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Peer Victimization and Adolescent Adjustment: The Moderating Role of Sleep

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Abstract

The present study examined multiple indices of sleep as moderators of the association between peer victimization and adjustment among typically developing adolescents. Participants included 252 adolescents ($M = 15.79$ years; 66% European American, 34% African American) and their parents. A multi-method, multi-informant design was employed to address the research questions. Sleep was assessed objectively with actigraphy (sleep minutes and sleep efficiency) and subjectively with self-reports. Adolescents reported on peer victimization and internalizing symptoms. Externalizing behaviors were examined with mother and father reports. Subjective sleep/wake problems moderated the associations between peer victimization and internalizing and externalizing symptoms. A stronger relation emerged between peer victimization and internalizing symptoms among adolescents who reported higher versus lower levels of sleep/wake problems. Adolescents with elevated sleep/wake problems had higher levels of externalizing symptoms across the range of peer victimization. However, for those with fewer sleep/wake problems, a positive relation between peer victimization and externalizing symptoms was observed. Actigraphy-based sleep minutes and sleep efficiency also moderated the relations between peer victimization and internalizing symptoms. Although peer victimization was associated with higher levels of internalizing symptoms for all youth, those who reported the lowest levels of such symptoms had longer and more efficient sleep in conjunction with low levels of peer victimization. Findings are novel and highlight the importance of considering both bioregulatory processes and peer relations in the prediction of adolescents' adjustment.

Keywords

peer victimization; sleep; internalizing; externalizing; adolescence

Peer Victimization and Adolescent Adjustment: The Moderating Role of Sleep

Experiences of peer victimization are often accompanied by internalizing (Reijntjes, Kamphuis, Prinzie, & Telch, 2010) and externalizing (Reijntjes et al., 2011) symptoms. However, the effects of peer victimization are not uniform, and prior studies have

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documented the protective or vulnerability functions of interpersonal factors such as friendships (Tu, Erath, & Flanagan, 2012) and parent-child relationships (Yeung & Leadbeater, 2010), as well as individual factors such as coping strategies (Kochenderfer-Ladd & Skinner, 2002) and physiological reactivity (Gregson, Tu, & Erath, 2014; Rudolph, Troop-Gordon, & Granger, 2010). Adopting a biopsychosocial approach that considers the interplay among bioregulatory, psychological, and social factors (El-Sheikh, Tu, Erath, & Buckhalt, 2014), the present study examined the moderating role of sleep in the association between peer victimization and internalizing and externalizing symptoms in typically developing adolescents.

Sleep problems are associated with a wide range of adjustment problems in adolescents (for reviews see Sadeh, Tikotzky, & Kahn, 2014, and Shochat, Cohen-Zion, & Tzischinsky, 2014), and could influence the extent to which peer victimization experiences affect youth adaptation. A newly emerging literature is highlighting the important role of sleep duration and quality as moderators of risk that could amplify or reduce the effects of familial and socioeconomic risk on youths' adjustment problems (Bernier, Bélanger, Tarabulsky, Simard, & Carrier, 2014; Lemola, Schwarz, & Siffert, 2012). This study builds on this growing literature and constitutes a novel assessment of whether sleep functions as a vulnerability or protective factor for adolescents' adjustment problems in the context of peer victimization. Sleep problems are indicated by shorter sleep duration (examined with actigraphy) and worse sleep quality (actigraphy-based efficiency and subjective problems) examined on a continuum. The inclusion of multiple sleep parameters (Astill et al., 2012; Sadeh et al., 2014) and the use of a multi-method approach to assess sleep are warranted and consistent with best practices (Sadeh, 2011a, 2015).

Peer Victimization and Adolescent Adjustment

Heightened levels of peer victimization, or experiences of physical, relational, or verbal aggression from peers, are often reported around the transition to adolescence (Nansel et al., 2001). Although a smaller percentage of youth experience chronic and frequent victimization, many youth experience at least occasional victimization (Wang, Iannotti, & Nansel, 2009). Furthermore, youth often report concerns about being bullied at school by other students (Anderson et al., 2000). Experiences of peer victimization can be particularly distressing during adolescence given the value that adolescents place on peer relationships and gaining peer group acceptance (Brown & Braun, 2013).

Maltreatment from peers has been linked with feelings of humiliation and anxiety (Nishina & Juvonen, 2005), as well as more negative self-evaluations and lower self-esteem (Reijntjes et al., 2010), which can contribute to youths' internalizing symptoms. Indeed, meta-analyses indicate concurrent (effect sizes r s ranged from .14 to .29, p s < .01 as reported in Hawker & Boulton, 2000) and longitudinal (effect size $r = .18$, $p < .001$ as reported in Reijntjes et al., 2010) effects of peer victimization on youths' internalizing symptoms. Peer victimization also predicts increases in externalizing symptoms over time (effect size $r = .14$, $p < .001$ as reported in Reijntjes et al., 2011), as maltreatment from peers may elicit feelings of anger or desires to retaliate against aggressors (Kochenderfer-Ladd, 2004). Collectively, these findings indicate that peer victimization is associated with both

internalizing and externalizing problems among adolescents. Nevertheless, the effects of peer victimization are heterogeneous and not all adolescents exposed to such victimization experience adjustment problems.

Adolescent Sleep and Adjustment

During adolescence, sleep problems, such as short duration and poor quality sleep, are common due to maturational changes in circadian rhythms that alter adolescents' sleep-wake patterns as well as increased social and academic time demands (Brand & Kirov, 2011; Crowley, Tarokh, & Carskadon, 2014). Recent research provides ample evidence that sleep problems (e.g., shorter duration, worse quality) are associated with internalizing and externalizing problems (for reviews see Astill et al., 2012 and Sadeh et al., 2014), as well as poor emotion regulation (Baum et al., 2014; Gruber, Cassoff, Frenette, Wiebe, & Carrier, 2012). Reflective of the key role that sleep plays across multiple facets of adaptation, sleep problems have also been associated with cognitive and academic problems (Astill et al., 2012; Beebe, 2011); disruptions in central nervous system activity (Walker & van Der Helm, 2009) including prefrontal cortex (PFC) processes (Dahl, 1996; Jones & Harrision, 2001); altered hypothalamic-pituitary-adrenal responses (e.g., increases in cortisol levels; El-Sheikh et al., 2008); less optimal autonomic nervous system activity (El-Sheikh, Erath, & Bagley, 2013); and interfere with adaptive coping strategies (Killgore et al., 2008).

In addition to direct associations with adjustment, sleep problems may exacerbate, and more optimal sleep may protect against, adolescents' internalizing and externalizing problems in the context of stress. The aforementioned links between sleep and multiple aspects of functioning (e.g., disruption of central or autonomic nervous system activity) may partially explain the moderating role of sleep because these systems and processes have ramifications for adjustment in the context of stress. The role of sleep as a moderator is growing in the family stress literature, but has yet to be examined in the peer context.

There are several moderation effects supportive of cumulative risk (Evans, 2003; Rutter, 1993) and dual-risk (Sameroff, 1983) perspectives, in which individuals may have a vulnerability that increases risk, or a protective factor that reduces risk, in the context of an environmental stressor. For instance, shorter sleep or reduced quality sleep (assessed subjectively and objectively) exacerbated the effects of marital conflict (Lemola et al., 2012) and parental psychological control (El-Sheikh, Hinnant, Kelly, & Erath, 2010) on youths' externalizing and internalizing problems, respectively. In contrast, better sleep quality attenuated the effects of maternal psychological control on youths' internalizing symptoms among a subsample of children from higher socioeconomic backgrounds (El-Sheikh et al., 2010). Thus, in line with studies examining family stress (El-Sheikh et al., 2010; Lemola et al., 2012), and consistent with dual or cumulative risk perspectives, worse sleep may potentiate associations between the stress of exposure to peer victimization and maladjustment. Conversely, youth with better sleep may be able to more effectively manage the emotional distress (e.g., El-Sheikh & Kelly, 2011; Killgore et al., 2008) associated with peer maltreatment, reducing their risk for maladjustment.

Yet, findings from other studies are consistent with the dual-protection model or protective-reactive moderating process (Luthar, Cicchetti, & Becker, 2000), in which a protective

attribute appears to be beneficial in the context of low risk, but not high risk. Indeed, longer and better quality sleep in conjunction with high levels of maternal sensitivity (Bordeleau, Bernier, & Carrier, 2012) or low parental psychological control (El-Sheikh, Tu, Erath, & Buckhalt, 2014) was associated with lower levels of adjustment problems (internalizing, externalizing) and higher levels of cognitive functioning, respectively. Therefore, it is also possible that better sleep may be more protective in the context of low but not high levels of peer victimization.

The Present Study

Contemporary developmental perspectives propose that among youth exposed to social stressors, biological processes can condition the effects on adjustment outcomes (El-Sheikh et al., 2009; Steinberg & Avenevoli, 2000). Further, growing empirical evidence is supporting the moderating role of sleep in several contexts of risk (e.g., Bordeleau et al., 2012; El-Sheikh, Hinnant et al., 2010; El-Sheikh, Tu et al., 2014; Lemola et al., 2012). Towards explication of vulnerability and protective factors, we examined objective and subjective sleep parameters as moderators of associations linking adolescent-reported peer victimization with adolescent-reported internalizing and parent-reported externalizing symptoms.

As noted, two patterns of moderation have tended to emerge in the literature regarding the role of sleep in contexts of risk, namely cumulative or dual-risk (Evans, 2003; Sameroff, 1983) and dual-protection or protective-reactive moderating process (Luthar et al., 2000). Thus, it is possible that, in line with cumulative risk, sleep problems (shorter duration, poorer quality) may function as vulnerability factors for greater maladjustment, whereas better sleep (longer duration, higher quality) may partially protect against adjustment problems, in the context of peer victimization. Further, consistent with dual-protection or protective-reactive moderation effects, it is also plausible that better sleep may confer protection against adjustment problems in the context of low versus high levels of peer victimization. We had no specific hypotheses about which pattern(s) of moderation effects would be observed.

Method

Participants

Families participated in four waves of data collection as part of the Family Stress Study examining relations between family functioning and youth development from childhood to adolescence. Data for the current study comes from the fourth wave (data collected in 2012–2013), and peer victimization and actigraphic sleep measures were only available at this wave. Participants were recruited through flyers distributed to three elementary school systems in the Southeastern United States at the first wave (data collected in 2005). Exclusion criteria included a diagnosis of attention deficit hyperactivity disorder, developmental delays, or a chronic illness. Eligibility criteria required parents to have been living together for at least two years.

At Time 1 (T1), participants included 251 school-aged children. Of children who participated at T1, 79% ($N = 199$) participated at T4 (93 boys, 106 girls; 64% European American and 36% African American; M age = 15.78 years, $SD = .82$). Due to a 5 year lag between the third and fourth wave of data collection and loss of participants (e.g., unable to contact families), an additional 53 families were recruited from the same school systems as the original sample to participate in the fourth study wave. These participants (25 boys, 28 girls; 74% European American, 26% African American; M age = 15.83 years, $SD = .78$) were recruited through the same methods, using the same exclusion/inclusion criteria, and from the same schools as T1 participants. No differences on demographics or primary study variables were found between participants who were recruited at T1 compared to T4. Thus, the final analytic sample was composed of 252 adolescents (118 boys, 134 girls; 66% European American, 34% African American; M age = 15.79 years, $SD = .81$).

According to their income-to-needs ratio (annual family income divided by federal poverty threshold for a given family size; U.S. Department of Commerce; www.commerce.gov), families in the current wave were from a wide range of socioeconomic backgrounds.

Approximately 14% of families were living in poverty (ratio < 1); 28% near the poverty line (ratio > 1 and < 2), 22% lower middle class (ratio > 2 and < 3), and 36% middle class (ratio > 3). A majority (58%) of adolescents lived with both biological parents, 24% lived with one biological parent and step-parent/partner, 14% lived in a single-parent household, and 4% lived with a legal guardian(s).

Procedure

The study was approved by the university's institutional review board. Consent and assent for participation were obtained from parents and adolescents, respectively. This study is part of a longitudinal investigation and only pertinent procedures are presented. Objective sleep data were collected with actigraphs delivered to the participants' homes during the regular school year, excluding holidays. Actigraphs were worn on adolescents' non-dominant wrist at bedtime for seven consecutive nights. A researcher called nightly to remind adolescents to complete the sleep diary, which was used to corroborate actigraphy data (Acebo & Carskadon, 2001). Nights during which medication was used (reported in sleep diary) were excluded from actigraphy analyses. On average, participants visited the lab 3.96 days ($SD = 12.25$) following the last night of actigraphy, and 79% of adolescents visited the university laboratory the day following the last night of actigraphy.

During the laboratory visit, parents and adolescents completed questionnaires. Adolescents' height (cm) and weight (kg) were measured in the laboratory with the Tantia digital weight scale and wall-mounted stadiometer (Arlington Heights, IL) to compute body mass index (BMI). Standardized BMI scores (zBMI) were calculated using participants' height, weight, sex, and age from a program provided by the Centers for Disease Control (2007).

Measures

Peer victimization—Adolescents completed the 9-item Social Experiences Questionnaire (SEQ; Crick & Grotpeter, 1996; Cullerton-Sen & Crick, 2005). Physical (e.g., "How often

do you get hit by another kid at school?") and relational (e.g., "How often have other kids said mean things about you to keep other people from liking you?") victimization items were assessed on a 5-point scale (1= *almost never* to 5= *almost always*) and averaged. Reliability and validity of the SEQ have been established with adolescents (Storch, Crisp, Roberti, Bagner, & Masia-Warner, 2005). In the current study, $\alpha = .88$.

Objective sleep—Sleep parameters were obtained using Motionlogger Octagonal Basic actigraphs (Ambulatory Monitoring Inc., Ardsley, NY). Actigraphy provides an objective and reliable method for deriving sleep duration and quality indices, particularly when multiple consecutive nights of actigraphy are obtained (Acebo et al., 1999). Scores for each epoch were determined with Sadeh's scoring algorithm (Sadeh, Sharkey, & Carskadon, 1994). On average, 5.44 nights ($SD = 1.77$) of valid actigraphy data were available per adolescent. Many youths had valid data for the entire week (33%); 26% had data for six nights, 18% for five nights, 9% for four nights, 4% for three nights, and 3% for less than three nights. Approximately 7% of participants did not have actigraphy data. Reasons for missing data included taking medication (e.g., for allergies) and the exclusion of those nights, forgetting to wear the actigraph, and mechanical problems. Sleep data for adolescents with fewer than five nights of valid actigraphy data ($n = 58$; 23%) were not included because of poor estimation of regular sleep (Meltzer, Montgomery-Downs, Insana, & Walsh, 2012).

The following well-established sleep parameters were derived: (a) sleep minutes – the number of minutes from sleep onset to wake time; and (b) sleep efficiency – percentage of epochs scored as sleep between sleep onset and wake time. Sleep minutes and sleep efficiency scores were generated by averaging data across all available nights. Night-to-night stability during the week was high for sleep minutes ($\alpha = .75$) and sleep efficiency ($\alpha = .95$).

Subjective sleep—Adolescents completed the School Sleep Habits Survey (Wolfson & Carskadon, 1998), which includes a 10-item Sleep/Wake Problems scale used in analyses. The Sleep/Wake Problems scale assesses oversleeping, unscheduled sleep, irregular sleep times, staying up late at night over the last two weeks, and satisfaction with one's sleep; items were rated on a 5-point scale (1 = *never* to 5 = *every day/night*). This scale had good internal consistency ($\alpha = .77$).

Internalizing symptoms—Adolescents completed the 49-item Revised Children's Manifest Anxiety Scale 2 (RCMAS 2; Reynolds & Richmond, 1978) and the 9-item Anxiety subscale of the Trauma Symptoms Checklist for Children (TSCC; Briere, 1996). Using the general response format of the TSCC, rather than the response format for a specific trauma, adolescents reported about anxiety in general (Briere, 1996). The RCMAS 2 and the TSCC have demonstrated good psychometric properties (Briere, 1996; James, Reynolds, & Dunbar, 1994). Items on the RCMAS 2 (e.g., "I worry about what other people think about me;" "I am afraid of a lot of things") were rated on a 2-point scale (0 = *no*, 1 = *yes*) and summed. Two items regarding sleep were removed; $\alpha = .92$. The percentage of adolescents with high levels of anxiety symptoms (scores > 2 SD from the mean; Reynolds & Richmond, 1997) on the RCMAS was 5%. Anxiety items on the TSCC (e.g., "feeling afraid something bad might happen;" "feeling nervous or jumpy inside") were rated on a 4-point

scale (0 = *never* to 3 = *almost all of the time*), and responses were summed; $\alpha = .86$. Approximately 4% of adolescents scored in the clinically significant range on TSCC anxiety symptoms ($T > 65$). The two measures were correlated ($r = .66, p < .001$).

Adolescents also completed the widely used and well-validated Children's Depression Inventory (CDI; 27 items; Kovacs, 1985) and the Depression subscale of the TSCC (9 items; Briere, 1996). Adolescents reported on depressive symptoms using the general response format of the TSCC (Briere, 1996). Items on the CDI (e.g., "I am sad all the time;" "I feel alone all the time") were rated on a 3-point scale and summed. Two items regarding sleep and one item regarding suicidal ideation were removed; internal consistency was high ($\alpha = .86$). Approximately 4% of adolescents scored within clinically significant levels of depressive symptoms on the CDI (scores > 20). Depression items on the TSCC (e.g., "Feeling sad or unhappy;" "Feeling like nobody likes me") were rated on a 4-point scale (0 = *never* to 3 = *almost all of the time*) and summed; $\alpha = .87$. Approximately 3% of adolescents scored within the clinically significant range of depressive symptoms on the TSCC ($T > 65$). The two measures of depression were highly correlated ($r = .72, p < .001$).

Externalizing symptoms—Mothers and fathers reported on adolescent externalizing symptoms via the Personality Inventory for Children-II (PIC-2; Lachar & Gruber, 2001). The Externalizing scale is comprised of two subscales (delinquency, impulsivity and hyperactivity; 24 items) that tap into aggression, impulsivity, non-compliance, delinquency, and disruptive behavior. Items were rated as true or false. Mothers' and fathers' reports about externalizing symptoms (T-scores) were highly correlated ($r = .83, p < .001$) and therefore averaged to create a single externalizing score; $\alpha = .89$. Approximately 12% of adolescents scored within the borderline or clinically significant range of externalizing symptoms ($T > 60$). Of the families in which only one parent participated, adolescents' externalizing scores were based only on mother reports in 82% of cases and only on father reports in 18% of cases.

Plan of Analysis

To reduce outlier effects, study variable values that exceeded 3 *SDs* were recoded as the next lowest or highest observed value within 3 *SDs* (Kline, 2005). In total 22 values were recoded, including five for peer victimization, one for sleep minutes, four for sleep efficiency, two for sleep/wake problems, five for anxiety symptoms, three for depressive symptoms, and two for externalizing symptoms. Skewness statistics and missing data (4% to 23%) on study variables were within the accepted range.

Using AMOS (Arbuckle, 2012), an internalizing latent variable was created using four indicators: anxiety symptoms based on the RCMAS, depressive symptoms based on the CDI, and both anxiety and depressive symptoms based on the TSCC (r s ranged from .59 to .76, all p s $< .001$). Standardized factor loadings were high (ranging from .80 to .88, all p s $< .001$). Creating a latent internalizing variable removes measurement error and captures the shared variance among multiple measures of internalizing symptoms. Next, a series of models were fitted in AMOS, which uses full information maximum likelihood (FIML) estimation to handle missing data (Acocck, 2005). To examine the independent and

interactive associations of peer victimization and adolescent sleep as predictors of adolescent internalizing and externalizing symptoms, separate models were examined for each outcome (internalizing and externalizing symptoms) and each sleep parameter (sleep minutes, sleep efficiency, sleep/wake problems). All control and predictor variables were mean-centered for analyses and significantly correlated variables were allowed to covary. For a conservative test of all models, adolescent sex, race/ethnicity, age, income-to-needs ratio, and zBMI were included as controls. The main effects of peer victimization and each sleep parameter were entered, followed by the interaction between peer victimization and sleep.

Significant interactions were probed using standard procedures (Dearing & Hamilton, 2006; Preacher, Curran, & Bauer, 2006). Simple slopes were tested to determine whether the predictor was significantly associated with the outcome at specific levels of the moderator. Plots illustrate associations between the predictor (peer victimization) and outcome (internalizing or externalizing symptoms) at lower ($-1 SD$) and higher ($+1 SD$) levels of the moderator (sleep) (Aiken & West, 1991). When reporting the findings, prediction is used in the statistical versus causal sense.

Results

Preliminary Analyses

As shown in Table 1, on average, participants experienced relatively low levels of peer victimization, slept for 6.7 hours of sleep per night, had high sleep efficiency, reported a wide range of sleep/wake problems, and were relatively well-adjusted. Additionally, peer victimization was associated with higher levels of subjective sleep/wake problems and internalizing symptoms (Table 1). An association between peer victimization and externalizing symptoms approached conventional levels of statistical significance. Sleep parameters were not correlated across assessment method (objective versus subjective), but objective sleep parameters were correlated in the expected direction. Subjective sleep/wake problems were associated with internalizing and marginally related to externalizing symptoms. Internalizing and externalizing symptoms were modestly correlated.

Correlations between demographic variables and primary study variables (not shown) revealed that higher income-to-needs ratio was associated with more sleep minutes ($r = .16$, $p < .05$), better sleep efficiency ($r = .17$, $p < .05$), and lower levels of externalizing symptoms ($r = -.26$, $p < .001$). Additionally, t -tests were conducted to examine sex and race/ethnic differences across study variables. In comparison to boys, girls had longer sleep duration ($M_{\text{girls}} = 418.78$ minutes, $SD = 53.36$; $M_{\text{boys}} = 391.99$ minutes, $SD = 53.36$; $t = 3.49$, $p < .01$) and better sleep efficiency ($M_{\text{girls}} = 92.12$, $SD = 6.23$; $M_{\text{boys}} = 89.59$, $SD = 6.60$; $t = 2.73$, $p < .01$), as well as higher levels of internalizing symptoms ($M_{\text{girls}} = .63$, $SD = 2.64$; $M_{\text{boys}} = -.70$, $SD = 2.36$; $t = 4.04$, $p < .001$). Compared to African American (AA) youth, European American (EA) adolescents had longer sleep duration ($M_{\text{EA}} = 413.59$ minutes, $SD = 50.05$; $M_{\text{AA}} = 387.97$ minutes, $SD = 61.93$; $t = 2.22$, $p < .01$). Correlations among study variables examining each measure of anxiety (RCMAS, TSCC Anxiety) and depression (CDI, TSCC Depression) were similar to the correlations using the internalizing latent variable.

Internalizing symptoms

Results from regression analyses are presented in Table 2 (controls were included but not depicted). Among control variables, sex (girls) and lower zBMI scores were associated with higher levels of internalizing symptoms ($B = -1.51, SE = .38, \beta = -.28, p < .001$; $B = -.39, SE = .19, \beta = -.14, p < .05$, respectively). Main effects of peer victimization and subjective, but not objective, sleep emerged. Specifically, peer victimization and higher levels of sleep/wake problems predicted higher levels of internalizing symptoms (Table 2). Further, central to this investigation, objective sleep and subjective sleep/wake problems moderated the association between peer victimization and internalizing symptoms.

Simple slopes analyses revealed that the positive association between peer victimization and internalizing symptoms was significant for adolescents with low ($B = 2.24, SE = .37, \beta = .41, p < .001$) and high ($B = 3.61, SE = .53, \beta = .66, p < .001$) sleep minutes. However, this association was more pronounced among adolescents with longer rather than shorter sleep duration (see Figure 1). Further, at high levels of peer victimization, adolescents had high levels of internalizing symptoms that did not vary based on sleep. However, at low levels of peer victimization, the predicted means for internalizing symptoms were lower for youth with longer than shorter sleep. Thus, adolescents who reported the lowest levels of internalizing symptoms had relatively long sleep duration accompanied by relatively low levels of peer victimization.

A somewhat similar pattern emerged for sleep efficiency. The association between peer victimization and internalizing symptoms was significant for adolescents with low ($B = 2.08, SE = .39, \beta = .38, p < .001$) and high ($B = 3.61, SE = .43, \beta = .66, p < .001$) sleep efficiency. However, as shown in Figure 2, the association was stronger among adolescents with higher in comparison to lower sleep efficiency.

Subjective sleep/wake problems also moderated the association between peer victimization and internalizing symptoms, but the pattern of effects was somewhat different than that observed for actigraphy-based sleep minutes and efficiency. As shown in Figure 3, peer victimization was associated with internalizing symptoms for adolescents with low ($B = 1.22, SE = .55, \beta = .22, p < .05$) and high ($B = 2.45, SE = .32, \beta = .45, p < .001$) subjective sleep/wake problems, and the effects were more pronounced for the latter group. Further, the highest level of internalizing symptoms was evident for youth who are exposed to high levels of peer victimization in conjunction with having higher levels of sleep/wake problems. Conversely, and consistent with moderation effects observed for objective sleep parameters, adolescents with fewer sleep/wake problems accompanied by lower levels of peer victimization reported the lowest levels of internalizing symptoms.

Externalizing symptoms

Among control variables, adolescents from lower income-to-needs homes had higher levels of externalizing symptoms ($B = -1.08, SE = .24, \beta = -.30, p < .001$). Main effects of peer victimization approached significance in the objective but not subjective sleep models and there were no direct effects involving sleep (Table 2). However, an interaction between peer victimization and subjective sleep/wake problems emerged. Specifically, peer victimization

was associated with externalizing symptoms among adolescents with fewer sleep/wake problems ($B = 6.23$, $SE = 2.50$, $\beta = .31$, $p < .05$) but not among adolescents with more sleep/wake problems ($B = .50$, $SE = 1.47$, $\beta = .03$, $p = .73$). As shown in Figure 4, adolescents with more sleep/wake problems had relatively high levels of externalizing symptoms regardless of peer victimization. Further, at low levels of peer victimization, predicted means for externalizing symptoms are higher for those with worse sleep. Similar to the prior pattern of moderation effects observed across Figures 1 to 3, adolescents with the lowest levels of externalizing symptoms were those with fewer sleep problems in conjunction with low levels of peer victimization.

Discussion

Experiences of peer victimization are associated with internalizing and externalizing symptoms (Reijntes et al., 2010; 2011). Yet, a number of studies have revealed that these associations are not evident for all youth and may depend on other factors. The present study is the first to examine sleep as a moderator of associations linking peer victimization with internalizing and externalizing symptoms in adolescence. Utilizing a multi-informant and multi-method design, several sleep parameters moderated the association between peer victimization and adolescents' adjustment. Results suggest that adolescents with relatively infrequent experiences of peer victimization and better sleep (longer duration, higher sleep quality) are less likely than their counterparts with peer victimization or sleep problems to exhibit internalizing or externalizing symptoms.

Highlighting the importance of sleep as a moderator, actigraphy-based sleep duration and efficiency interacted with peer victimization to predict internalizing symptoms. Stronger effects between victimization and adjustment were observed among adolescents with better (longer duration, higher efficiency) than worse sleep. At low levels of peer victimization, adolescents who experienced better sleep tended to report the lowest levels of internalizing symptoms. However, for youth exposed to high levels of peer victimization, longer and better quality sleep did not appear to be protective, and these youth had relatively high levels of internalizing problems regardless of sleep. These findings are consistent with a dual-protection pattern of association and the protective-reactive moderating process proposed by Luthar et al. (2000). Specifically, more optimal sleep appeared beneficial in the context of low (i.e., low peer victimization) but not high risk. Also consistent with dual-protection, subjective sleep/wake problems moderated the association between peer victimization and externalizing symptoms, and the lowest levels of symptoms were observed for youth with better sleep that is accompanied by low victimization.

Subjective sleep/wake problems also moderated the association between peer victimization and internalizing symptoms, yet the pattern of effects was more supportive of dual and cumulative risk perspectives (Evans, 2003; Sameroff, 1983). In particular, youth with both higher sleep problems and elevated peer victimization had the highest predicted levels of internalizing symptoms. At the same time, one should not draw a clear demarcation between the two patterns of moderation effects. For example, for the moderation effect discussed in this paragraph, adolescents with low levels of victimization accompanied by fewer sleep problems had the lowest levels of internalizing symptoms. This finding could be justifiably

interpreted as supportive of a dual-protection pattern as well. Of importance is that across all of the moderation effects, adolescents with lower victimization and better sleep had the lowest levels of externalizing and internalizing symptoms.

The pattern of dual-protection observed clearly for three out of the four moderation effects in this study, and somewhat for the fourth, is consistent with studies on positive parenting, in which maternal sensitivity predicted lower levels of internalizing and externalizing problems (Bordeleau et al., 2012) and greater attachment security (Bernier et al., 2014) among children with longer but not shorter sleep duration in infancy. Providing additional support for the dual-protection findings, higher levels of cognitive functioning were found among adolescents who experienced low harsh parenting or parental psychological control in conjunction with better sleep efficiency (El-Sheikh et al., 2014).

The pattern of dual-risk, observed here for one moderation effect, is also consistent with a few others in this emerging literature. Shorter sleep duration and greater variability in sleep schedule exacerbated the effects of marital conflict on adolescents' aggressive behavior (Lemola et al., 2012). Further, poorer actigraphy-based sleep quality exacerbated the effects of maternal psychological control on children's depression and anxiety, whereas better sleep quality attenuated these effects among a subsample of children from higher socioeconomic backgrounds (El-Sheikh et al., 2010). Additionally, among preschool children characterized as high in negative emotionality, actigraphy-based sleep problems (reduced sleep efficiency, more long wake episodes, high sleep latency) functioned as vulnerability factors for low sociometric ratings of peer acceptance and high ratings of peer rejection (Lu, Tu, El-Sheikh, & Vaughn, 2015)

There are several potential explanations for the moderating role of sleep. For instance, sleep insufficiency or poor quality sleep may disrupt PFC activity and executive functions (Astill et al., 2012; Dahl, 1996; Walker & van der Helm, 2009), hypothalamic-pituitary-adrenal responses (e.g., increases in cortisol secretion; El-Sheikh et al., 2008), or autonomic and emotion regulation (Baum et al., 2014; El-Sheikh et al., 2013; Gruber et al., 2012). Further, disrupted sleep may interfere with adaptive coping (Killgore et al., 2008), which has ramifications for adjustment problems in the context of stress (e.g., Kochenderfer-Ladd & Skinner, 2002). The moderating role of sleep in the aforementioned studies of family stress and in the current study of peer stress may be explained in part by the combined effects of sleep on multiple cognitive, emotional, and behavioral-stress response systems.

Interaction effects are difficult to replicate. Thus, the fact that two patterns are emerging when sleep is considered as a moderator of risk, in different samples of children across toddlerhood to adolescence, and in the context of different risk factors and outcomes, is noteworthy. One could speculate about sample and methodological features, as well as outcome domains, which may account for the differential patterns of moderation effects. Yet, given the lack of clarity across studies, we believe that such speculation is premature pending future investigations.

Similar to common findings in the literature, the subjective and objective sleep parameters were not associated (Kelly & El-Sheikh, 2011; Sadeh, 2011b). Actigraphy and subjective

sleep as examined in this study may tap into different aspects of sleep. Whereas actigraphy examines body movements to provide objective estimates of sleep duration and quality, subjective reports of sleep index perceived problems with initiating and maintaining sleep, oversleeping, staying up late at night, unscheduled sleep, and satisfaction with one's sleep. Both methodologies have advantages and disadvantages and the inclusion of both is considered more optimal than reliance on one method alone (Sadeh, 2011a). Additionally, some differential effects of sleep quantity and quality on adjustment have emerged in the literature. For instance, shorter sleep duration, but not reduced sleep efficiency, has been directly linked with youths' internalizing and externalizing symptoms (for meta-analysis see Astill et al., 2012); whereas others have found effects with sleep quality, but not duration (Kelly, Marks, & El-Sheikh, 2014). Yet other studies have found that both sleep duration and quality, assessed subjectively and objectively, are associated with various indices of adjustment (for a review see Sadeh et al., 2014). Thus, the inclusion of multiple sleep parameters are warranted (Sadeh, 2015).

There are several limitations of the present study and directions for future research. The community sample is characterized by non-clinical levels of both sleep and adjustment problems and relatively low levels of peer victimization were reported. Thus, caution should be exercised when generalizing the findings to other populations. Further, adolescents reported on victimization and internalizing symptoms whereas parents reported on externalizing symptoms. Thus, reporter effects may account for some of the differential findings between the two outcome domains. In addition, given the cross-sectional design, conclusions about directionality or causality cannot be drawn. Longitudinal associations linking both peer victimization (Reijntes et al., 2010; 2011) and sleep problems (Astill et al., 2012) with internalizing and externalizing problems are well-documented, and an important future direction would be to investigate whether the moderating function of sleep is evident over time. Additionally, although we examined sleep as the moderator of effects, alternative models are possible (e.g., adjustment problems may moderate the association between peer victimization and sleep), and our focus on sleep does not imply that other moderators of risk may be operative. Furthermore, future studies could include peer reports of victimization as adolescent and peer reports of peer victimization may each provide uniquely important information (Juvonen, Nishina, & Graham, 2001).

Despite these limitations, this multi-method study provides evidence that sleep moderates associations linking peer victimization with internalizing and externalizing symptoms during adolescence. These findings contribute to our understanding of which adolescents may have better or worse psychological adjustment in the context of peer victimization. Further, findings extend identified moderators of risk in the association between victimization and adjustment to include sleep. The present study highlights the importance of contemporaneous assessments of bioregulatory processes and peer relations in the prediction of adolescents' adjustment.

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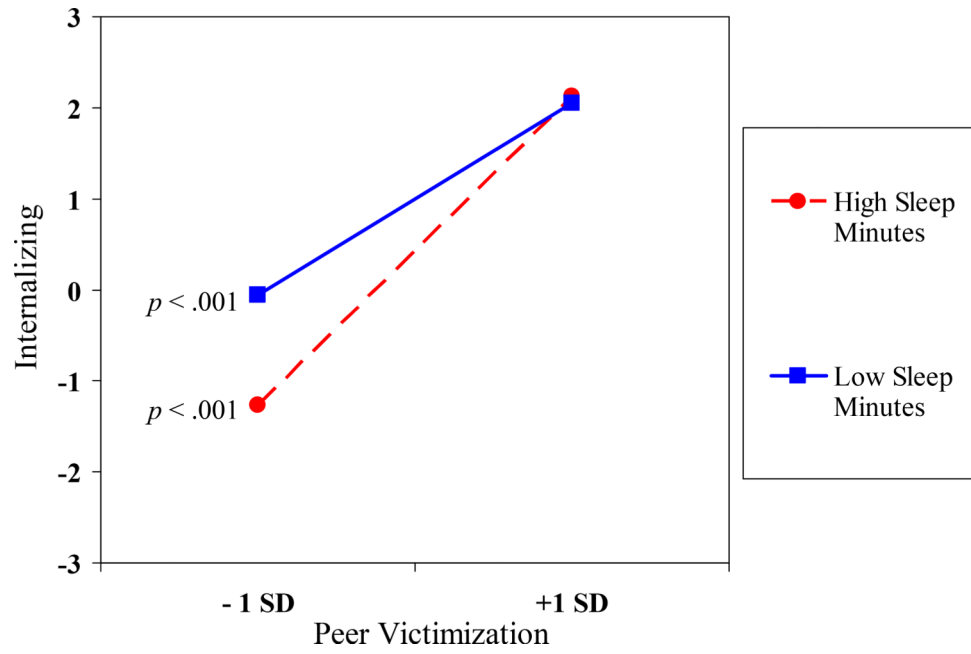


Figure 1. The association between peer victimization and internalizing symptoms at low and high sleep minutes.

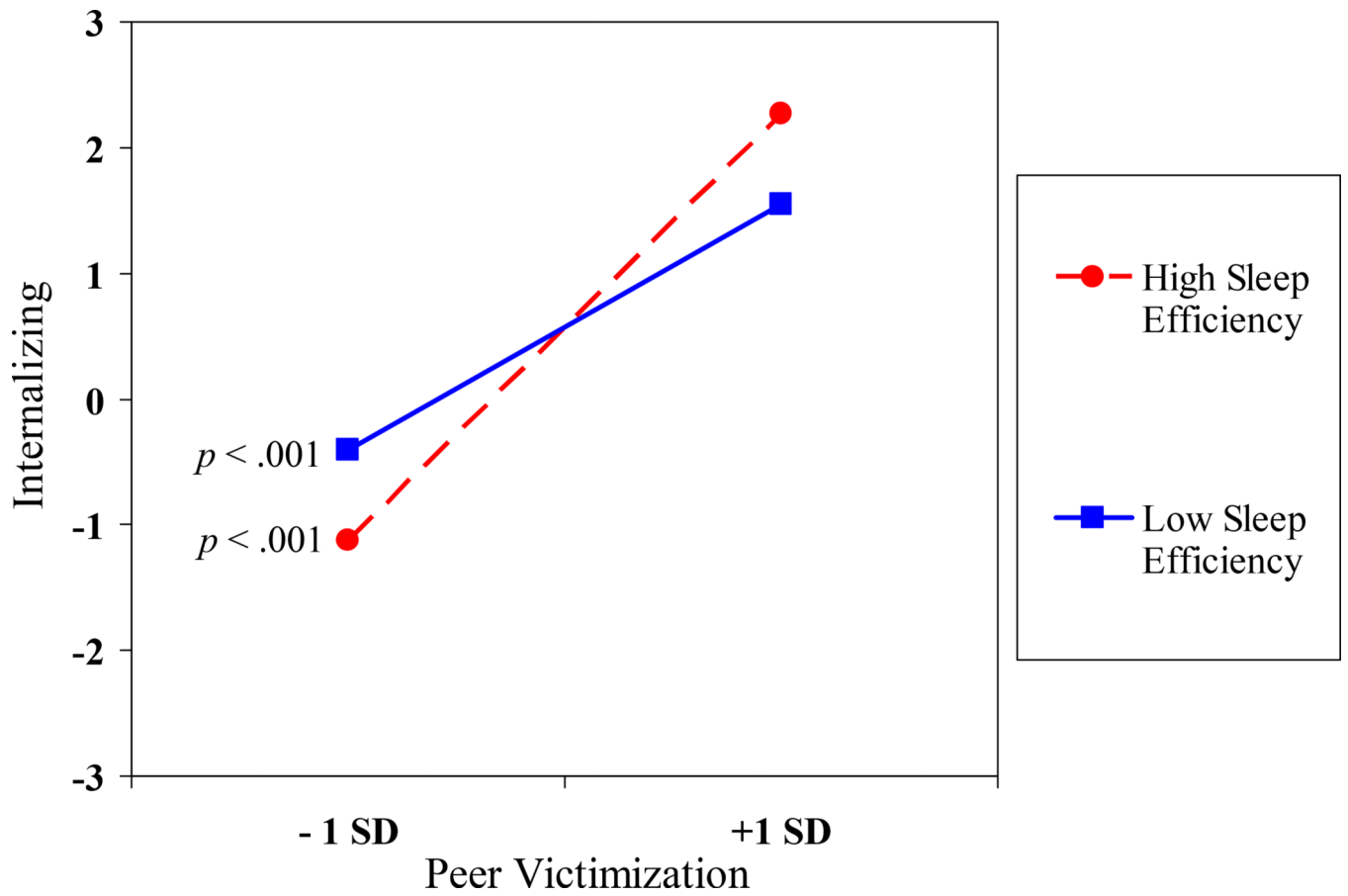


Figure 2. The association between peer victimization and internalizing symptoms at low and high sleep efficiency.

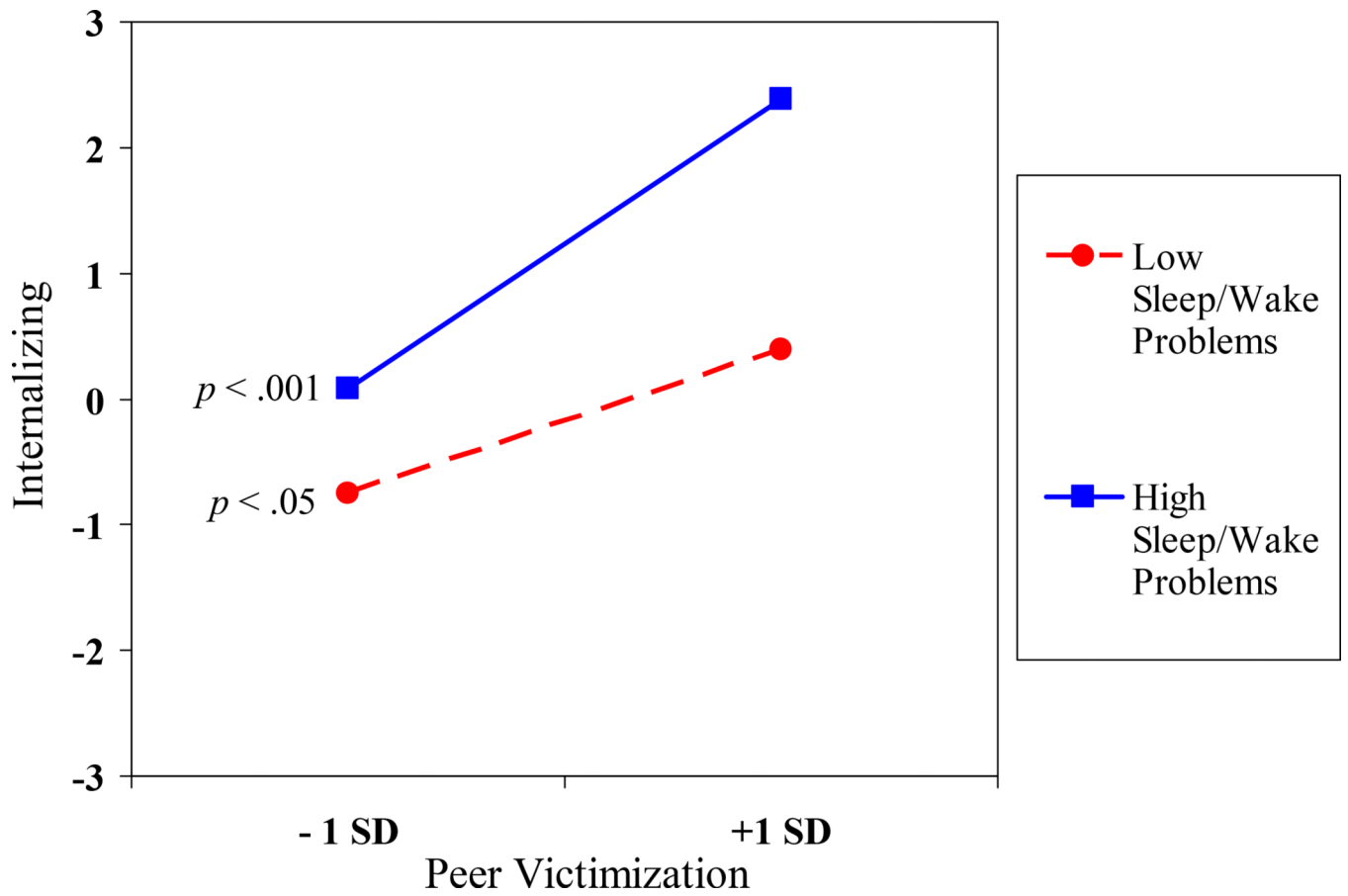


Figure 3. The association between peer victimization and internalizing symptoms at low and high levels of sleep/wake problems.

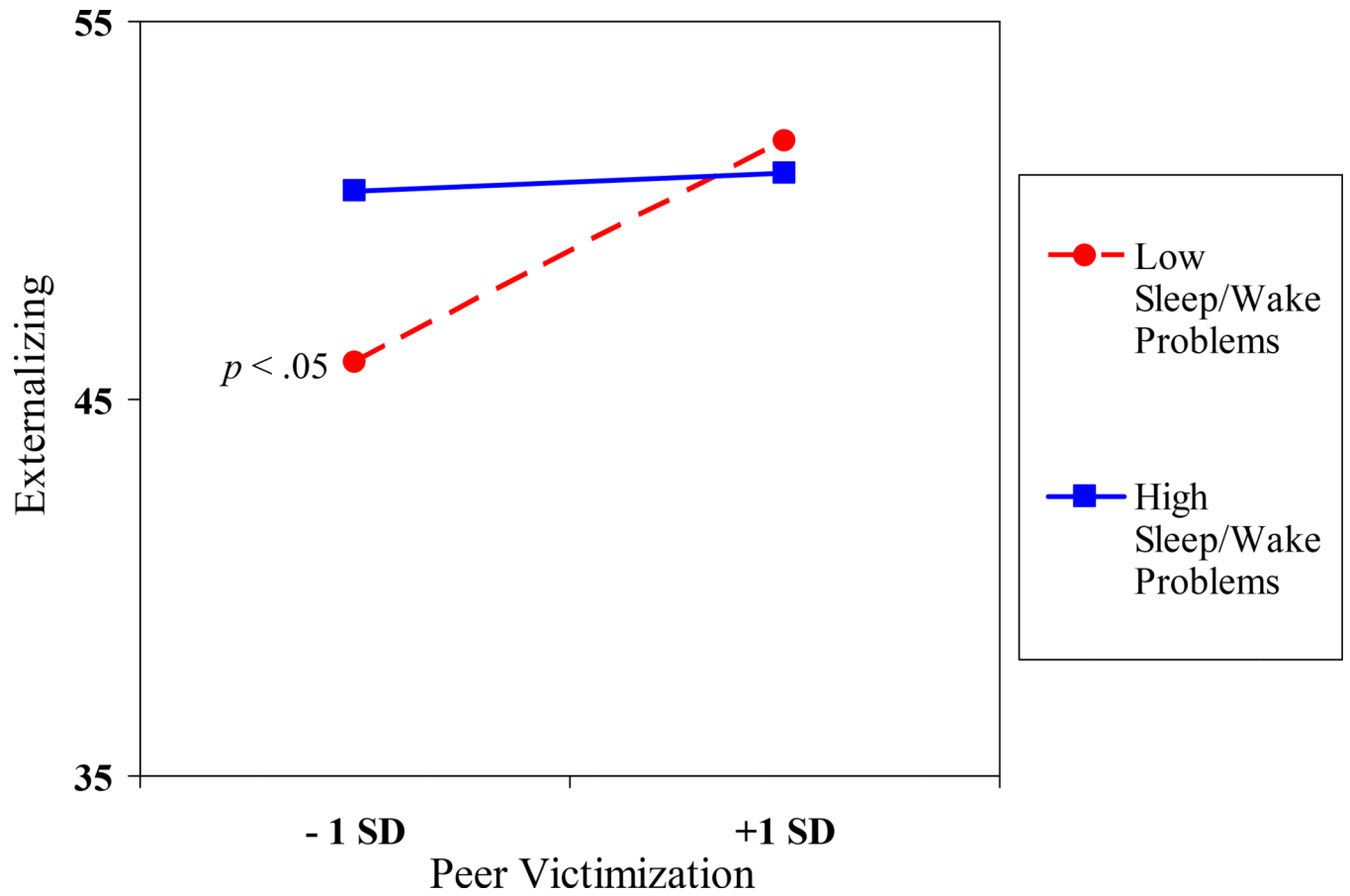


Figure 4. The association between peer victimization and externalizing symptoms at low and high levels of sleep/wake problems.

Table 1
 Descriptive Statistics and Correlations among Peer Victimization, Sleep Parameters, and Internalizing and Externalizing Behaviors

	1	2	3	4	5	6
1. Peer victimization (self-report)	-					
2. Sleep minutes (actigraphy)	-.09	-				
3. Sleep efficiency (actigraphy)	.02	.60***	-			
4. Sleep-wake problems (self-report)	.36***	-.09	.01	-		
5. Internalizing (self-report)	.51***	-.07	.09	.43***	-	
6. Externalizing (parent report)	.13+	-.01	.04	.13+	.20**	-
Mean	1.31	406.42	90.95	19.90	.00	47.88
(SD)	(.47)	(54.70)	(6.51)	(6.65)	(2.60)	(9.35)

Note. Mean (SD) for self-reported internalizing symptoms is based on a latent factor score derived from a latent variable created with adolescent reports on the Revised Children's Manifest Anxiety Scale ($M = 2.41, SD = 1.68$), Trauma Symptoms Checklist for Children-Anxiety scale ($M = 2.96, SD = 3.39$), Children's Depression Inventory ($M = 6.78, SD = 5.67$), and the Trauma Symptoms Checklist for Children- Depression scale ($M = 3.50, SD = 3.74$).

** $p < .01$.

*** $p < .001$.

Unstandardized and Standardized Regression Coefficients Linking Peer Victimization and Sleep with Adjustment

Table 2

	Internalizing			Externalizing		
	<i>B</i> (<i>SE</i>)	β	R ²	<i>B</i> (<i>SE</i>)	β	R ²
Sleep minutes model						
Peer victimization (PV)	7.68*** (.89)	.56***	40.4%	2.31 ⁺ (.1.34)	.12 ⁺	11.2%
Sleep minutes	-.01 ⁺ (.01)	-.12 ⁺		.00 (.01)	.02	
PV x Sleep minutes	.03* (.02)	.14*		.01 (.03)	.02	
Sleep efficiency model						
PV	7.46*** (.84)	.55***	40.2%	2.26 ⁺ (1.33)	.11 ⁺	11.6%
Sleep efficiency	.00 (.01)	.00		.08 (.11)	.06	
PV x Sleep efficiency	.31*** (.12)	.17**		.07 (.20)	.03	
Sleep-wake problems model						
PV	4.77*** (.94)	.35***	46.1%	1.55 (1.42)	.08	14.3%
Sleep-wake problems	.28*** (.06)	.29***		.14 (.10)	.10	
PV x Sleep-wake problems	.24* (.10)	.14*		-.44* (.19)	-.18*	

Note. All models controlled for adolescent sex, ethnicity, age, income-to-needs, and zBMI.

⁺ $p < .10$.

* $p < .05$.

*** $p < .001$.