ADJUSTMENT PROBLEMS, SLEEP, AND DISORDERED EATING ATTITUDES AND BEHAVIORS

By

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To my mother and father for their unconditional love and support, and to my brother for teaching me the value of humility and hard work
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TABLE OF CONTENTS

ACKNOWLEDGMENTS ............................................................................................................. 4
LIST OF TABLES ..................................................................................................................... 7
LIST OF FIGURES ................................................................................................................ 8
ABSTRACT .................................................................................................................................. 9

CHAPTER

1 INTRODUCTION ....................................................................................................................... 11
   Background ............................................................................................................................... 11
   The Current Study .................................................................................................................. 15

2 METHODS .............................................................................................................................. 17
   Participants and Procedures .................................................................................................. 17
   Measures ................................................................................................................................. 17
      Demographic Information .................................................................................................. 17
      Internalizing and Externalizing Symptoms ....................................................................... 18
      Disordered Eating Attitudes and Behaviors ...................................................................... 18
      Sleep Disturbance .............................................................................................................. 19
      Daytime Sleepiness ............................................................................................................ 19
   Data Analysis Plan .................................................................................................................. 20

3 RESULTS .................................................................................................................................. 22
   Descriptive Information and Covariate Testing .................................................................. 22
   Preliminary Analyses ............................................................................................................. 23
   Parallel Mediation Analyses ............................................................................................... 23
      Internalizing Symptoms ..................................................................................................... 23
      Externalizing Symptoms .................................................................................................... 24
   Moderated Mediation Analyses ........................................................................................... 24
      Internalizing Symptoms ..................................................................................................... 24
      Externalizing Symptoms .................................................................................................... 25

4 DISCUSSION ........................................................................................................................... 31
   Limitations ............................................................................................................................. 34
   Future Directions ................................................................................................................... 35
   Conclusion ............................................................................................................................... 36

LIST OF REFERENCES ............................................................................................................... 38
<table>
<thead>
<tr>
<th>Table</th>
<th>page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1</td>
<td>Means, Standard Deviations, and Correlations for Key Study Variables .......... 26</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1</td>
<td>The mediational effects of sleep-related problems on the relationship between internalizing symptoms and disordered eating</td>
<td>27</td>
</tr>
<tr>
<td>3-2</td>
<td>The mediational effects of sleep-related problems on the relationship between externalizing symptoms and disordered eating</td>
<td>28</td>
</tr>
<tr>
<td>3-3</td>
<td>The moderational effects of age on the indirect effect of internalizing symptoms on disordered eating through sleep-related problems</td>
<td>29</td>
</tr>
<tr>
<td>3-4</td>
<td>The moderational effects of age on the indirect effect of externalizing symptoms on disordered eating through sleep-related problems</td>
<td>30</td>
</tr>
</tbody>
</table>
Adjustment problems (internalizing and externalizing symptoms) increase risk for disordered eating; however, the mechanism through which these relationships occur remains unclear. Sleep-related problems may be a potential link as they are associated with emotional functioning, behavioral functioning and disordered eating. The present study first aims to examine the mediating roles of two sleep-related problems (sleep disturbance and daytime sleepiness) in the relationships between youth adjustment problems and disordered eating. Second, it aims to explore if age moderates these relations.

Participants were 225 youth (8-17 years) and legal guardians attending a primary care appointment. Participants completed questionnaires about youth disordered eating attitudes and behaviors, internalizing symptoms, externalizing symptoms, sleep disturbance, and daytime sleepiness. Mediation and moderated mediation analyses were utilized.

Daytime sleepiness was found to be a significant mediator in the relationship between internalizing symptoms and disordered eating regardless of age, while sleep disturbance was only a significant mediator in this relationship for youth <12 years old.
Similarly, daytime sleepiness was a significant mediator in the relationship between externalizing symptoms and disordered eating regardless of age, while sleep disturbance was only a significant mediator in this relationship for youth <10 years old. These final moderated mediation models explained 21% and 23%, respectively, of the variance in disordered eating. As sleep-related problems are frequently improved with the adaption of health behaviors conducive to good sleep, these results may suggest a relatively modifiable target to reduce youth risk for disordered eating.
CHAPTER 1
INTRODUCTION

Background

Disordered eating in youth is a major health concern with 9% of American adolescents meeting criteria for a specific eating disorder or an eating disorder not otherwise specified (Field et al., 2012; Swanson, Crow, Le Grange, Swendsen, & Merikangas, 2011). Moreover, subclinical disordered eating attitudes and behaviors (e.g., skipping meals, binging, excessive concern about shape and weight) are even more prevalent (Field et al., 2012; Neumark-Sztainer, Wall, Larson, Eisenberg, & Loth, 2011). Though disordered eating attitudes and behaviors peak in late adolescent to early adulthood, there is growing evidence of their occurrence at increasingly younger ages (Neumark-Sztainer et al., 2011). It is estimated that 28%-55% of girls and 17%-30% of boys (6-11 years) report wanting to be thinner (Ricciardelli & McCabe, 2001), and that 48.2% of girls and 34.8% boys (mean age 12.8 years) engage in unhealthy weight control behaviors, such as dieting, fasting, and purging (Neumark-Sztainer et al., 2011). These attitudes and behaviors in youth are concerning as they are associated with negative outcomes including obesity, additional psychopathology, and substance use (Field et al., 2012; Micali, Ploubidis, De Stavola, Simonoff, & Treasure, 2014).

Adjustment problems, such as internalizing and externalizing symptoms, are known predictors for disordered eating attitudes and behaviors (Herpertz-Dahlmann et al., 2008; Holm-Denoma, Hankin, & Young, 2014). Previous studies have consistently associated internalizing symptoms (e.g., symptoms of anxiety and depression) with disordered eating attitudes and behaviors cross-sectionally and longitudinally (Gardner, Stark, Friedman, & Jackson, 2000; Holm-Denoma et al., 2014; Swinbourne & Touyz,
Measelle, Stice, and Hogasen (2006) found depression in adolescent girls (12-19 years) predicted later disordered eating attitudes and behaviors but not vice versa. Similarly, Kaye and colleagues (2014) found that 42% of women with anorexia nervosa or bulimia nervosa reported developing one or more anxiety disorders in childhood and that the majority of those women indicated that their anxiety disorder onset predated their eating disorder.

In contrast to internalizing symptoms, the relationship between externalizing symptoms (e.g. symptoms of aggression and conduct problems) and disordered eating attitudes and behaviors has only recently gained attention (Slane, Burt, & Klump, 2010). Nevertheless, there is mounting evidence for externalizing symptoms playing a significant role in the development of disordered eating attitudes and behaviors in youth (Herpertz-Dahlmann et al., 2008; Marmorstein, von Ranson, Iacono, & Succop, 2007). For instance, Herpertz-Dalhmann and colleagues (2008) found parent-reported externalizing problems to be significantly greater in boys and girls (mean age 14.6 years) with disordered eating behavior than in their same age peers without disordered eating pathology. More compellingly, Marmorstein and colleagues (2007) evaluated these associations in a prospective cohort study following female twins from age 11 to 17. Their results revealed externalizing behavior to both predict and be predicted by dysfunctional eating attitudes and behaviors.

Despite disordered eating attitudes and behaviors being linked with both internalizing and externalizing symptoms, little is known about how these associations may present differently across age groups in youth. To our knowledge only one study has examined this question in the context of internalizing symptoms.
and no studies have yet evaluated this question in the context of externalizing symptoms. Holm-Denoma and colleagues (2014) found that the relationship between depression and eating pathology increased with age and was stronger in girls than in boys, while the relationship between anxiety and eating pathology remained consistent across age and gender. Thus, it appears that the association between youth internalizing symptoms and disordered eating attitudes and behaviors may differ systematically by age and gender. However, additional research is needed to clarify these patterns and to examine this question in regards to externalizing symptoms.

Research has also yet to evaluate the mechanisms through which adjustment problems increase risk for disordered eating attitudes and behaviors in youth. Sleep-related problems may be a potential link as they have substantial impacts on child development and eating behavior (Taheri, Lin, Austin, Young, & Mignot, 2004; Wheaton, Perry, Chapman, & Croft, 2013). It is estimated that 25-43% of youth experience a sleep-related problem during childhood (Owens, 2008). Children (9-12 years) more frequently report sleep disturbances (i.e. insomnia, nightmares, and somnambulism), while adolescents (13-16 years) are more likely to report subjective daytime sleepiness (i.e. feeling tired during the day; Alfano, Zakem, Costa, Taylor, & Weems, 2009; Shanahan, Copeland, Angold, Bondy, & Costello, 2014). Moreover, sleep disturbance and daytime sleepiness are both highly comorbid with internalizing and externalizing symptoms in youth (Gregory & Sadeh, 2012; Meltzer & Mindell, 2007; Owens, 2008). A recent study revealed youth (9-16 years) with a current diagnosis of depression, anxiety, oppositional defiant disorder or conduct disorder endorsed three
times more sleep problems, on average, than youth without a psychiatric diagnosis (Shanahan et al., 2014).

Sleep-related problems are also known to impact physiological and behavioral factors related to food consumption (Taheri et al., 2004). Further, recent studies have linked sleep-related problems to disordered eating attitudes and behaviors. Wheaton and colleagues (2013) found that short sleep duration (< 7 hours per night) was associated with greater use of unhealthy weight control behaviors in male and female adolescents. Additionally, Trace and colleagues (2012) found sleep disturbance, daytime sleepiness, sleep restriction, sleeping poorly, and problems falling asleep all positively correlated with binge eating in women (20-47 years).

Despite evidence of sleep-related problems impacting youth adjustment and eating behavior, few studies have evaluated how youth adjustment problems and sleep-related problems may work together to impact disordered eating attitudes and behaviors. To our knowledge, no studies have yet evaluated this potentially synergistic relationship in the context of externalizing symptoms and only Nguyen-Rodriguez, McClain, & Spruijt-Metz (2010) have examined this question in the context of internalizing symptoms in a sample children. They found anxiety, but not depression, mediated the relationship between sleep onset latency and emotional eating in minority children (8-12 years). In adults, Lombardo and colleagues (2014) found depression mediated the relationship between insomnia (i.e., > 4 weeks of non-restorative sleep and difficulty initiating or maintaining sleep) and disordered eating symptoms in women. However, their follow-up study using a sample of women with diagnosed eating disorders failed to fully support these findings and showed depression mediated the
associations between poor sleep and both drive for thinness and body dissatisfaction, but not the relationship between poor sleep and bulimia symptoms (Lombardo, Battagliese, Venezia, & Salvemini, 2015).

The Current Study

Although these studies provide support for internalizing symptoms and sleep-related problems working synergistically to impact disordered eating attitudes and behaviors, little is known for how sleep-related problems may contribute to the observed relationship between externalizing symptoms and disordered eating attitudes and behaviors. Further, the inconsistent results and dearth of research in youth highlight the need for further research in this area. Additionally, considering the high comorbidity between anxiety and depression (Axelson & Birmaher, 2001), the focus of previous studies on depression or anxiety individually may not fully capture the extent of these associations. Thus, the present study aims to evaluate these associations in youth using broadband measures of both internalizing and externalizing symptoms. We also aim to build on previous research by examining the unique mediating roles of two different types of sleep-related problems (sleep disturbance and daytime sleepiness) in the relationships between internalizing/externalizing symptoms and disordered eating attitudes and behaviors in youth. Finally, given age-based differences in these factors, this study seeks to explore how these associations present across school-age youth.

First, we hypothesize that sleep disturbance and daytime sleepiness will each uniquely mediate the association between youth internalizing symptoms and disordered eating attitudes and behaviors. We also expect a similar mediating effect of sleep disturbance and daytime sleepiness on the relationship between externalizing symptoms and disordered eating attitudes and behaviors. Second, based on previously
noted age-related differences in eating disturbances and sleep-related problems, we hypothesize that age will moderate these indirect effects. As young children report more sleep disturbance and adolescents report more daytime sleepiness (Alfano et al., 2009; Shanahan et al., 2014), we hypothesize that sleep disturbance will only be a significant mediator in these relations for young children while daytime sleepiness will only be a significant mediator in adolescents.
CHAPTER 2
METHODS

Participants and Procedures

A total of 225 youth, and their accompanying parent or legal guardian, were recruited to participate while attending a regularly scheduled pediatric primary acute or well care appointment. Data were taken from a larger study examining youth unhealthy eating and weight control behaviors. Overall, 409 eligible dyads were approached; 174 chose not to participate in the study after their clinic appointment due to time concerns; 10 agreed to participate but then withdrew or were later found ineligible.

Research staff approached eligible patients and caregivers after their clinic appointment. Youth were eligible if they were between the ages of 8 and 17, English-speaking, and accompanied by an English-speaking legal guardian. Youth were ineligible if they were diagnosed with short stature, intellectual disability, or a psychotic disorder. After completing informed consent and assent procedures, participating caregivers and youth separately completed questionnaire packets. A research team member was available to answer questions. Families were compensated with a $5 gift card for their time. The governing Institutional Review Board approved the larger study.

Measures

Demographic Information

Caregivers provided demographic information including family income, youth age, sex, and race. Youth height and weight measurements were obtained from participant’s electronic medical records either from that visit or the next most recent clinic visit.
**Internalizing and Externalizing Symptoms**

The Child Behavior Checklist (CBCL) was used to measure youth internalizing and externalizing symptoms (Achenbach, 2001). The CBCL is a 113-item parent-report measure of adjustment problems in youth between ages 4 and 18 years. For every item, parents rate their child’s behavior on a 3-point scale (Not True = 0; Somewhat or Sometimes True = 1; Very True or Often True = 2). Extensive reliability and validity data have been reported on the CBCL, including excellent internal consistency and test-retest reliability, a stable factor structure, and positive relations with other measures of childhood behavior (Dutra, Campbell, & Westen, 2004). The 32-item internalizing scale is the composite of the anxious/depressed (e.g., cries a lot; fears going to school), withdraw/depressed (e.g., unhappy, sad or depressed), and somatic complaints subscales (e.g., physical problems without known medical cause). The externalizing scale includes 35 items and is the composite of the rule-breaking behavior subscale (e.g., lying or cheating) and aggressive behavior subscale (e.g., argues a lot). The current study used t-scores; scores between 65 and 69 indicate borderline clinically impaired functioning; scores ≥ 70 indicate clinically impaired functioning. Cronbach’s alpha for the internalizing and externalizing scales for current study were .89 and .93 respectively.

**Disordered Eating Attitudes and Behaviors**

Youth reported disordered eating attitudes and behaviors were assessed with the 26-item Children’s Eating Attitudes Test (ChEAT; Maloney, McGuire & Daniels, 1998). Youth rate how often they engage in specific disordered eating attitudes and behaviors from four domains (dieting, restricting and purging, food preoccupation, and oral control) on a 6-point Likert scale from “Never” to “Always.” The present study used the total
score, which is the sum of all items. Higher scores reflect greater maladaptive eating attitudes and behaviors. Scores ≥20 are considered clinically elevated. The ChEAT has good internal reliability and concurrent validity with measures of body dissatisfaction and weight control behaviors (Smolak & Levine, 1994); Cronbach’s alpha in this sample was .76.

**Sleep Disturbance**

To assess youth sleep disturbance, parents completed the Sleep Disturbance Scale for Children (SDSC; Bruni et al., 1996). This 26-item measure assesses youth sleep problems in six domains: disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of arousal/nightmares, sleep-wake transition disorders, disorders of excessive somnolence, and sleep hyperhidrosis. Parents rate how frequently their child experienced specific sleep problems in the past six months using a 5-point Likert scale from “Never” to “Always/Daily.” The current study used the total sleep problem index (sum of all items). Higher scores reflect greater severity of sleep disturbance symptoms. The suggested cut off for significant sleep disturbance is 39. The SDSC has good test-retest reliability and concurrent validity with objective measures of sleep disturbance (Lewandowski, Toliver-Sokol, & Palermo, 2011); Cronbach’s alpha in this sample was .87.

**Daytime Sleepiness**

Youth-reported daytime sleepiness was measured with the 8-item Pediatric Daytime Sleepiness Scale (PDSS; Drake et al., 2003). Youth rate how often they experience specific sleep-related behaviors (e.g., fall asleep or get drowsy during class periods) on a 5-point Likert scale from “Never” to “Very Often/Always.” Items are summed for a total score with higher scores reflecting greater daytime sleepiness.
“Excessive daytime sleepiness” was defined as scores of >20 based on cutoffs used in previous studies (Moseley & Gradisar, 2009). The PDSS has excellent psychometric properties (Lewandowski et al., 2011); Cronbach’s alpha in this sample was .75.

**Data Analysis Plan**

Data were analyzed using IBM SPSS, Version 22.0. Imputation was used for missing data in main study variables. Descriptive statistics were calculated for demographic variables and key study variables. Correlational analyses between demographic variables and disordered eating attitudes and behaviors (ChEAT) were used to select covariates for subsequent analyses.

Pearson correlations were used to determine associations between internalizing symptoms, externalizing symptoms, sleep disturbance, daytime sleepiness, ChEAT and youth age. Two parallel mediation models and two moderated mediation models were conducted in the SPSS macro PROCESS (Hayes, 2012). Based on Aiken, West, and Reno (1991), all predictor variables were mean centered to reduce multicollinearity. The first parallel mediation model evaluated the indirect effects of youth internalizing symptoms on disordered eating attitudes and behaviors through sleep disturbance and daytime sleepiness. Then, the first moderated mediation model was used to evaluate if age moderated these associations. This process was repeated for the second parallel mediation model and second moderated mediation model, with externalizing symptoms replacing internalizing symptoms. The PROCESS macro uses non-parametric, bootstrap procedures (10,000 samples) to generate estimates of the sampling distribution for indirect and conditional indirect effects (Preacher & Hayes, 2004). Post-hoc probing was also conducted in the PROCESS macro using the Johnson-Neyman
technique to provide estimates of indirect effects at the 10\textsuperscript{th}, 25\textsuperscript{th}, 50\textsuperscript{th}, 75\textsuperscript{th}, and 90\textsuperscript{th} percentiles of the moderator.
CHAPTER 3
RESULTS

Descriptive Information and Covariate Testing

Youth \((n = 225)\) were between the ages of 8 and 17 \((M = 12.39, \ SD = 2.70)\); 55% of the sample was female; BMI z-scores were between -3.60 and 3.45 \((M = 0.91, \ SD = 1.22)\). The sample was 55% African American, 27% Caucasian, 10% bi-racial, 3% Hispanic, and 5% “other” or did not endorse a race. The median family income range was $20,000 to $29,000 with the majority of caregivers (79%) reporting an annual household income of <$40,000. Descriptive statistics for key study variables are recorded in Table 3-1. Of youth participants, 9% had ChEAT scores indicative of clinically significant disordered eating attitudes and behaviors, 51% had SDSC scores indicative of significant sleep disturbance and 20% had PDSS scores suggesting excessive daytime sleepiness. Additionally, 16% of youth participants had parent-reported scores on the CBCL internalizing scale at or above the borderline clinically impaired range, while 17% had parent-rated externalizing symptoms falling at or above the same borderline clinically impaired range.

Pearson correlations showed no associations between ChEAT scores and youth BMI z-score \((r = .12, \ p = .07)\) or family income \((r = -.07, \ p = .33)\). Youth race was dummy coded and a one-way ANOVA using Caucasian as the reference group revealed no differences in ChEAT scores across youth race, \(F(5, 218) = .17, \ p = .97\). An independent samples t-test revealed ChEAT scores to significantly differ across youth sex. Girls \((M = 11.09, \ SD = 9.25)\) endorsed greater disordered eating attitudes and behaviors than boys \((M = 9.39, \ SD = 6.00)\), \(t(222) = -2.53, \ p = .01\). Youth sex was included as a covariate in subsequent models.
Preliminary Analyses

Correlational analyses were conducted to examine the independent relationships between key study variables (see Table 1). Internalizing symptoms, externalizing symptoms, sleep disturbance, and daytime sleepiness were all significantly correlated. Greater internalizing symptoms and greater externalizing symptoms were both associated with greater sleep disturbance and greater daytime sleepiness. These variables were also significantly correlated with ChEAT scores, such that increases in internalizing symptoms, externalizing symptoms, sleep disturbance and daytime sleepiness were all independently associated with greater disordered eating attitudes and behaviors. Age was not significantly associated with any key study variables.

Parallel Mediation Analyses

Internalizing Symptoms

Results from first parallel mediation analysis revealed a significant overall model, $F(4, 204) = 11.57, p < .001$, and accounted for 18% of the variance in ChEAT scores (See Figure 3-1). Supporting our hypothesis, bootstrapped confidence intervals showed both sleep disturbance and daytime sleepiness independently mediated the association between internalizing symptoms and ChEAT scores. Holding daytime sleepiness constant, the indirect effect of internalizing symptoms on disordered eating attitudes and behaviors through sleep disturbance was $\beta_{ indirect} = .06, SE = 0.03, CI_{95}: 0.01 - 0.12$. Holding sleep disturbance constant, the indirect effect of internalizing symptoms on disordered eating attitudes and behaviors through daytime sleepiness was $\beta_{ indirect} = .03, SE = 0.01, CI_{95}: 0.01 – 0.07$. 
**Externalizing Symptoms**

Results from the second parallel mediation analysis revealed the overall model to also be significant, \( F(4, 204) = 12.95, p < .001, \) and accounted for 20% of the variance in ChEAT scores (See Figure 3-2). Bootstrapped confidence intervals of the indirect effects partially supported our hypothesis. They showed daytime sleepiness, but not sleep disturbance, to independently mediate the association between externalizing symptoms and ChEAT scores. Holding sleep disturbance constant, the indirect effect of internalizing symptoms on disordered eating attitudes and behaviors through daytime sleepiness was significant \( \beta_{\text{indirect}} = .04, SE = 0.02, CI_{95} : 0.01 - 0.08. \) Conversely, holding daytime sleepiness constant, the indirect effect of externalizing symptoms on disordered eating attitudes and behaviors through sleep disturbance was not significant \( \beta_{\text{indirect}} = .04, SE = 0.02, CI_{95} : 0.00 - 0.08. \)

**Moderated Mediation Analyses**

**Internalizing Symptoms**

The moderated mediation models examined the potential moderating role of age on these indirect effects. The first moderated mediation analysis model (see Figure 3-3) was significant overall, \( F(7, 201) = 7.67, p < .001, R^2 = .21. \) Results showed a significant interaction between youth age and sleep disturbance (\( \beta = -.04, SE = 0.02, p = .03 \)) when predicting ChEAT scores. There was no significant interaction between youth age and daytime sleepiness (\( \beta = -.00, SE = 0.03, p = .92. \)) This pattern was supported by bootstrapped confidence intervals for indexes of moderated mediation indicating a significant conditional indirect through sleep disturbance (\( CI_{95} : - 0.05 – - 0.01) \) but not through daytime sleepiness (\( CI_{95} : - 0.01 – 0.00). \) Post-hoc probing was used to examine bootstrapped confidence intervals of the conditional indirect effects at the 10\(^{th}\), 25\(^{th}\), 50\(^{th}\),
75th and 90th percentiles of age in our sample (8, 10, 12, 15 and 16 years, respectively). Findings revealed that the indirect effect of internalizing symptoms on ChEAT scores through sleep disturbance was significant only for youth aged 12 and under (CI95: 0.01 – 0.13). Thus, sleep disturbance only mediated the relationship between internalizing symptoms and disordered eating attitudes and behaviors in youth aged 12 and younger, while daytime sleepiness was a significant mediator across all ages.

**Externalizing Symptoms**

The second moderated mediation analysis model evaluated the role of age in the indirect effects of externalizing symptoms on ChEAT scores through sleep disturbance and daytime sleepiness (see Figure 3-4). This model was significant overall, \( F(7, 201) = 8.41, p < .001, R^2 = .23 \). There was a significant interaction between youth age and sleep disturbance (\( \beta = -.04, SE = 0.02, p = .03 \)) when predicting ChEAT scores, but results revealed no significant interaction between youth age and daytime sleepiness (\( \beta = -.00, SE = 0.03, p = .98 \)). This pattern was supported by bootstrapped confidence intervals for indexes of moderated mediation indicating a significant conditional indirect through sleep disturbance (CI95: - 0.04 – 0.01) but not through daytime sleepiness (CI95: - 0.01 – 0.01). Post-hoc probing was used to examine bootstrapped confidence intervals of the conditional indirect effects at the 10th, 25th, 50th 75th and 90th percentiles of age in our sample. Findings revealed the indirect effect of internalizing symptoms on ChEAT scores through sleep disturbance to only be significant for youth aged 10 and under (CI95: 0.03 – 0.16). Thus, sleep disturbance only mediated the relationship between externalizing symptoms and disordered eating attitudes and behaviors in youth aged ten and younger, while daytime sleepiness was a significant mediator across all ages.
Table 3-1. Means, Standard Deviations, and Correlations for Key Study Variables

<table>
<thead>
<tr>
<th>Disordered Eating Attitudes and Behaviors (ChEAT)</th>
<th>Child Behavior Checklist Internalizing (CBCL Int.)</th>
<th>Child Behavior Checklist Externalizing (CBCL Ext.)</th>
<th>Sleep Disturbance (SDSC)</th>
<th>Daytime Sleepiness (PDSS)</th>
<th>Youth Age</th>
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<tr>
<td>ChEAT</td>
<td>--</td>
<td>--</td>
<td></td>
<td></td>
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<tr>
<td>CBCL Int.</td>
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<td>--</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CBCL Ext.</td>
<td>0.28**</td>
<td>0.69**</td>
<td>--</td>
<td></td>
<td></td>
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<tr>
<td>SDSC</td>
<td>0.26**</td>
<td>0.58**</td>
<td>0.48**</td>
<td>--</td>
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<tr>
<td>PDSS</td>
<td>0.37**</td>
<td>0.16*</td>
<td>0.21**</td>
<td>0.21**</td>
<td>--</td>
</tr>
<tr>
<td>Youth Age</td>
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<td>0.04</td>
<td>-0.07</td>
<td>0.01</td>
<td>-0.02</td>
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<tr>
<td>(M)</td>
<td>9.86</td>
<td>52.68</td>
<td>51.90</td>
<td>41.93</td>
<td>14.89</td>
</tr>
<tr>
<td>((SD))</td>
<td>(8.03)</td>
<td>(12.38)</td>
<td>(12.21)</td>
<td>(11.30)</td>
<td>(6.52)</td>
</tr>
</tbody>
</table>

Note. * \(p < .05\). ** \(p < .01\)
Figure 3-1. The mediational effects of sleep-related problems on the relationship between internalizing symptoms and disordered eating attitudes and behaviors when controlling for youth sex. The first path between internalizing symptoms and disordered eating attitudes and behaviors is before sleep disturbance and daytime sleepiness are added. The second path is the sleep disturbance and daytime sleepiness in the model. Unstandardized B weights are reported. *p<.05. **p<.01.
Figure 3-2. The mediational effects of sleep-related problems on the relationship between externalizing symptoms and disordered eating attitudes and behaviors when controlling for youth sex. The first path between externalizing symptoms and disordered eating attitudes and behaviors is before sleep disturbance and daytime sleepiness are added. The second path is the sleep disturbance and daytime sleepiness in the model. Unstandardized B weights are reported. *p<.05. **p<.01.
Figure 3-3. The moderational effects of age on the indirect effect of internalizing symptoms on disordered eating attitudes and behaviors through sleep-related problems when controlling for youth sex. The first path between internalizing symptoms and disordered eating attitudes and behaviors is before sleep disturbance, daytime sleepiness and age are added. The second path is the sleep disturbance, daytime sleepiness and age in the model. Unstandardized B weights are reported. *p<.05. **p<.01.
Figure 3-4. The moderational effects of age on the indirect effect of externalizing symptoms on disordered eating attitudes and behaviors through sleep-related problems when controlling for youth sex. The first path between externalizing symptoms and disordered eating attitudes and behaviors is before sleep disturbance, daytime sleepiness and age are added. The second path is the sleep disturbance, daytime sleepiness and age in the model. Unstandardized B weights are reported. *p<.05. **p<.01.
The current study examined the potential mediating effects of sleep-related problems in the relationships between youth adjustment problems and disordered eating attitudes and behaviors. Previous research has linked sleep-related problems with internalizing symptoms, externalizing symptoms and disordered eating attitudes and behaviors in youth. However, to our knowledge, this is the first study to evaluate whether youth sleep-related problems function as mediating variables between youth adjustment problems and disordered eating attitudes and behaviors.

As expected, our preliminary analyses revealed internalizing symptoms, externalizing symptoms, sleep disturbance and daytime sleepiness to all be independently, positively correlated with disordered eating attitudes and behaviors in our sample. These results are consistent with previous literature and further support adjustment and sleep-related problems being notable risk factors for disordered eating attitudes and behaviors in youth (Herpertz-Dahlmann et al., 2008; Holm-Denoma et al., 2014; Wheaton et al., 2013). Surprisingly, age was not associated with disordered eating attitudes and behaviors in our sample. This finding is inconsistent with the majority of previous research showing rates of disordered eating to increase throughout adolescence (Swanson et al, 2011; Neumark-Sztainer et al., 2011). This lack of association may be related to the differences in measures used between studies. Specifically, the current study used a global measure of disordered eating attitudes and behaviors (ChEAT), while previous studies have frequently examined specific disordered eating behaviors (i.e., diet pills, laxative use, vomiting or diuretics). This rationale is further supported by results from another recent study which found rates of
these attitudes and behaviors, as measured by the ChEAT, to be inversely related to age in sample of overweight youth (ages 8-12; Gowey, Lim, Clifford, & Janicke, 2014).

Our parallel mediation hypotheses were partially supported. As expected, mediation analyses revealed daytime sleepiness to independently mediate the relationships between both internalizing and externalizing symptoms and disordered eating attitudes. Conversely, results showed sleep disturbance to only independently mediate the relationship between internalizing symptoms and disordered eating attitudes and behaviors, but not the relationship between externalizing symptoms and disordered eating attitudes and behaviors. The parallel mediation models explained 18% and 20% of the variance, respectively, in youth disordered eating attitudes and behaviors. These results may be related to our measures of adjustment problems (CBCL) and of sleep disturbance (SDSC) being parent-report, while our measures of daytime sleepiness (PDSS) and of disordered eating attitudes and behaviors (ChEAT) were youth self-report. Parents have been shown to frequently rate their offspring as having fewer sleep-related problems than youth endorse on self-report measures (Smedje, Broman, & Hetta, 2001). Further, Paavonen and colleagues (2002) found internalizing symptoms correlated with both parent- and youth-report of sleep-related problems, while externalizing symptoms were only related to youth-report.

When age was included as a moderator of these relations, our final moderated mediation models accounted for 21% and 23% of the variance in disordered eating attitudes and behaviors, respectively. These analyses partially supported our moderated mediation hypotheses. As expected, sleep disturbance was only a significant mediator in the relationships between both internalizing and externalizing symptoms and
disordered eating attitudes and behaviors in younger youth. This role of sleep disturbance in these relationships may be related to sleep disturbances being more prevalent in children than in adolescents (Alfano et al., 2009; Shanahan et al., 2014). This pattern may also be related to the SDSC being a parent-report measure. Parents may be more aware of sleep disturbance in younger children due to increased monitoring and younger children being more likely to awaken their parents. In turn, this increased awareness may put parents at risk for underreporting sleep disturbance in adolescents.

In contrast, consistent with previous research linking daytime sleepiness with both emotional and behavioral functioning in youth (Gregory & Sadeh; Smedje et al., 2001), moderated mediation analyses revealed daytime sleepiness to mediate the relationships between both internalizing and externalizing symptoms and disordered eating attitudes and behaviors across all ages in our sample. The consistent role of daytime sleepiness as a mediator in these relationships may be related to its association with higher rates of impulsive behavior and executive functioning deficits (Owens, 2008). Though youth with adjustment problems are at greater risk for disordered eating attitudes and behaviors, it is possible that this risk is only realized when youth are less able to effectively modulate their behaviors. These results may also be related to fatigue being a central symptom of depression (American Psychiatric Association, 2013); as internalizing symptoms include both symptoms of anxiety and depression, youth with internalizing symptoms may be at higher risk for feeling sleepy during the day in addition to any fatigue associated with sleep disturbance specifically. This pattern of indirect effects is also notable as it provides further support for recent
research showing daytime sleepiness to be a distinct predictor of poorer daytime functioning, separate from sleep disturbance (Anders, Iosif, Schwichtenberg, Tang, & Goodlin-Jones, 2012). This conceptualization is in contrast to previous studies that describe daytime sleepiness as an outcome of sleep disturbance (Tan, Healey, Gray, & Galland, 2012). Moreover, results from the current study suggest that the roles of these sleep-related problems in the relationships between youth adjustment problems and disordered eating attitudes and behaviors differ despite previous research linking both of these sleep-related problems with greater disordered eating attitudes and behaviors (Trace et al., 2012; Wheaton et al., 2013).

Taken together, results from this study suggest that both daytime sleepiness and sleep disturbance may be mechanisms through which youth adjustment problems increase risk for disordered eating attitudes and behaviors. Further, it appears that the role of sleep disturbance in these relationships is dependent on age. Clinically, these findings suggest that interventions targeting youth internalizing/externalizing symptoms as a means of reducing risk for disordered eating attitudes and behaviors may be rendered more effective by incorporating treatment approaches to reduce sleep-related problems. As sleep-related problems can frequently be improved with the adoption of health behaviors conducive to good sleep (Tan et al., 2012), this may be a relatively modifiable target for health care providers to reduce youth risk for disordered eating attitudes and behaviors.

**Limitations**

Several limitations should be considered in the context of these results and should inform future research. First, while mediation analyses suggest directionality (i.e., sleep-related problems being a potential mechanism through which adjustment
problems increase risk for disordered eating attitudes and behaviors), the current study's cross-sectional design limits the ability to draw conclusions about the directional nature of these relationships. Second, all measures were subjective, which makes our findings liable to reporting bias. However, despite this limitation, the rates of clinically significant symptoms in our sample were comparable to general population estimates: disordered eating attitudes and behaviors (9%), internalizing symptoms (16%), externalizing symptoms (17%), sleep disturbance (51%) and daytime sleepiness (20%; Field et al., 2012; Kessler, Petukhova, Sampson, Zaslavasky, & Wittchen, 2012; Owens, 2008; Swanson et al., 2011). Additionally, our measure of sleep disturbance (SDSC) includes two overlapping items with our measure of daytime sleepiness (PDSS). Finally, while our sample was both ethnically and socioeconomically diverse, participant's voluntary choice to participate may have created a unique, biased sample.

**Future Directions**

Results from the current study provide preliminary support for sleep-related problems being a potential target for intervention to reduce youth risk for disordered eating attitudes and behaviors. Future research is warranted to address these limitations and further explore these relationships. First, as the sleep measures used in the current study were relatively broad self-report measures, future research should aim to corroborate these relationships using objective measures of sleep (i.e. actiwatches). Objective measures like actiwatches would allow researchers to measure specific components of sleep disturbance such as sleep onset latency, sleep efficiency, total sleep time, and frequent night awakenings. These distinct measurements would, in turn, enable future studies to evaluate if the results from the current study are in fact related to sleep disturbance overall, or if they might be better explained by specific components
of sleep disturbance or potentially short sleep duration. Second, adjustment problems have been shown to both predict and be predicted by sleep-related problems. Thus, future studies should evaluate the possibility of bidirectional influences by examining potential moderational relationships among youth adjustment problems and sleep-related problems when predicting disordered eating attitudes and behaviors. Further, longitudinal designs following youth as they age through adolescence would allow for more advanced statistical methods to better clarify the temporal relationship among these variables in youth. For instance, multilevel modeling would enable researchers to evaluate whether adjustment problems preclude sleep-related problems, and under what circumstances, or for which persons, these relationships occur. Finally, if follow-up studies continue to reveal sleep-related problems mediating the relationships between youth adjustment problems and disordered eating attitudes and behaviors, research is warranted to develop and evaluate the efficacy of interventions targeting sleep-related problems as a means of reducing disordered eating attitudes and behaviors in youth.

**Conclusion**

In sum, sleep disturbance and daytime sleepiness may be mechanisms through which adjustment increase risk for disordered eating attitudes and behaviors in youth. This study also suggests that the mediating roles of specific sleep-related problems change based on age. Though no causal relationships can be established based on these findings, this study provides promising support for a potentially modifiable target for healthcare providers to reduce disordered eating attitudes and behaviors in youth. Notably, while these models accounted for over 20% of the variance in disorder eating attitudes and behaviors, a significant amount of variance remains to be explained. Future studies should continue to investigate these relationships using longitudinal
designs and objective measures for sleep. Further research is also warranted to evaluate the role of sleep-related problems within the context of other risk factors for disordered eating attitudes and behaviors such as social and family functioning.
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

Marie L. Chardon graduated summa cum laude from Bucknell University in 2012 with Bachelor of Arts degrees in psychology and French. She then worked as a research assistant and project coordinator in a developmental psychology lab for two years prior to coming to the University of Florida in August 2014. She is currently a graduate student in the Department of Clinical and Health Psychology doctoral program at the University of Florida, with a concentration in pediatric psychology. She received her Master of Science degree from the University of Florida in the spring of 2016.