumped”. Due to low rates of endorsement, responses were combined into two indicators: whether they had been threatened with a knife or gun (0 = *no*; 1 = *yes*), and whether they have been “jumped” (0 = *no*; 1 = *yes*).

Substance use—At Wave 3, participants responded to multiple questions about cigarette smoking, alcohol use, and marijuana use. For the current study, three indicators were used to measure problematic cigarette smoking, alcohol, and marijuana use. Problematic cigarette smoking was assessed with “During the past 30 days, on the days you smoked, how many cigarettes did you smoke each day?” Those who had not smoked in the past 30 days were given a response of ‘none’. Responses were coded as 0 = *none*, 1 = 1, 2 = 2–9, 3 = 10–20, 4 = 20+ *cigarettes*. Problematic alcohol use referencing binge drinking was measured with the

question, “During the past 12 months, on how many days did you drink five or more drinks in a row?” Participants that indicated not drinking in the past 12 months were given a response of ‘none’. Responses were coded as 0 = *none*, 1 = *couple times a year*, 2 = *once a month or less*, 3 = *couple times a month/week*, 4 = *3–7 times a week*. Problematic marijuana use was measured by asking participants “During the past 30 days, how many times have you used marijuana?” Those stating they had not used marijuana in the past year were given the response ‘none’. Responses were coded as 0 = *none*, 1 = *1*, 2 = *2–9*, 3 = *10+ times*.

Planned Analyses

Latent class analysis (LCA) was conducted to identify classes of adolescents based on psychosocial experience, and determine whether obese adolescents had a higher likelihood of belonging to psychosocial classes predictive of problematic substance use in young adulthood. In LCA underlying patterns of observed categorical variables are used to classify individuals with similar responses, behaviors, or characteristics into latent classes (Hagenaars & McCutcheon, 2009; Lanza, Collins, Lemmon, & Schafer, 2007; Nylund, Bellmore, Nishina, & Graham, 2007). Predictors of class membership (covariates) and distal outcomes of class membership can be estimated as well. LCA utilizes an iterative process using full information maximum likelihood estimation.

The 3-step approach developed by Vermunt (2010) and popularized by Asparouhov and Muthén (2014) was utilized to examine predictors and distal outcomes of the identified psychosocial classes. In the first step, the best fitting psychosocial class model was identified using indicators of depression, social stigmatization, deviant peer affiliation, and victimization. Statistical indices, parameter estimates, and practical implications were considered in choosing the optimal model (Collins & Lanza, 2010).

After identifying the optimal class model, the second step of the LCA involved creating a most likely class variable using the latent class posterior probabilities obtained in step 1. Logits reflecting the classification uncertainty rate were also obtained, which were applied in the third step of the analysis to account for measurement error in the most likely class variable. Covariate and distal outcome variables were not yet included in the model, but they were designated here as auxiliary variables to be saved in the dataset used in the final step of the analysis.

In the third step, the most likely class variable was used to assess predictors and outcomes of the psychosocial classes while accounting for measurement error in classification. Obesity status and demographic variables (sex, ethnicity, maternal education) were examined as predictors of the latent class model to determine whether adolescent obesity at Wave 1 was predictive of membership in specific psychosocial classes at Wave 2. Additionally, three indicators of problematic substance use were treated as distal outcomes of the latent class model to assess whether particular psychosocial classes predicted problematic substance use in young adulthood. The mean of cigarette smoking, binge drinking, and marijuana use was used to identify significant differences in substance use between psychosocial classes. Analyses were conducted using Mplus Version 7.11 (Muthén & Muthén, 2012).

Results

Descriptives

Adolescent BMI% calculated at Wave 1 indicated that 10.5% (n=1088) of adolescents met obesity status. Of these 1,088 obese adolescents at Wave 1, 75% (n=812) remained obese at Wave 2 and 73% (n=792) met obesity status at Wave 3. Using chi-square and t-tests to assess differences between groups, Table 1 compares obese and non-obese adolescents on key demographic variables, psychosocial indicators, and substance use behaviors. Males, African Americans, Latinos, and those reporting lower maternal education were significantly more likely to be obese. Obese adolescents reported significantly greater social marginalization and victimization than non-obese adolescents. They also reported a significantly greater number of friends using cigarettes, but no differences were found for binge drinking or using marijuana. Additionally, only certain depressive symptom levels, such as being unhappy, were higher among obese adolescents. In terms of substance use behaviors, obese adolescents reported significantly higher levels of cigarette smoking and marijuana use compared to non-obese adolescents. No significant differences were found between groups for binge drinking.

Latent class analysis

Model selection—LCA was conducted to identify latent classes of psychosocial context based on indicators of depression, marginalization, deviant peer affiliation, and victimization. The unconditional model was specified (i.e., one-class model), which was then used as a comparison for an increasing number of classes until the models specified no longer converged or had useful application. Table 2 presents the statistical fit indices for five classes (the sixth-class model did not converge). Statistical indices, like the Bayesian Information Criterion (BIC; Schwartz, 1978) and the Lo-Mendell-Rubin likelihood ratio test (LMR LRT; Lo, Mendell, & Rubin, 2001), as well as interpretability of classes were used in determining model selection. The fit indices did not point to one specific class model, but because the indices began to level off significantly after the three-class model and the fifth class had the lowest BIC value, the three-, four-, and five-class models were further explored. Examination of parameter estimates indicated that the four-class model was best-fitting for representing psychosocial context classes in adolescence. Adolescents in each latent class of the four-class model had similar response patterns to the observed indicators and class response patterns were distinct from each other. The four classes were meaningful and each represented a significant proportion of the sample.

Identified classes—Figure 1 illustrates the item-response probabilities of each class of the four-class model. About a third (31.6%) of participants were classified into an Adjusted class (Class 1) reflecting very low levels of depression, marginalization, victimization, and low frequencies of deviant peer affiliation. The remaining three classes were characterized by some variation of psychosocial maladjustment.

Participants in the Deviant Peer/Victimization class (Class 2; 26.9%) reported low levels of depressive symptoms and marginalization, but higher frequencies of deviant peer affiliation and victimization. For example, only 3% of adolescents in the Adjusted Class (Class 1)

reported being threatened with a knife/gun or jumped, while 19% of adolescents in the Deviant Peer/Victimization class (Class 2) reported being threatened and 15% being jumped.

Adolescents in the Moderate Depression class (Class 3; 25.4%) endorsed low levels of marginalization, victimization, and deviant peer affiliation similar to those in the Adjusted class, but responses to depressive symptoms revealed moderately higher levels of depression. The majority of participants stated they were experiencing symptoms 'sometimes' and to a lesser extent 'all of the time'.

The smallest class represented adolescents with the highest levels and frequencies of psychosocial maladjustment. This class was identified as the Maladjusted class (Class 4; 15.9%). The highest levels of depressive symptoms and marginalization were found in this class. Frequencies of deviant peer affiliation and victimization were somewhat similar to those in the Deviant Peer/Victimization class.

Predictors of class membership—Covariates were included in the LCA model to determine whether obese adolescents were more or less likely to belong to particular psychosocial classes. Covariates included obesity status, sex, race/ethnicity (African American, Asian, Latino, White), and maternal education. Table 3 presents the multinomial logistic regression findings using the Adjusted class (Class 1) as a reference class. Adolescents meeting obesity status had a higher likelihood of being classified into the Maladjusted class ($\beta = .24$, $OR = 1.26$, $p < .05$) than the Adjusted class. Obese adolescents also had a higher likelihood of belonging to the Maladjusted class than the Moderate Depression class ($\beta = .25$, $OR = 1.29$, $p < .05$). A higher likelihood of belonging to the Maladjusted class compared to the Deviant Peer/Victimization class among obese adolescents was only marginally significant ($\beta = .22$, $OR = 1.25$, $p = .08$).

As for the other predictors of class membership (see Table 3 for statistical values), females were more likely than males to be classified into the Moderate Depression or Maladjusted classes compared to the Adjusted class, but were less likely than males to be classified into the Deviant Peer/Victim class than Adjusted class. African American adolescents had a higher likelihood of belonging to the Adjusted class than any other class. Asian American adolescents were less likely to belong to the Deviant Peer/Victim class than the Adjusted class. Latino and White adolescents had a lower likelihood of belonging to the Moderate Depression or Maladjusted class compared to the Adjusted class, but no difference was found between membership in the Deviant Peer/Victim class and Adjusted class. Adolescents residing with mothers with higher vs. lower education status had a higher likelihood of belonging to the Adjusted class compared to any other class.

Distal outcomes—To test whether the identified psychosocial classes predicted to problematic substance use in young adulthood, continuous indicators of cigarette smoking, binge drinking, and marijuana use were assessed as distal outcomes. For each substance use indicator, average use was compared between psychosocial classes. Mean scores of substance use behavior differed significantly for many class comparisons, as illustrated in Table 4.

Overall, belonging to the Deviant Peer/Victim and Maladjusted classes predicted higher levels of problematic substance use behaviors. Results for cigarette smoking showed that the Deviant Peer/Victim class smoked the highest number of cigarettes on days smoked in the past 30 days (vs. Adjusted $\chi^2 = 188.85, p < .001$; vs. Moderate Depression $\chi^2 = 238.54, p < .001$; vs. Maladjusted $\chi^2 = 29.00, p < .001$). Those in the Maladjusted class reported the second highest level of cigarette smoking, which was significantly higher than the Adjusted ($\chi^2 = 76.41, p < .001$) and Moderate Depression ($\chi^2 = 87.93, p < .001$) classes. The Moderate Depression and Adjusted classes reported similar lower levels of cigarette smoking ($\chi^2 = 2.49, p > .05$).

Findings for binge drinking indicated that the Deviant Peer/Victim class reported the highest levels of binge drinking in the past 12 months compared to all other classes (vs. Adjusted $\chi^2 = 90.15, p < .001$; vs. Moderate Depression $\chi^2 = 148.95, p < .001$; vs. Maladjusted $\chi^2 = 62.80, p < .001$). The Adjusted and Maladjusted classes reported similar levels of binge drinking ($\chi^2 = .52, p > .05$). The Moderate Depression class reported significantly lower levels of binge drinking compared to the other classes (vs. Adjusted $\chi^2 = 4.78, p < .05$; vs. Deviant Peer/Victim $\chi^2 = 148.95, p < .001$; vs. Maladjusted $\chi^2 = 6.43, p < .05$).

As for marijuana use, the Deviant Peer/Victim class reported significantly greater use in the last 30 days compared to any other class (vs. Adjusted $\chi^2 = 134.67, p < .001$; vs. Moderate Depression $\chi^2 = 160.50, p < .001$; vs. Maladjusted $\chi^2 = 35.96, p < .001$). The Maladjusted class had significantly greater marijuana use compared to the Adjusted ($\chi^2 = 30.65, p < .001$) and Moderate Depression ($\chi^2 = 31.65, p < .001$) classes. The Moderate Depression and Adjusted classes had similar lower levels of marijuana use ($\chi^2 = .13, p > .05$).

Changes in substance use levels from adolescence (Wave 2) to young adulthood (Wave 3) by psychosocial class were also analyzed. Mean increases in cigarette smoking were seen for each class (+.32 Adjusted; +.10 Deviant Peer/Victim; +.28 Moderate Depression; +.05 Maladjusted). As for binge drinking and marijuana, mean decreases were observed among the Deviant Peer/Victim (−.41 for binge drinking; −.32 for marijuana) and Maladjusted (−.32 for binge drinking; −.22 for marijuana) classes. Mean increases in binge drinking and marijuana were observed among the Adjusted (+.41 for binge drinking; +.27 for marijuana) and Moderate Depression (+.42 for binge drinking; +.29 for marijuana) classes.

Discussion

Recent empirical work has demonstrated that the relationship between obesity status and substance use is complex and not well understood. The current study sought to gain a better understanding of this relationship by examining whether adolescents' psychosocial context could inform associations between adolescent obesity and problematic substance use in young adulthood. Compared to non-obese adolescents, obese adolescents had a higher likelihood of experiencing psychosocial maladjustment characterized by depressive symptoms, stigmatization, deviant peer affiliation, and victimization. Experiencing this type of all-encompassing maladjustment in adolescence predicted the second highest levels of cigarette smoking and marijuana use in young adulthood. Although the most problematic substance use levels in young adulthood were seen from adolescents belonging to a

psychosocial class characterized by only deviant peer affiliation and victimization (not depression or stigmatization), the results suggest that obese adolescents' higher likelihood of experiencing psychosocial maladjustment is a likely contributing factor to their increased risk of problematic cigarette smoking and marijuana use.

Given the wealth of literature indicating that obese adolescents are at higher risk of depression, rejection from peers, and bullying/victimization (Falkner et al., 2001; Halfon et al., 2013; Lumeng et al., 2010; Strauss & Pollack, 2003; Xie, Ishibashi, Lin, Peterman, & Susman, 2013), it is not surprising that obese adolescents had a higher likelihood of belonging to the Maladjusted class compared to non-obese adolescents. This class was characterized by the most negative psychosocial experience, including the highest levels of depressive symptoms and social marginalization as well as victimization and deviant peer affiliation levels similar to those in the Deviant Peer/Victim class. The addition of deviant peer affiliation to the psychosocial context usually explored in the child obesity literature is significant, as findings revealed obese adolescents are likely to experience a psychosocial context with relatively high levels of deviant peer affiliation. Thus, this study not only confirmed that obese adolescents have a higher likelihood of experiencing a negative psychosocial context reflecting previously examined constructs like depression, but also identified deviant peer affiliation as a potential new correlate of obesity status.

The current study also demonstrated that certain psychosocial contexts in adolescence were predictive of future problematic substance use in young adulthood. Specifically, adolescents belonging to the Deviant Peer/Victim class engaged in higher levels of cigarette smoking, binge drinking, and marijuana use in young adulthood. This corroborates a wealth of literature highlighting the detrimental effects of deviant peer affiliation on delinquent behavior (Brook et al., 2013; Fergusson, Swain-Campbell, & Horwood, 2002). Although the Deviant Peer/Victim and Maladjusted classes had somewhat similar levels of victimization and deviant peer affiliation, levels of deviant peer affiliation were higher among the Deviant Peer/Victim class. This small but nonetheless increased level in deviant peer affiliation may help explain why the Deviant Peer/Victim class had higher levels of substance use compared to the Maladjusted class. Even small increases in deviant peer affiliation during adolescence can significantly increase susceptibility to problem behavior like substance use (Monahan, Rhew, Hawkins, & Brown, 2014; Prinstein, Boergers, & Spirito, 2001). Furthermore, it is possible that adolescents that affiliate with deviant peers without marked depression levels, such as those in the Deviant Peer/Victim class, may be more prone to sensation seeking that contributes to risky behavior. There is little evidence to suggest adolescents high in sensation seeking are at risk of depression, but an abundance of research indicates high levels of sensation seeking increases engagement in risky behaviors, including substance use (Greene, Krmar, Walters, Rubin, & Hale, 2000; Hampson, Tildesley, Andrews, Barkley, & Peterson, 2013). Sensation seeking might have been higher in the Deviant Peer/Victim class compared to the other classes, which potentially may inform why this group had the highest levels of substance use.

Although obese adolescents were not more or less likely to belong to the Deviant Peer/Victim class, their higher likelihood of membership in the Maladjusted class also placed them at risk for problematic substance use. This class had the second highest levels of

cigarette smoking and marijuana use, which were significantly higher compared to the Adjusted and Moderate Depression classes. Examining the change of problematic substance use from adolescence into young adulthood revealed that adolescents in the Deviant Peer/Victim and Maladjusted classes were exhibiting problematic substance use in adolescence. The slight increase in cigarette smoking and decrease in binge drinking and marijuana among these classes in young adulthood suggests that although problematic substance use was evident in young adulthood, it was already a prominent concern in adolescence.

Experiencing psychosocial maladjustment in adolescence may ultimately inform why adolescent obesity has been linked to substance use behaviors like cigarette smoking in past studies. As more and more studies establish the link between adolescent obesity and smoking (Caria et al., 2009; Cawley et al., 2004; Huang et al., 2013; Hussaini et al., 2011; Lanza et al., 2014), it is important to note that the strength of this relationship may be tied to an adolescent's psychosocial experience. If obese adolescents are at risk for cigarette smoking because of their higher likelihood of psychosocial maladjustment, the lack of a negative psychosocial context for some obese adolescents may also explain why associations between obesity and cigarette smoking have not always been found. Psychosocial context may also be used to explain the relationship between obesity status and marijuana use in a manner similar to cigarette smoking, although compared to cigarette smoking, very little research has been conducted or shown any significant relationship between adolescent obesity and marijuana use (Farhat et al., 2010; Huang et al., 2013; Pasch et al., 2012). With these preliminary findings linking obesity and problematic substance use to a negative psychosocial context, it is critical to now examine the pathways that are leading to co-occurrence between obesity and risky health behaviors like cigarette smoking.

The current findings suggest that pathways incorporating deviant peer affiliation and negative coping strategies among obese adolescents should be comprehensively tested in future research. Obese adolescents may be more likely to engage in risky behaviors if they believe it will bring them greater social acceptance by peers (Weischold, Wiesner, & Silbereisen, 2014). The motivation to decrease victimization, exclusion, or rejection from peers may push obese adolescents into desperate attempts at social acceptance. These attempts may include trying to join peer groups on the social periphery (i.e., deviant peers) while gradually increasing their popularity status. Additionally, following the principles of the self-medication hypothesis (Bolton et al., 2009; Weiss et al., 1992), it is likely that some obese adolescents use substances to try and cope with the negative emotions resulting from social stigmatization and depressive symptoms (Anderson et al., 2006; Bucchianeri et al., 2014). Additional research is warranted to determine why obese adolescents engage with deviant peers and how they cope with negative emotions.

Other pathways and processes need to be examined as well. Biological and neurological pathways need to be addressed, as previous evidence has shown that food and substances share similar reward sites in the brain (DiLeone, Taylor, & Picciotto, 2012; Volkow & Wise, 2005). Furthermore, it is possible that behaviors like cigarette smoking occur because of the popular belief that smoking decreases appetite and is a way to lose and manage weight (Harakeh, Engels, Monshouwer, & Hanssen, 2010; Lowry, Galuska, Fulton, Wechsler, & Kann, 2002; Potter, Pederson, Chan, Aubut, & Koval, 2004). Examining multiple processes

is crucial because it is unlikely one pathway can explain the association between obesity and substance use. For instance, in this study obese adolescents were not more likely to engage in binge drinking as a result of belonging to the Maladjusted class. Previous findings on adolescent obesity and alcohol use are largely mixed, with the majority of prospective studies finding weak relationships between obesity and problematic alcohol use (Farhat et al., 2010; Fonseca et al., 2009; Weichold et al., 2014; Pasch et al., 2012). Potentially this relationship may be better explained with an emphasis on biobehavioral pathways (Weichold et al., 2014) that take into account risk factors like impulsivity and self-regulation.

Limitations of the current study need to be considered. First, the study relied on self-reported, not measured, height and weight to obtain BMI% for adolescents. However, relatively minor differences in reliability between self-reported and measured BMI have been reported in adolescence (Field, Aneja, & Rosner, 2007), and as noted earlier self-reported BMI was found to be reliable for 96% of adolescents at Wave 1 (Goodwin et al., 2000). Second, the degree to which we could examine psychosocial constructs (depression, social stigmatization, victimization, and deviant peer affiliation) was limited in part by the nature of the survey assessment and by the statistical analyses used. For instance, victimization questions were solely related to physical aggression, with relatively low levels of endorsement. Deviant peer affiliation asked for number of friends engaging in certain behaviors, but not the degree to which deviant acts were occurring. Also, a shortened version of the CES-D for depression was used due to restrictions in statistical modeling capabilities. Third, unlike many longitudinal studies that assess participants at the same age across time, Add Health utilized cohort sampling that resulted in an age range of approximately 8 years at each wave of assessment (e.g., Wave 3 includes participants 18–26 years). This makes it difficult to identify specific developmental periods that could explain increases in psychosocial maladjustment or normative vs. non-normative increases in substance use. However, by focusing on participants that were in high school when psychosocial context was measured we were better able to capture adolescents' psychosocial experience prior to their transition into young adulthood.

Conclusion

The current study conducted a preliminary, but necessary, step towards understanding why obese adolescents may be motivated to engage in problematic substance use. Obese adolescents' higher likelihood of depression, stigmatization, and victimization alongside deviant peer affiliation needs to be considered as key underlying mechanisms linking obesity status to health-risk behaviors, like cigarette smoking and marijuana. The relationship between adolescent obesity and regular cigarette smoking reported in previous studies may be partly explained by a higher likelihood of psychosocial maladjustment among obese youth. Future research should seek to parse out the motivating influences leading to health-risk behaviors among obese adolescents.

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Figure 1.
Psychosocial Context Classes in Adolescence: Item-response Probabilities (N=10,637)

Table 1

Comparison of Study Variables by Obese vs. Non-obese Status in Adolescence (N=10,637)

	Obese	Non-obese
<i>Demographics</i>	%	
Females vs. males ***	41.6 vs. 58.4	51.5 vs. 48.5
African American ***	27.8	21.8
Asian	7.4	8.2
Latino *	18.2	15.5
White ***	42.3	51.6
Maternal education <i>M(SD)</i> **	2.49(1.29)	2.64(1.30)
<i>Depressive Symptoms (Sample items)</i>	<i>M(SD)</i>	
Bothered by things	.56(.70)	.56(.69)
Hopeless	1.13(.97)	1.15(.96)
Unhappy *	.95(.84)	.89(.79)
Lonely	.50(.72)	.46(.69)
Hard to start	.67(.72)	.64(.69)
<i>Social Marginalization</i>	<i>M(SD)</i>	
Not socially accepted **	1.20(.49)	1.16(.44)
Not loved/wanted *	1.13(.39)	1.11(.36)
<i>Deviant Peer Affiliation</i>	<i>M(SD)</i>	
No. friends cigarette smoking *	.95(1.10)	.87(1.09)
No. friends alcohol use	1.18(1.18)	1.17(1.17)
No. friends marijuana uses	.79(1.04)	.74(1.03)
<i>Victimization</i>	%	
Someone jumped you **	10.8	7.8
Pulled a knife/gun on you **	12.8	9.6
<i>Substance Use Behaviors</i>	<i>M(SD)</i>	
Binge drinking	1.06(1.32)	1.10(1.30)
Cigarette smoking **	.97(1.45)	.80(1.32)
Marijuana use **	.56(1.08)	.48(.99)

 $p < .001$;**
 $p < .01$;*
 $p < .05$.

Table 2

Latent Class Model Fit Indices (N=10,637)

Classes	Log Likelihood	Free Parameters	BIC	Adjusted BIC	AIC	LMR LRT <i>P</i> -value for <i>k-1</i>	Entropy
1	-175793.58	53	352078.59	351910.16	351693.16	N/A	N/A
2	-165971.72	107	332935.55	332595.52	332157.44	.000	.81
3	-163532.17	161	328557.14	328045.50	327386.33	.000	.76
4	-161500.14	215	324993.78	324310.54	323430.28	.86	.77
5	-160097.97	269	322690.13	321835.28	320733.93	.76	.79

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion; LMR LRT = Lo-Mendell-Rubin likelihood ratio test.

Table 3

Estimated Odds Ratios (OR) of Class Membership based on Obesity Status, Sex, Race/Ethnicity, and Maternal Education (N=9,854)

	Reference class: Adjusted (Class 1)					
	vs. Deviant Peer/Victimization (Class 2)		vs. Moderate Depression (Class 3)		vs. Maladjusted (Class 4)	
	β (SE)	OR(95%CI)	β (SE)	OR(95%CI)	β (SE)	OR(95%CI)
Obese vs. non- obese	.02(.11)	1.02(.82–1.27)	–.02(.11)	.98(.79–1.22)	.24(.11)*	1.26(1.02–1.58)
Female vs. Male	–.21(.07)**	.81(.71–.93)	.19(.07)**	1.21(1.05–1.39)	.59(.07)***	1.80(1.57–2.07)
African American vs. non-AA	–.90(.24)***	.41(.25–.65)	–.62(.24)**	.54(.34–.86)	–.75(.24)**	.47(.30–.76)
Asian/Pacific Islander vs. non- API	–.59(.26)*	.55(.33–.92)	.11(.26)	1.11(.67–1.86)	–.01(.26)	.99(.59–1.65)
Latino vs. non- Latino	–.47(.25)	.62(.38–1.02)	–.50(.24)*	.61(.38–.97)	–.63(.24)*	.54(.33–.85)
White vs. non- White	–.42(.23)	.66(.42–1.03)	–.94(.23)***	.39(.25–.61)	–1.13(.23)***	.32(.21–.51)
Higher vs. lower mother education	–.14(.03)***	.87(.82–.92)	–.09(.03)**	.92(.86–.97)	–.20(.03)***	.82(.77–.87)

p < .001;

**
p < .01;

*
p < .05.

Table 4

Comparison of Problematic Substance Use Behaviors in Young Adulthood based on Psychosocial Class Membership in Adolescence (N=8,245)

	Mean cigarettes smoked per day in past 30 days	Mean days of binge drinking in past 12 months	Mean times of marijuana use in past 30 days
<i>Psychosocial class</i>			
Adjusted (Class 1)	.43	.94	.26
Deviant Peer/Victim (Class 2)	1.45	1.49	.88
Moderate Depression (Class 3)	.38	.84	.25
Maladjustment (Class 4)	.94	.98	.48

Note. Cigarette smoked per day in past 30 days coded as 0 = none, 1 = 1, 2 = 2–9, 3 = 10–20, 4 = 20+. Binge drinking in past 12 months coded as 0 = none, 1 = couple times a year, 2 = once a month or less, 3 = couple times a month/week, 4 = 3–7 times a week. Marijuana use in past 30 days coded as 0 = none, 1 = 1, 2 = 2–9, 3 = 10+ times.