

**EXAMINING THE RELATIONSHIP OF DIETING BEHAVIOR AND
SUBSTANCE USE AMONG FEMALE ADOLESCENTS**

by

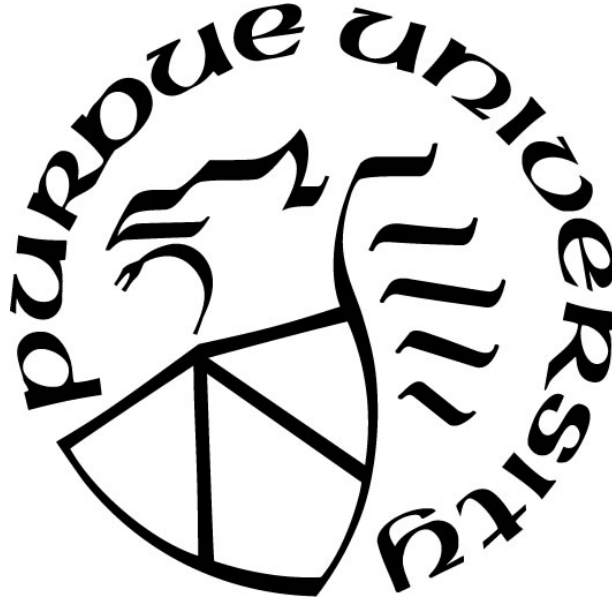
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To my family

ACKNOWLEDGMENT

I would like to acknowledge all of the work, time, and commitment my mentor, Dr. Tamika Zapolski, put into making this project a successful representation of my abilities.

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LIST OF ABBREVIATIONS

ABBREVIATION	DESCRIPTION
DB	Dieting behavior
SU	Substance use

ABSTRACT

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Title: Examining The Relationship Of Dieting Behavior And Substance Use Among Female Adolescents.

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The problem behavior theory suggests that the engagement in one problematic behavior increases the likelihood of engagement in another problematic behavior. Previous research has found among youth an increasing probability of co-occurring dieting and substance use behavior, particularly among girls. However, to date findings are inconclusive on the temporal ordering of these behaviors. Further, limited research has been conducted to explore whether the temporal ordering of the two behaviors exist similarly between White and Black youth. The present study will use a cross-lagged panel design across one year to examine the temporal ordering between dieting behavior and substance use among a sample of 2,016 adolescent females (grade mean=7; 77.2% White; 22.8% Black). We hypothesized that a bidirectional relationship would be observed between the two behaviors. However, given no published studies on this relationship by race, no a priori hypotheses were made for this second aim. Result showed that within the full sample dieting behavior significantly predicted substance use one year later, but the inverse relationship was not found. Additionally, this effect was replicated in the White sample but null effects in both directions was found among Black youth. These findings provide support for a temporal relationship between dieting behavior and substance use, such that the former predicts risk for the latter. Moreover, although there is evidence of race differences in the risk pathway, further research is needed to confirm this effect. Future studies are also needed to determine whether this observed temporal relationship is present among adolescent females of other

racial/ethnic groups, as well as if the relationship varies as a function of other demographic variables, such as age (e.g., early, mid, or late-adolescence).

INTRODUCTION

Dieting behavior has been characterized as the engagement in abnormal eating behaviors, such as the use of purging (vomiting or laxative use), diet pill use, fasting, or restrictive eating, with the goal of controlling weight (Neumark-Sztainer, Story, & French, 1996). Dieting behavior has also been characterized by more generalized behaviors aimed to control weight, such as endorsement of ever being on a diet or ever tried to lose weight (Littleton & Ollendick, 2003; Neumark-Sztainer et al., 1996), or engagement in non-food related methods to lose weight such as exercising (Johnson, Cohen, Kasen, & Brook, 2002). Examining dieting behaviors, rather than the presence of an eating disorder during adolescence is critical, as many young girls suffer from some type of problematic eating disturbance even though they do not meet full criteria for a clinical diagnosis (Rosen, 2010; Stice & Peterson, 2007). For example, it has been estimated that over one-half of teenage girls use unhealthy weight control behaviors such as skipping meals, fasting, smoking cigarettes, vomiting, and taking laxatives (Gustafson-Larson & Terry, 1992; Neumark-Sztainer et al., 2006). Additionally, studies have documented that more than half of 9-11-year-olds are “sometimes” or “very often” on diets (Gustafson-Larson & Terry, 1992). These findings highlight that there are many youth struggling with eating and body image issues (Stachowitz, Choi, & Schweinle, 2014; Larson, Neumark-Sztainer, & Story, 2009), which may not be captured in treatment efforts that tend to focus more on youth with diagnosed eating disorders (Stachowitz et al., 2014).

Another behavior that is highly prevalent among youth in the United States is substance use. It is estimated that by 8th grade 21% have used alcohol, marijuana, inhalants, or hard drugs in their lifetime (Johnston, O’Malley, Bachman, & Schulenberg, 2012). These rates only increase with age, with 35% of youth reporting lifetime substance use by 10th grade and 49% reporting

lifetime substance use by 12th grade. The use of substances during adolescence is a significant public health concern, as adolescent use is associated with numerous health consequences, including cognitive impairments (Hawkins, Catalano, & Miller, 1992; Volkow, Baler, Compton, & Weiss, 2014; Winward, Bekman, Hanson, Lejuez, & Brown, 2014), decreased school performance (Henry, Knight, & Thornberry, 2012), increased risk for mental health diagnosis (Kaminer, 2016; Kuepper et al., 2011), and increased risk for substance use disorders during adulthood (Schulenberg et al., 2015; Schulte, Ramo, & Brown, 2009).

Examining the Association Between Dieting Behavior and Substance Use

Engagement in both dieting behaviors and substance use during adolescence has also been well documented (Stice, Burton, & Shaw, 2004; Stice, Presnell, & Bearman, 2001), particularly among adolescent females (Pisetsky, May Chao, Dierker, May, & Striegel-Moore, 2008). For example, Vidot, Messiah, Prado, and Hlaing (2016) found among a sample of adolescents 12-18, 60.1% of those who reported dieting behavior also reported substance use, compared to 37% of girls who used one or more substance but did not report dieting behavior. Similarly, Ross and Ivis (1999) found that among a Canadian sample of adolescent girls who engaged in bingeing and compensatory behavior also engaged in alcohol (81.3%), tobacco (50.3%), marijuana (44.6%) and other drug use (63.6%). Moreover, rates of co-occurring dieting behavior and substance use have been found to be increasing among female adolescents (Neumark-Sztainer, Wall, Larson, Eisenberg, & Loth, 2011; Patte & Leatherdale, 2016; Stachowitz et al., 2014), suggesting they are a particularly high-risk group.

Studies have found that male adolescents are also concerned about their weight and body image (Eichen, Conner, Daly, & Fauber, 2012; Neumark-Sztainer et al., 2002; Neumark-Sztainer et al., 2006). However, the rate at which they use dieting behaviors or substances, like steroids, to

regulate weight is disproportionate to the trends seen among females. For example, studies have found effects between endorsing dieting behavior with alcohol and marijuana intake disproportionately larger for females (Eichen et al., 2012; Rohde et al., 1996), as well as a more rapid trajectory for use during adolescence (Measelle, Stice, & Hogansen 2006; Neumark-Sztainer et al., 2011) than males.

Although there is no explicit theoretical basis for the relationship between substance use and dieting behavior, the problem behavior theory has been proposed to help explain why maladaptive behaviors such as substance use and dieting behaviors co-occur (Eichen et al., 2012; Stice et al., 2004). Specifically, the problem behavior theory speculates that engaging in one problem behavior increases the likelihood of involvement in other problem behaviors (Jessor & Jessor, 1977). According to this theory, problem behaviors are defined as behaviors socially defined as a problem, a source of concern, or as undesirable by the norms of conventional society. Behaviors typically included are substance abuse, delinquency, and precocious sexual activity, and have typically been found to co-occur together (Donovan & Jessor, 1985). Building on this theory, Donovan & Jessor (1985) found that these problematic behaviors were accounted for by a single common factor of deviance from social norms or unconventionality. Collectively the authors identified them as a “syndrome” of problem behavior, particularly during late childhood through adolescence. In regard to dieting behaviors, Neumark-Sztainer, Story, and French (1996) went further to argue that dieting behaviors belonged within this syndrome category, finding that adolescents who used unhealthy weight loss methods (i.e., using laxatives, water pills (diuretics), diet pills, and/or vomiting) were more likely to engage in other health compromising behaviors typically included in the problem behavior syndrome.

In addition to work based on the problem behavior theory, literature has also been extracted examining factors associated with dieting behavior and substance use separately, which is suggestive of similar mechanisms or risk factors for both behaviors. For example, engagement in dieting behavior and substance use are both impacted by changes in mood and cognition (Sinha & O'Malley, 2000), suggesting that youth may engage in both behaviors due to emotion regulation or maladaptive cognitions. Dieting and substance use have also been found to share addictive characteristics such as craving, lack of control, and denial which increase the odds of continued engagement in either behavior (Pearlstein, 2002; Rothman, Blough, & Baumann, 2008; Sinha & O'Malley, 2000), and thus may be related to their co-occurrence. Additionally, both behaviors involve neurological reward pathways that result in the release of serotonin, dopamine, gamma-aminobutyric acid, and endogenous opioid peptide systems (Pearlstein, 2002; Sinha & O'Malley, 2000). For example, the reward pathways activated during binge-purge episodes, for instance, were similar to those found during alcohol use (Dawe and Loxton, 2004; Sinha & O'Malley, 2000). Although these findings are suggestive of common mechanisms and risk factors, to our knowledge no study has explicitly tested if these factors explain the co-occurrence of dieting and substance use during adolescence.

Directionality Between Dieting Behavior and Substance Use

There is some theoretical work published, though sparse, on understanding the temporal ordering between dieting behavior and substance use. Specifically, the dietary restraint model posits that factors that can result in relaxation of cognitive control over eating, such as intoxication, can result in disinhibited eating and binge eating episodes (Polivy & Herman, 1985). As such, the dietary restraint theory proposes a prospective effect from substance use to risk for subsequent bulimic behavior. Although no theory has been posited for the converse relationship with dieting

behaviors preceding risk for substance use, as discussed by Stice, Burton, and Shaw (2004), there are several mechanisms noted by which dieting behaviors, specifically bulimic pathology, might increase substance use risk. Specifically, the authors noted that a strong drive for thinness can increase risk for substance use as a means for weight loss. Additionally, they noted studies that suggest that regulation of emotions can increase risk for substance use as a result of dieting behavior, such that dieting behaviors can promote feelings of shame or guilt which can in turn increase risk for substance use as a coping strategy (Stice et al., 2004). However, similar to literature on the co-occurrence of dieting behavior and substance use, to date few studies have been conducted testing the dietary restraint theory or the proposed mechanisms to help explain the temporal ordering of dieting behavior and substance use among female adolescents. Yet, outside of testing theories and mechanisms, there is a substantial body of research examining the temporal relationship between the two behaviors.

The largest body of literature on the temporal ordering between dieting behavior and substance use has been conducted on the unidirectional effect of dieting behavior on later substance use among adolescents, with support found for this risk pathway (Krahn et al., 1996; Neumark-Sztainer et al., 2006). For example, Conway, Swendsen, Husky, He, and Merikangas (2016) found that among a national sample of adolescents, prior dieting behavior symptoms increased the risk of transition from nonuse to first use of any substance. Krahn et al. (1996) found that as frequency of dieting in the 6th grade increased, so did frequency of alcohol consumption, assessed in 9th grade. This effect was found above and beyond the influence of other risk factors, including approval of alcohol use, perceptions of peer use, and personal feelings of shyness and self-esteem (Krahn et al., 1996). Additionally, studies among adolescents within the eating disorder literature have found that high frequency of impulsive eating and purging behavior precedes substance use (Blinder,

Blinder, & Sanathara, 1998; Mann et al., 2014). This effect has also been found across nationalities, with a positive relationship in the frequency of dieting behavior and later alcohol frequency found among adolescents in the U.S. and Canada (Brewerton, Rance, Dansky, O'neil, Kilpatrick, 2014; Bulgin & Frederick Amar, 2016; Patte & Leatherdale, 2016).

To date, a limited number of studies have examined the opposite pathway, such that the presence of substance use during adolescence predicts later dieting behavior. Among the available studies, a null effect has been observed. Johnson, Cohen, Kasen, and Brook (2002) found that adolescent substance abuse did not predict onset of eating pathology in adulthood. In a systematic review of female adolescents and adults, Harrop and Marlatt (2010) found that among studies examining the unidirectional relationship between dieting behavior and substance use, dieting behavior predicted substance use but substance use did not predict increased dieting behavior. To our knowledge, only two studies have been conducted that examined the competing pathways within the same model, both also providing no evidence of substance use predicting later dieting behavior (Measelle et al., 2006; Stice et al., 2004). However, both studies did find that dieting behavior predicted later substance use (Measelle et al., 2006; Stice et al., 2004).

Although no previous studies have found a direct effect of substance use predicting later dieting behavior, there are some limitations within the previous literature, such as the operationalization of dieting behavior, that may have influenced the observed results. Specifically, adolescent dieting behavior has typically focused on the effects of specific eating pathology symptoms that are inconsistent across studies. For instance, some studies examined bulimic symptoms of bingeing and purging (Measelle et al., 2006; Stice et al., 2004), whereas others examined DSM-IV eating pathology criteria that includes restrictive eating (Johnson et al., 2002). In addition to the varying ways dieting behavior has been operationalized, studies have typically

focused on eating pathology, rather than a more generalized conceptualization of dieting behavior. We posit that by generalizing the construct of dieting behavior, we are more likely to capture subthreshold levels of dieting behavior that are likely to have been missed within existing literature. Thus, the current study aims to add to this body of literature by examining the bidirectional effect between more general dieting behavior and substance use among a large community sample of adolescent girls over a one-year time period.

Differentiating Dieting Behavior and Substance Use Relationship by Race

Much of the research outlined in the studies presented above are largely comprised of White females, thus providing limited insight as to whether these relationships are cross-culturally valid. This is important as engagement in both dieting behavior and substance use have been shown to differ across racial groups. Specifically, studies have found that Black girls report higher levels of body satisfaction compared to their peers (Rodgers, Watts, Austin, Haines, & Neumark-Sztainer, 2017), which is in turn associated with lower prevalence of dieting behavior (Neumark-Sztainer et al., 2002). Whereas, White girls report more weight-related concerns leading to an increased prevalence of dieting behavior (Crago, Shisslak, & Estes, 1996; Garry, Morrissey, & Whetstone, 2003; Hodson, Newcomb, Locke, & Goodyear, 2006; Neumark-Sztainer et al., 2002; Rodgers et al., 2017; Rothstein, Sbrocco, & Carter, 2017). In relation to substance use, White female adolescents are more likely to engage in alcohol (Kann, 2016; Keyes et al., 2015), cigarette (Chung, Kim, Hipwell, & Stepp, 2013; Kann, 2016), and illicit substance use other than marijuana (Kann, 2016) than Blacks female adolescents, whereas rates of marijuana use are higher among Black girls than White girls (Kann, 2016).

Thus, there is clear evidence of differences across race in both dieting behavior and substance use, with dieting behavior and engagement in most substances found at higher rates

among White girls in comparison to Black girls. What remains unknown is whether the association between the two behaviors as noted above is also found across racial groups and whether the temporal ordering differs by race. The second aim of the present study is to examine whether the relationship between dieting behavior and substance use is found across racial groups – youth who self-identity as either non-Hispanic White or non-Hispanic Black. Being able to obtain a better understanding of the relationship between these two behaviors in terms of race can help determine the generalizability of the effect most often observed among White females. If differences are found, these findings can guide future research to better understand mechanisms underlying risk across racial groups, as well as highlighting factors that may be more culturally specific in regard to dieting behavior and substance use within racial groups.

The Current Study

We aim to fill gaps in previous literature by examining the relationship between dieting behavior and substance use among a large sample of female youth who are in 4th through 12th grade. The first aim of the present study is to expand on current literature by exploring both the concurrent and temporal relationship of general dieting behavior and substance use. Based on the problem behavior theory, we hypothesize that dieting behavior, operationalized by a composite of six dieting behaviors (i.e., tried to lose weight, eaten less food to lose weight, exercised to lose weight, gone without eating for one day or more to lose weight, taken any diet pills, powders, or liquids to lose weight without a doctor's advice, and vomited or taken laxatives to lose weight) will be associated with substance use, operationalized by a composite of six substance use behaviors (i.e., smoked cigarettes, used smokeless tobacco, had at least one drink of alcohol, used marijuana, used inhalants, and used other drugs (cocaine, ecstasy, LSD, crank)) within each time point. We also hypothesized a bidirectional prospective relationship between both behaviors across

a 1-year time period. For the second aim we will stratify the full sample by race to examine whether the concurrent and temporal ordering of dieting behavior and substance use is also found within each racial group. Given no published studies to our knowledge of race differences in this risk pathway, this aim is exploratory and therefore no a priori hypotheses on racial differences between these variables was determined.

METHODS

Participants and Setting

Participants for this study were drawn from a 5-wave parent study examining school and health behavior outcomes among students between 4th and 12th grade. Participants were sampled from 159 schools (21 school districts) in a large Midwestern county. Informed consent forms were sent to parents of potential participants and were asked to return signed forms back to the school if they wished to provide consent each year. Approximately 12,000 students participated each year. However, retention rates across waves were modest, with 27.7% of participants completing two waves of data, 12.2% completing three waves of data, and 5.4% completing four or five waves of data (see Barnes, Almerigi, & Hsu, 2009). For the present study data was used across waves 4 and 5 of the parent study, given that they included the highest retention of participants (47.5%). Given the interest in racial differences in the relationship between dieting behavior and substance use among female adolescents, the analysis was restricted to only include female participants who self-identified as non-Hispanic White or non-Hispanic Black. Thus, the current sample was 2016 adolescent girls (1558 non-Hispanic White and 458 non-Hispanic Black) who responded to the variables of interest across two waves. Youth were in 7th grade on average at year 1 ($M_{\text{gradeY1}}=6.91$, $SD_{\text{gradeY1}}=1.58$) and 8th grade on average at year 2 ($M_{\text{gradeY2}}=7.9$, $SD_{\text{gradeY2}}=1.58$).

Table 1: Descriptive Statistics For Year 1 Grade, Dieting Behavior, and Substance Use Among Total Sample and by Race

	Total M (SD)	White M (SD)	Black M (SD)
Year 1 Grade	6.91 (1.58)	6.93 (1.57)	6.84 (1.59)
Dieting Behavior			
DB time 1	11.19 (4.11)	11.22 (4.07)	11.10 (4.25)
DB time 2	11.23 (4.13)	11.28 (4.05)	11.06 (4.38)
Substance Use			
SU time 1	6.62 (.09)	6.67 (.10)	6.47 (.08)
SU time 2	6.99 (.12)	7.05 (.12)	6.78 (.10)

Note. White (n=1558); Black (n=458).

Dieting behavior scores ranged from 6-24 with higher scores indicating a greater number of dieting behaviors used and/or greater prevalence of dieting behavior. Substance use scores ranged from 6-42 with higher rates indicating a greater number of substances used and/or greater prevalence of substance use.

Procedures

After parental consent was obtained, eligible students were administered assent forms providing information on the study procedures, confidentiality, risk and benefits of participation, and who they can talk to about the survey. Those students who provided assent were then given paper-pencil surveys and were given up to 45 minutes to complete the survey.

Measures

Demographic and Background Measures

Participants were asked to indicate their gender, grade, and ethnic/racial background (i.e., African American, American Indian, Hispanic, Asian, Multiracial, White, and Other). For data analysis, only youth who self-identified as non-Hispanic White or non-Hispanic Black were included. Additionally, the full sample of 4th through 11th grade at time 1 were included.

Dieting Behavior

Participants were asked to indicate to what intensity they have exhibited six dieting behaviors in the past year: “tried to lose weight,” “eaten less food to lose weight,” “exercised to lose weight,” “gone without eating for one day or more to lose weight,” “taken any diet pills, powders, or liquids to lose weight without a doctor’s advice,” and “vomited or taken laxatives to lose weight.” Response choices were on a 4-point Likert scale, where 1 (*Never*), 2 (*Not much*), 3 (*Sometimes*), 4 (*A lot*). All six questions will be summed to represent a composite dieting behavior score. Scores can range from 6-24. Previous studies have used a composite of similar responses to represent this construct (Neumark-Sztainer et al., 2006; Vidot et al., 2016; Gadalla & Piran, 2007), with the scale providing high internal consistency ranging from .83-.97 (Neumark-Sztainer, 2011; Measelle et al., 2006). The internal consistency for the current study was also high across the two time-points ($\alpha = .82$ and $\alpha = .83$, respectively).

Substance Use

The substance use measure was adapted from items included in various national studies conducted among youth (e.g., Monitoring the Future, YRBSS). Participants were asked to indicate how many days in the past 30 days had they engaged in the following six behaviors: “smoked cigarettes,” “used smokeless tobacco,” “had at least one drink of alcohol,” “used marijuana,” “used inhalants,” and “used other drugs (cocaine, ecstasy, LSD, crank).” Response choices were provided on a 7-point Likert scale, with 1 (*0-days*), 2 (*1 or 2 days*), 3 (*3-5 days*), 4 (*6-9 days*), 5 (*10-19 days*), 6 (*20-29 days*) and 7 (*everyday*). The scores will be summed to represent a composite drug use score. The scores can range from 6-42. Previous studies using this measure in a similar population have found high internal consistency, $\alpha = .87$ (Litwiller & Brausch, 2013). The internal

consistency for the current study was also high across the two time-points ($\alpha = .85$ and $\alpha = .86$, respectively).

Data Analyses

Due to the size and scope of the parent study, the initial data cleaning plan involved including those participants who 1) identified as female, 2) self-identified as either non-Hispanic White or non-Hispanic Black/African American, and 3) had completed items on at least one of the variables of interest across the two time-points. Those who endorsed more than one of the included races were excluded. All other measures, except for demographics, for the parent study were excluded. Given this inclusion criteria the present sample is 2,016 participants.

After data cleaning, composite variables were created for substance use and dieting behavior. Skewness and kurtosis of the study variables were also assessed, with results indicating acceptable values for dieting behavior at each time point (time 1: skewness = .65, kurtosis = .1; time 2: skewness = .69, kurtosis = .23). However, values were non-normally distributed for substance use (time 1: skewness = 8.58, kurtosis = 96.20; time 2: skewness = 6.25, kurtosis = 46.71). Thus, values for substance use were log transformed (time 1: skewness = 4.76, kurtosis = 27.90; time 2: skewness = 3.92, kurtosis = 17.44) to address the extreme positive skew (see Table 1).

To address missing values, missing data was imputed using mean substitution for youth who had no more than 2 of the 6 responses missing on each scale prior to creating the composite scores ($N_{\text{cases}}=92$, 4.6%). Further, for those without composite scores on a scale due to either having greater than 2 items missing on a scale or not completing the measure at that time point ($N_{\text{cases}}=482$, 23.9%) composite values were imputed once entered into the SEM model using multi-linear model estimation.

Path Analysis

The first study aim, which was to examine the concurrent and temporal relationship between substance use and dieting behavior, was tested using path analysis through MPlus, (Muthen & Muthen, 1998; see Figure 1). For the path analysis, four common fit indices were used to examine the acceptability of the data to the specified path model: chi-square index with a degrees of freedom ratio (Kline, 2015; Ullman, 1996); the comparative fit index (CFI: Bentler, 1990); the root mean squared error of approximation (RMSEA; Browne & Cudeck, 1993; Steiger & Lind, 1980); and the standard root mean squared residuals (SMSR; Bentler, 1995). Based on the recommendations by Hu and Bentler (1999), the size of our model, and using a maximum likelihood estimating procedure, suggests that a chi-square to degrees of freedom ratio less than 2.0, a CFI of at least .90, a RMSEA less than .06, and SMSR less than .08 together would indicate a good fit between the hypothesized model and the data. A subjective criterion that was also used was that the model would exhibit statically significant paths that explain substantial variance in the outcomes (Burkholder & Harlow, 2003). Race was stratified in the model, using multigroup analysis, to examine whether the proposed pathways were observed within each racial group.

Power Analysis

A post hoc power analysis was conducted to determine the effect size possible for the present sample of data. This analysis was conducted using G*Power 3.1 software (Faul, Erdfelder, Lang, & Buchner, 2007). For the first aim of the study using multiple linear regression analysis, with the full sample of 2016, three predictors, a small effect size ($f^2 = 0.15$), at an α -level of .05, it is determined that our sample size yielded power at 1.0 indicating we have adequate power to observe a true effect, if present. This analysis was completed again for the second aim among the sample of 1558 White and 458 Black youth with the same results.

RESULTS

Preliminary Analyses

Dieting behavior was fairly common, with 80.9% of youth reporting dieting behavior at time 1 which slightly increased to 81.6% by the second wave. Additionally, though much less prevalent than dieting behavior, 17.6% reported substance use, which increased by the second wave to 22.2%.

Demographic variables and the health behaviors were found to be similar across racial groups. Both groups were in 7th grade on average at year 1 (Whites: $M_{\text{gradeY1}}=6.93$, $SD_{\text{gradeY1}}=1.57$; Blacks: $M_{\text{gradeY1}}=6.84$, $SD_{\text{gradeY1}}=1.59$). Substance use was slightly higher among White girls at both time points ($M_{\text{SU1}}=6.66$, $SD_{\text{SU1}}=.10$ and $M_{\text{SU2}}=7.05$, $SD_{\text{SU2}}=.12$) compared to Black girls ($M_{\text{SU1}}=6.47$, $SD_{\text{SU1}}=.08$ and $M_{\text{SU2}}=6.78$, $SD_{\text{SU2}}=.10$), although the range was greater for White youth ($\text{Range}_{\text{SU}}=6-42$) compared to Black youth ($\text{Range}_{\text{SU1}}=6-20$ and $\text{Range}_{\text{SU2}}=6-32$). White and Black girls also had similar rates of dieting behavior, although rates were slightly higher for White girls ($M_{\text{DB1}}=11.22$, $SD_{\text{DB1}}=4.07$ and $M_{\text{DB2}}=11.28$, $SD_{\text{DB2}}=4.05$) compared to Black girls ($M_{\text{DB1}}=11.10$, $SD_{\text{DB1}}=4.25$ and $M_{\text{DB2}}=11.06$, $SD_{\text{DB2}}=4.38$). Independent samples t-test revealed that the differences in means for all variables by race were not statistically significant.

Path Analysis

A path model was used to test the hypotheses of the relationship between dieting behavior and substance use both concurrently and prospectively at each time period. The path model fit the data well, $\chi^2(2) = 86.66$, $p < .001$; CFI = .95; SMSR = .08. The model's low degrees of freedom created an artificially large RMSEA value of .15 even though χ^2 analysis was significant, therefore it was not interpreted as an indication of unacceptable model fit (Kenny, Kaniskan, & McCoach,

2011). For the total sample, examining the concurrent relationship between substance use and dieting behavior, a significant association was found between each variable at both time 1 ($b = .084, p < .001$) and time 2 ($b = .038, p = .007$). Among the total sample, time 1 dieting behavior also predicted later substance use ($b = .002, p = .009$) after controlling for time 1 substance use and grade at time 1. However, substance use was not found to predict later dieting behavior ($b = .147, p = .907$) after controlling for time 1 dieting behavior and grade at time 1.

Multigroup Analysis by Race

Multigroup analysis was used to stratify the model by race to test the second hypothesis examining whether the relationship between dieting behavior and substance use at each time point varied by race. The race-specific model fit the data well, $\chi^2(4) = 96.95, p < .001$; CFI = .94; SMSR = .08. Among White youth, prevalence of substance use and dieting behavior was similar to the full sample. Substance use and dieting behavior were significantly associated at both time points (time 1: $t = .300, b = .109, p < .001$; time 2: $t = .263, b = .050, p < .001$). Among the White sample dieting behavior at time 1 predicted substance use one year later ($b = .002, p = .008$). However, substance use at time 1 did not predict later dieting behavior ($b = -.009, p = .992$). For Black youth a different relationship was observed. The association between substance use and dieting behavior at both time points was not statistically significant ($t = -.024, b = -.006, p = .71$; $t = .044, b = -.005, p = .691$, respectively). Moreover, there were no significant prospective paths between the two variables. Substance use at time 1 did not predict later dieting behavior ($b = 1.963, p = .373$). Additionally, dieting behavior at time 1 did not predict later substance use ($b = .002, p = .095$).

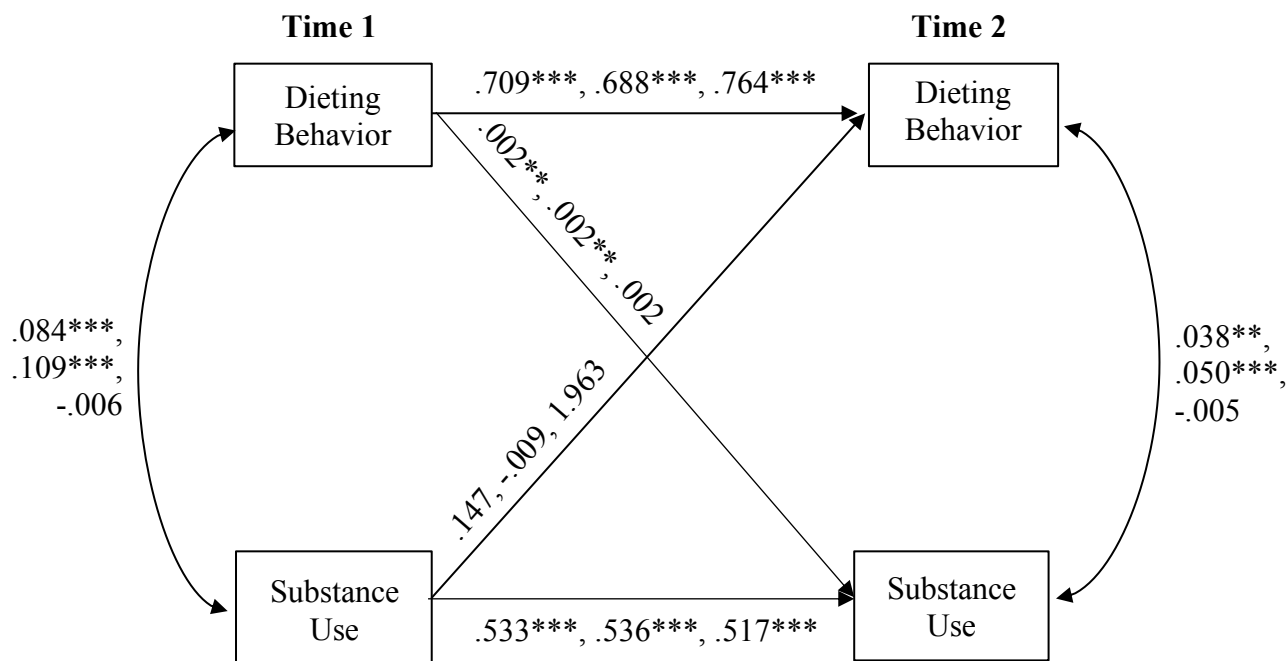


Figure 1: Cross-lagged panel design predicting the co-occurrence and temporal ordering of dieting behavior and substance use

Notes: Depiction of a path analysis representing the pathways for the association of dieting behavior and substance use first for the total sample, then Whites, then Blacks. Not included in the figure, for ease of presentation, are standardized betas, disturbance terms and error terms.

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

DISCUSSION

Dieting behavior and substance use are problematic issues that have been documented to be highly prevalent among adolescents, and females in particular (Brown, Skelton, Perrin, & Skinner, 2016; Neumark-Sztainer et al., 2002). Given the negative health consequences associated with both dieting behavior (Stachowitz et al., 2014; Larson et al., 2009) and substance use (Kaminer, 2016; Schulenberg et al., 2015; Volkow et al., 2014) across adolescence and into adulthood, understanding how these behaviors interact with each other is critical as such evidence can be used to inform intervention programming.

Path Model Between Dieting Behavior and Substance Use

Based on the problem behavior theory (Jessor & Jessor, 1977) it was hypothesized that dieting behavior and substance use would be positively correlated. Moreover, based on the dietary restraint model (Polivy & Herman, 1985) and previous studies (Krahn et al., 1996; Neumark-Sztainer et al., 2006), we hypothesized that each behavior would prospectively predict the other behavior over a 1-year time period. Our findings found partial support for these hypotheses with a significant concurrent association found at each time period, however only one prospective pathway was found: dieting behavior at time 1 significantly predicted substance use at time 2. The data did not support the opposite hypothesized pathway of substance use predicting later dieting behavior.

Our finding that dieting behavior predicts later substance use is consistent with the existing literature (Bulgin & Frederick Amar, 2016; Conway, Swendsen, Husry, He, & Merikangas, 2016; Harrop and Marlatt, 2010). However, the null effect of substance use on later dieting behavior, though consistent with the two prior studies examining the bidirectional relationship of dieting

behavior and substance use (Measelle et al., 2006; Stice et al., 2004), is inconsistent with the dietary restraint model (Polivy & Herman, 1985). There are some plausible explanations why a null effect between substance use and dieting behavior was found. First, the dietary restraint model suggests that the reasoning for the relationship between substance use and dieting behavior is due to intoxication and deficits in impulse control, however neither of these factors were explicitly examined in the current study. Thus, it is plausible that although youth reported their frequency of substance use, which was fairly low across both time-points, they were not asked to indicate frequency of intoxication. Moreover, in regard to impulse control, it is plausible that although a direct prospective relationship between substance use and dieting behavior was not found, an indirect effect through impulse control may be evident. However, impulse control was not examined in the current study and warrants further investigation.

Also, though the problem behavior theory does not theorize the temporal ordering of behaviors, it is based on the assumption that both behaviors are “problematic.” Thus, it is plausible that our findings of a null effect observed in the prospective effect of substance use and dieting behavior may suggest that dieting behaviors may not be “problematic” enough to be influenced by substance use. As stated previously, common problem behaviors included in studies that support the problem behavior theory are self-harm, risky sex, and substance use, which can be considered to have more immediate and immanent consequences than dieting behavior (Dawe & Loxton, 2004; Neumark-Sztainer et al., 1996). Given that these other problem behaviors are generally considered substantially more deviant, it may be more likely for youth to progress to such behaviors that pose comparable or greater risk than those, such as dieting behaviors, that pose less immediate risk. For example, a similar risk line of thought is used when discussing the gateway pathway for drug use, in that individuals tend to experiment with less risky substances before more

risky substances (Van Leeuwen et al., 2011). In a similar vein, dieting behavior leads to later substance use as it is a riskier behavior, whereas the opposite may be less likely to happen as dieting behavior may be presumed to be less risky than substance use.

These findings may suggest clinical implications in regard to addressing dieting behavior and substance use within intervention efforts. Given our finding of a prospective relationship between dieting behavior on later substance use, which is also consistent with several other studies (e.g., Bulgin & Frederick Amar, 2016; Conway et al., 2016; Harrop and Marlatt, 2010), suggests that prevention efforts aimed at reducing risk for both dieting behavior and substance use may be best addressed by focusing first on dieting behavior, as reducing dieting behavior risk can subsequently reduce risk for substance use. However, if focused less on prevention but addressing current engagement in either behavior, given evidence of positive concurrent associations between the two behaviors at each time point, findings suggest that focusing on one behavior may also reduce risk in the other. For example, Das, Salam, Arshad, Finkelstein, and Bhutta (2016) found that school-based primary prevention programs that include antidrug information combined with refusal skills, self-management skills, and social skills training were effective in reducing marijuana and alcohol use among adolescents as well as decreases in dieting. Such programs may also be enhanced by explicitly discussing material on dieting behavior in substance use programs and vice versa.

Multigroup Analysis by Race

The study's second aim was to examine whether the relationship between dieting behaviors and substance use were found across racial groups, specifically among non-Hispanic White and non-Hispanic Black females. Based on previous literature (Kann, 2016; Neumark-Sztainer et al., 2002), we predicted that White girls would have higher rates of substance use and higher rates of

dieting behavior. However, independent samples t-test revealed no significant differences between the means by race for all study variables. This indicates that in our sample frequency of engagement in dieting or substance use were not different by race.

That said, we did observe a significant concurrent association and a unidirectional effect from dieting behavior to later substance use only for White girls. Non-significant effects were found for both the concurrent and prospective relationships among Black females. However, the magnitude of the effect for the prospective relationship between dieting behavior and substance use for Black girls, though non-significant, was equivalent to the effect for White girls, which was statistically significant. This difference in significance levels with equivalent beta values suggests that the non-significant effect may be due to power, as White girls represented 2/3 of the total sample. Future research is warranted examining these relationships among Black girls with larger sample sizes.

Our findings also suggest that substance use and dieting are two independent problem behaviors among Black youth. As such, prevention efforts for one cannot be held to prevent the other behavior. However, we do believe that the problem behavior theory should still be held among this group although the hypotheses were not accepted. The literature suggests that Black girls do exhibit greater prevalence for other risky behavior, such as having sex and engaging in violence, than White girls (Blum et al., 2000). It could be that the interaction of problematic behavior might not include dieting behavior for Black girls, but instead included other problematic delinquent behavior that can increase vulnerability of substance use (Neumark-Sztainer et al., 2002). Also of note, a recent meta-analysis found that current substance use and problematic behavior programs are not adequately targeting specific predictors like gender, socioeconomic status, or race (Das, Salam, Arshad, Finkelstein, & Bhutta, 2016). Therefore, conducting

interventions for Black girls should involve culturally specific substance use prevention components.

In sum, a large body of the literature on dieting and substance use has primarily focused on White youth. The concern was if there was not an association between the two behaviors by race or if the pathways differed by race, prevention efforts for addressing these behaviors could be misguided. Our findings indicated that the observed relationships between dieting behavior and substance use was only observed among White female youth. Null effects were found for the concurrent and temporal ordering of dieting and substance use among Black girls, though the null effect for the prospective relationship may have been a byproduct of power. Thus, further research is needed on examining these relationships among larger nationally representative samples of Black youth. However, given the null effect for the concurrent associations, for Black girls there may be other factors that have a stronger association with substance use. Lastly, given that the current study only focused on the risk pathway for White and Black youth, future research is needed to examine this effect among other racial/ethnic minority groups compared to Whites.

Limitations

Although there are many benefits of this study that can have important implications for prevention of substance use and dieting behavior among adolescent populations, there are some limitations that should be noted. First, a composite for substance use was used rather than examining the effect of dieting behavior on a specific drug category. The use of a composite may have deflated the potential effect for Black girls given that they are less likely to use substances other than marijuana compared to White girls (Kann, 2016). Future studies could expand upon our findings by examining the relationship between dieting behavior and specific types of substance use that are more prevalent among Black communities.

Another limitation is the use of self-report data, which is subject to reporter-bias. Although students were told that their responses would be kept confidential, because the surveys were conducted while at school there is the possibility that students underreported their behaviors. However, previous research has found that adolescents appear to be the most valid reporters of their own behavioral difficulties (Cantwell, Lewinsohn, Rohde, & Steeley, 1997), reducing concerns regarding the use of self-report for the current study. Additionally, the study does not consider environmental factors that could potentially act as a third variable that momentarily impacted the study pool. For instance, the study was conducted in areas surrounding Flint, Michigan and may have included students that had recently been affected by high levels of lead in their water supply, which could induce neurocognitive impairment (DeWitt, 2017). Therefore, there is some possibility that the conclusions reached could potentially be impacted by the unclear timeline of water contamination that might have affected some participants and not others in another district. To address this limitation intraclass correlation coefficients were performed across both waves to see if there were any differences in the samples based on school and school district and it was determined to not be true. Finally, although an adequate sample size was obtained and our data suggests there were no significant differences between the groups, Black girls were much less represented than White girls which could have resulted in an inflated effect found among White girls due to their large sample. Future studies might find a comparable representative sample of Black youth and potentially match them with the sample of White youth to see if the relationship is inflated.

Future Directions

Findings from the current study can also be a catalyst for futures studies in the area of dieting behavior and substance use among adolescents. First, as noted above in regard to cognitions

regarding dieting and thinness, future studies might combine research on motives of dieting (i.e., thinness, risk taking, impulse control) with research on the co-occurrence of these behaviors across cultures. Second, it's possible that effects of dieting behavior on substance use or vice versa is developmentally anchored. Given evidence on increases in substance use (Johnston et al., 2012; Miech, Johnston, O'malley, Bachman, & Schulenberg, 2016) and dieting behavior (Krahn et al., 1996) across development, there might be a critical period when one behavior may have a stronger effect on the other. For the current study we used the full sample of youth from 4th grade to 12th grade and controlled for any potential variations in risk due to grade level. Thus, we may have found null findings simply because the effects were being cancelled out by the varying development effects between 4th grade and 12th grade. We explored this in our post hoc analysis stratifying the sample by grade into three groups: high school sample 9-11th grade at time 1 (78.4% White; 21.6% Black), middle school 6-7 grade at time 1 (79.2% White; 20.8% Black), and young group 4-8 grade at time 1 (77.1% White; 22.9% Black). Independent samples t-test were conducted and determined that there were no significant differences between the group means on any of the study variables.

We found interesting differences by race when stratifying the sample by grade, which suggests that the risk model may be developmentally specific. Among both the high school and middle school sample, null effects were found for the prospective relationship between dieting behavior and substance use and vice versa for both races (see Figure 2 and 3 for effect sizes). However, among the young group (grades 4-8) dieting behavior was found to predict later substance use among both White ($b = .002, p = .029$) and Black youth ($b = .002, p = .041$). Neither race group showed a significant prospective relationship of substance use and later dieting

behavior (White: $b = 1.364$, $p = .244$; Black: $b = 4.274$, $p = .168$, respectively). See Figure 4 for all effect sizes.

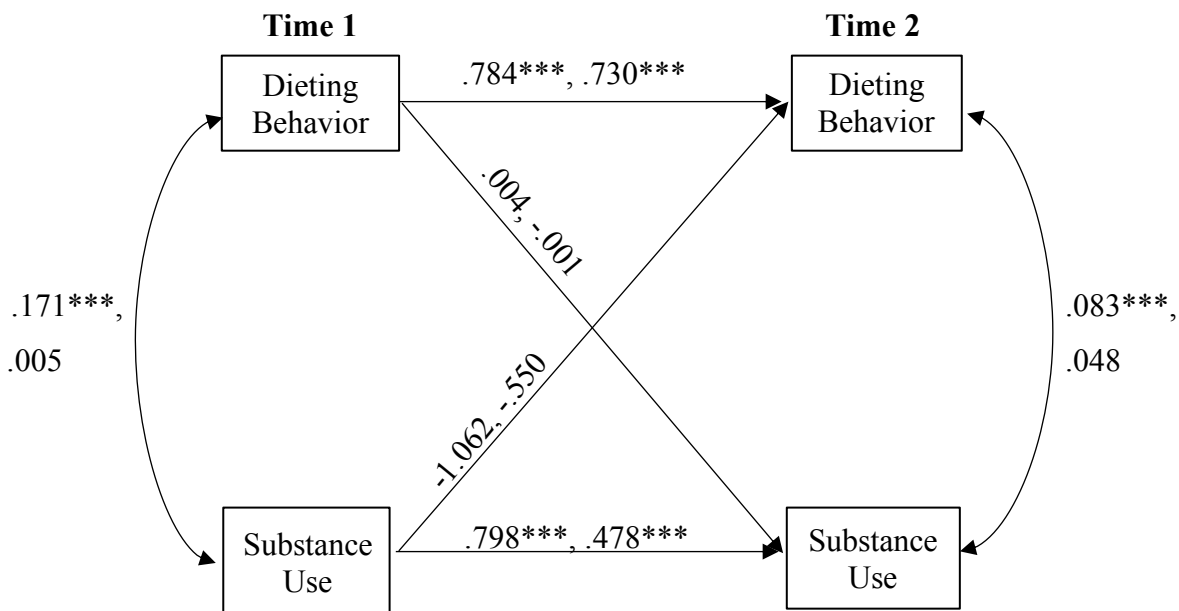


Figure 2: Post hoc cross-lagged panel design among high school subgroup

Notes: Depiction of a path analysis representing the pathways for the association of dieting behavior and substance use first for White youth then Black youth. Not included in the figure, for ease of presentation, are standardized betas, disturbance terms and error terms.

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

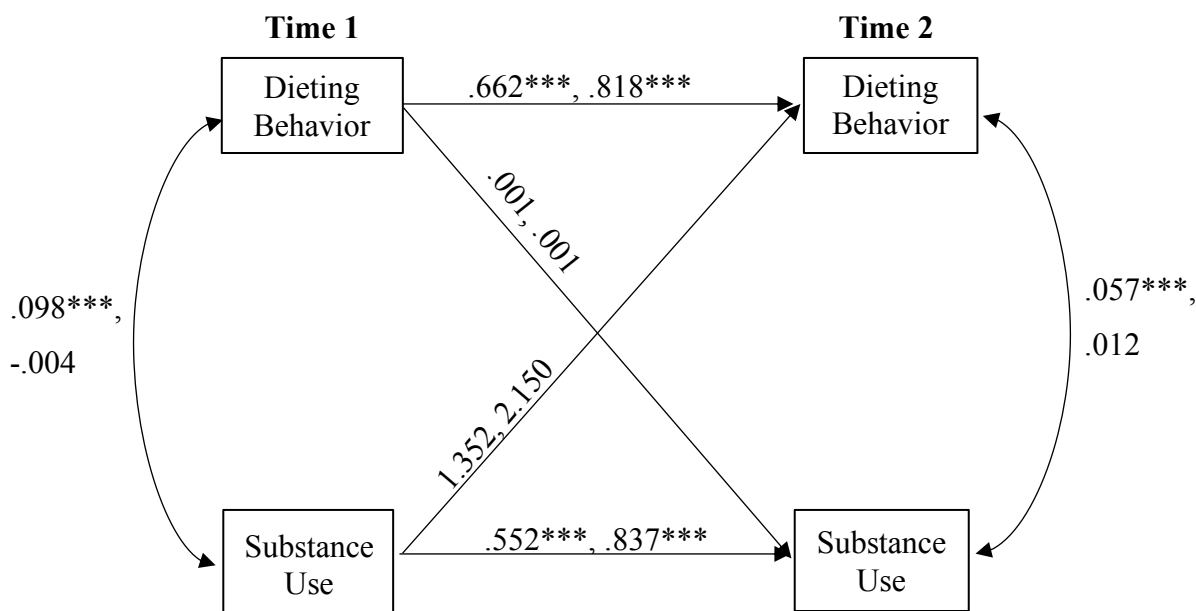


Figure 3: Post hoc cross-lagged panel design among middle school subgroup

Notes: Depiction of a path analysis representing the pathways for the association of dieting behavior and substance use first for White youth then Black youth. Not included in the figure, for ease of presentation, are standardized betas, disturbance terms and error terms.

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

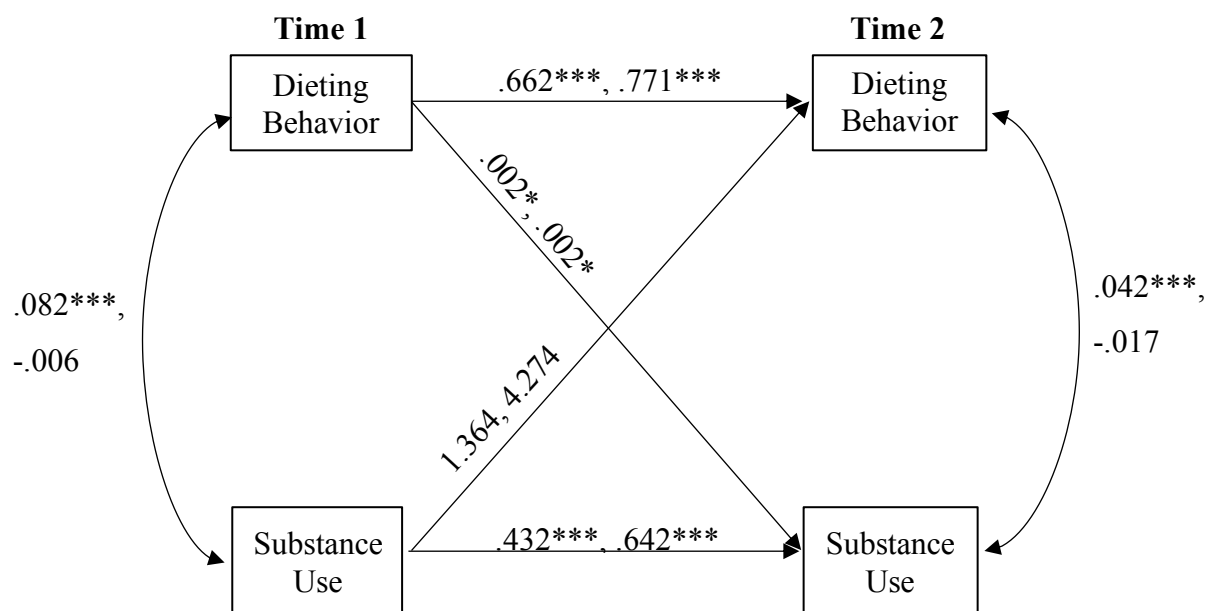


Figure 4: Post hoc cross-lagged panel design among young subgroup

Notes: Depiction of a path analysis representing the pathways for the association of dieting behavior and substance use first for White youth then Black youth. Not included in the figure, for ease of presentation, are standardized betas, disturbance terms and error terms.

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

We also looked specifically at the relationship between dieting behavior and substance use during the 8th grade year. Our analysis originally included 8th graders for time 1 in the sample of middle school group however, they were removed to better capture behavior during middle school even at time 2. When 8th graders were included in the middle school analysis we observed an effect of dieting behavior on later substance use for Black and White youth. However, when 8th graders were excluded from the model there was no relationship found for either race. This led us to consider whether 8th grade might be a critical time where this effect might be strongest in the present sample. After running the model among only 8th graders, we found that dieting behavior predicted later substance use among both White ($b = .007, p = .002$) and Black youth ($b = .010, p = .004$). As consistent with the full model we did not find a prospective relationship in which substance use predicted later dieting behavior (White: $b = 3.490, p = .127$; Black: $b = 6.944, p = .179$). This finding suggests that the transition to high school might be a critical time among both Black and White youth, where they are most vulnerable to the effects of dieting on substance use.

These grade differences suggest that while there are racial differences in the association between dieting and substance use, it's also important to consider how grade might impact this relationship. Previous studies have observed the relationship between dieting and substance use typically among adolescents aged 11-15 (Measelle et al., 2006; Neumark-Sztainer et al., 2006; Stice et al., 2004) and found similar effects, not stratified by race. However, no study has identified a specific developmental period that adolescents might be most vulnerable. Further research should be done to better understand the interaction of grade/age and race and when this effect may pose the greatest risk.

CONCLUSION

Although the prevalence rates of dieting behavior was high, substance use was low in the present sample. However, among the general population we are seeing upwards of 49% of adolescents engaging in at least one substance or alcohol use in the past year by 12th grade (Johnston et al., 2012). With support that dieting behavior predicts later substance use, our findings suggest that prevention efforts should focus on engagement in dieting behavior and its influence on substance use. Further, although our main analyses did not find an effect between dieting behavior and substance use among Black youth, this may be a byproduct of power. Moreover, our post-hoc analysis did suggest that the transition to high school makes both Black and White youth more vulnerable to engage in substance use as a consequence of dieting behavior. Therefore, further research is needed to confirm the effect of dieting behavior on substance use risk for Black girls with larger sample sizes, as well as examine whether risk varies based on developmental period. Such findings can help inform research on risk processes for White and Black girls across adolescence, and ultimately inform prevention programming to decrease risk and the long-term impact of both behaviors among at-risk youth.

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