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Associations among sleep, daily experiences, and loneliness in adolescence: Evidence of moderating and bidirectional pathways

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A B S T R A C T

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The present study examined the dynamic associations among daily stress levels, affect, and objective sleep quality in adolescence. We also explored loneliness as a potential moderator of these associations. Seventy-eight adolescents participated over three days. They completed diary reports of stressful experiences and affect five times a day while wearing an actigraph to obtain objective measurement of sleep. They also provided self-reports of loneliness. High daily stress was associated with shorter sleep duration. Models testing bidirectional associations indicated that prior day stress was associated with shorter sleep duration, but poor sleep duration and sleep efficiency were also associated with greater stress the next day. Loneliness was a significant moderator of the associations between daily stress and sleep duration and latency such that lonely individuals had shorter sleep durations and sleep latencies after particularly stressful days. Results suggest daily dynamic associations among loneliness, daily stress, and objective measures of adolescent sleep.

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An accumulation of evidence has demonstrated that adolescents do not get enough sleep (Carskadon, 1990a, 1990b; Morrison, McGe, & Stanton, 1992; National Sleep Foundation, 2011a; Wolfson & Carskadon, 1998). Both biological (e.g., changes in circadian rhythms) and contextual (e.g., earlier school start times) factors are associated with changes in sleep patterns during adolescence (Carskadon, 2011, 1999; Dahl & Lewin, 2002). Not surprisingly, adolescents' lack of sleep has health consequences; poor sleep has been associated with obesity (Gupta, Mueller, Chan, & Meininger, 2002), risk for suicide (Choquet, Kovess, & Poutignat, 1993; Liu, 2004), anxiety and depression (Alfano, Zakem, Costa, Taylor, & Weems, 2009), reduced academic performance (Wolfson & Carskadon, 2003), and increased stress levels and negative mood (Lund, Reider, Whiting, & Prichard, 2010). Although prior research has consistently linked poor sleep with adolescent health determinants, fewer studies have focused on predictors of poor sleep that include day-to-day fluctuations in stress or affect, and how more stable individual characteristics, like loneliness, interact with these daily experiences to influence sleep patterns. Much prior research has also been limited by the reliance on single subjective or self-report measures of sleep. Given that affect and stress levels may bias self-reports of sleep behaviors, it appears increasingly important to examine these associations using objective indicators of sleep. In an attempt to address these limitations, the current study examined: a) the *day-to-day* associations among negative and positive affect (NA; PA), stress levels and objective sleep quantity and quality; and b)

whether loneliness moderated the associations among affect, stress, and sleep in an adolescent sample transitioning into college.

Daily experiences of stress, affect, and sleep

Stressful experiences, ranging from shift work and daily hassles to childhood trauma, have been linked with sleep disturbances (Chung & Cheung, 2008; Greenfield, Lee, Friedman, & Springer, 2011; Lund et al., 2010; Van Reeth et al., 2000). For instance, Lund et al. (2010) found that tension and stress were the most important contributors to poor sleep in a large sample of college students. Additionally, daily self-reports of perceived stress and worry have been shown to predict poorer subjective sleep and objective sleep efficiency (Åkerstedt Kecklund, & Axelsson, 2007; Galambos, Howard, & Maggs, 2010; Tworoger, Davis, Vitiello, & McTiernan, 2005). A few studies found no effects of perceived stress on sleep, but these studies focused specifically on clinical samples or stress following traumatic events (Lavie, Carmeli, Mevorach, & Liberman, 1991; Pillar, Malhotra, & Lavie, 2000).

Experimental sleep deprivation designs have been used to illustrate the linkages between NA and PA in relation to objective measures of sleep. In a combined sample of adolescents and adults, less PA was seen in sleep-deprived participants as compared to those who received adequate sleep (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). Similarly, in a sample of adolescents, less PA and a lower PA to NA ratio were seen in sleep-deprived youth when compared to those who were rested (Dagys et al., 2012). There is less consistent evidence of the associations between NA and PA and subjective and objective measures of sleep in naturalistic environments. Although two early studies of healthy adolescents found small (Price, Coates, Thoresen, & Grinstead, 1978) or no associations (Clark & Watson, 1988) between subjective sleep and negative emotional states, most studies have been conducted in adult or clinical populations (Bower, Bylsma, Morris, & Rottenberg, 2010; Cousins et al., 2011; Hamilton et al., 2008). For example, in a diary study of older adults, subjective, but not objective, assessments of sleep were significantly correlated with less PA and greater NA the next day (McCrae et al., 2008). In regards to trait measures of affect, Norlander, Johansson, and Bood (2005) found that individuals with high trait PA and low trait NA had the greatest subjective sleep quality when compared to individuals with low PA and high NA. Thus, an association between daily or trait affect and subjective assessments of sleep has been established in adults, but less is known about the associations in healthy adolescents in naturalistic environments.

Associations among affect, stress, and sleep are particularly important during adolescence, as this developmental period is characterized by high variability and increases in affect and stress (Arnett, 1999; Colton & Gore, 1991; Larson, Csikszentmihalyi, & Graef, 1980; Larson & Richards, 1994). Adolescents exhibit more extreme levels of emotion compared to children or adults in daily life and in response to stress (Larson & Richards, 1994). Therefore, beyond biological shifts in sleep (e.g. homeostatic pressure; Jenni, Achermann, & Carskadon, 2005), it is possible that adolescents may experience daily or chronic changes in sleep due to the high variability and intensity of their emotions, coupled with the interpersonal and environmental transitions that characterize this developmental period (Graber & Brooks-Gunn, 1996; Smetana, Campione-Barr, & Metzger, 2006).

Daily reciprocal relations among sleep and affect or stress levels

A second consideration for research on daily experiences and sleep is the need to disambiguate whether daytime affect or stress predict sleep that night or whether sleep one evening predicts the next day's affect or stress levels. One strategy to address the potential for bidirectional effects is to use daily diary measures of stress, affect, and objective measures of sleep over consecutive days and nights. Two recent studies of adolescents and young adults have examined the day-to-day associations among stress levels or affect and self-reported sleep duration and quality. In a daily experience study of ninth graders, greater stress during the day predicted less sleep at night, which in turn, was associated with higher anxiety, depressed mood and fatigue the next day (Fuligni & Hardway, 2006). Similar dynamic associations were found in a two-week diary study of first year university students; Galambos, Dalton, and Maggs (2009) found that higher PA significantly predicted greater sleep quality, and in turn, greater sleep quality predicted higher PA and lower NA. As such, a second aim of the present study was to examine the day-to-day reciprocal associations among stress and affect and *objective* sleep since, to our knowledge, no daily diary studies have examined these reciprocal relations in a normative sample of adolescents with objective measures of sleep.

Evidence of moderation: loneliness

Previous studies have shown that the associations between stress and sleep are only significant under specific conditions or for particular groups. For example, Hanson and Chen (2010) found that the effect of daily stressors on sleep was moderated by childhood adversity, such that young adults with worse childhood environments slept fewer minutes on the days they encountered more stressors. Another study found that coping style moderated the effects of stress on sleep (Sadeh, Keinan, & Daon, 2004). College students who utilized more emotion-focused coping styles experienced a shift towards worse sleep quality between low and high stress periods. These studies suggest that individual traits or past experiences may moderate the associations among daily stressors or affect and sleep, particularly in adolescents or college students.

An individual trait that may be of particular importance for adolescents is loneliness. Although one of the primary developmental tasks of adolescence is to establish intimate relationships (Buhrmester, 1990), studies have shown that loneliness is prevalent during this developmental period (Heinrich & Gullone, 2006). Loneliness is the pain and distress