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Sleep hygiene and sleep quality as predictors of positive and negative dimensions of mental health in college students

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Abstract: College students are one of the top at-risk groups for chronic sleep loss and poor sleep quality, which can yield deleterious effects on health. The college population is also notorious for poor sleep hygiene, or modifiable behaviors that promote sufficient sleep quantity and quality. Research suggests sleep can impact both positive and negative aspects of college mental health, but few studies have examined the effects of sleep on both subjective well-being and depression within one model. Further, little research has tested sleep hygiene as a modifiable risk factor for positive and mental aspects of health. The present study tested structural equation models in which sleep quality either partially or fully mediated the effects of sleep hygiene behaviors on depression and poor subjective well-being. A partial mediation model (CFI = .98, TLI = .94, RMSEA = .08) suggested a very good-fitting model, and sleep hygiene yielded significant direct and indirect effects on both depression and subjective well-being. Findings suggest intervention efforts targeting the improvement of sleep hygiene and sleep quality among college students may yield effects on student well-being, which can improve mental health among this at-risk population.

Subjects: Health Psychology; Mental Health; Sleep Medicine

Keywords: depression; well-being; sleep health; sleep behaviors; emerging adults

ABOUT THE AUTHORS

Our research group examines antecedents of sleep characteristics, including sleep quality, sleep duration, and daytime alertness, as well as the cognitive and physiological consequences of poor sleep. Our lab studies cognitive, attitudinal, and behavioral factors that predict sleep among adolescent and college populations and tests how resulting sleep outcomes can influence mental and physical health, such as depression, body mass index, blood pressure, and performance. In the present study, findings connecting sleep behaviors to mental health outcomes can inform application efforts among college students to improve mental health, which can generate a cascading effect for better performance, physical health, college retention, and more. Our research can inform both policy and intervention efforts and connects health psychology to a host of other research areas and educational settings.

PUBLIC INTEREST STATEMENT

College students often report chronic sleep problems and may engage in poor sleep hygiene behaviors, such as worrying before bed and going to bed at inconsistent times. Academic pressures and life changes characterizing college life may also leave students at a greater risk for poor mental health. Mental health includes both positive aspects (subjective well-being) and negative aspects (depression) that can affect physical health and overall quality of life. The present study hypothesized that poor sleep quality would predict greater depression and worse subjective well-being, and that sleep hygiene practices would serve as an indirect risk factor. Findings showed that college students reporting better sleep quality also reported better mental health outcomes. Additionally, sleep hygiene behaviors directly and indirectly predicted depression and subjective well-being. Interventions targeting the improvement of sleep hygiene practices and sleep quality among college students may improve mental health among this at-risk population.

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1. Introduction

In the United States, insufficient sleep is a growing public health concern, one that the Centers for Disease Control and Prevention (2009) has declared under-recognized despite deleterious effects on health. For adults, insufficient sleep can be characterized as sleep durations shorter than the recommended age-appropriate amount (7+ hours per night for young adults and adults; Hirshkowitz et al., 2015), and/or poor sleep quality with or without the presence of a sleep disorder (Knutson, 2012). Perceived sleep quality consists of subjective reports of the continuity and restfulness of sleep, including perceptions of sleep disturbances. Sleep disturbances can include symptoms and disorders such as insomnia, excessive daytime sleepiness, and circadian rhythm disturbances, to name a few (Alvaro, Roberts, & Harris, 2013). Research suggests that prevalence rates of short sleep and poor sleep quality have substantially increased over the past 30 years (Knutson, Van, Rathouz, DeLeire, & Lauderdale, 2010; National Center for Health Statistics, 2005).

While the general population has experienced an increase in sleep problems, data from the Behavioral Risk Factor Surveillance System survey suggest that nearly half (45.5%) of Americans reporting insufficient sleep 1–13 days over the past month are between the ages of 18–24 (Centers for Disease Control and Prevention, 2009). Such findings are aligned with studies suggesting emerging adults, particularly college students, are at risk for chronic insufficient sleep (Ahrberg, Dresler, Niedermaier, Steiger, & Genzel, 2012; Forquer, Camden, Gabriau, & Johnson, 2008). Reports from much larger samples yield similar results; the American College Health Association (2007) surveyed 94,806 students from 117 colleges across the country and found that 64.9% of participants reported not getting enough sleep to wake feeling rested at least three of the past seven days. College students also experience poor sleep quality, with approximately 24% of the aforementioned sample (21,957 participants) reporting sleep difficulties (American College Health Association, 2007). College students may be at greater risk for insufficient sleep because of physiological, social, and contextual factors (Jensen, 2003) that generate a greater susceptibility to poor sleep and maladaptive sleep behaviors.

Much research has been devoted to sleep problems as a risk factor for psychopathology, particularly depression. Depression is characterized by symptoms such as sad or irritable mood, reduced interest in activities, difficulty concentrating, fatigue, and thoughts of suicide. Clinical research has consistently demonstrated comorbidity between sleep problems and depression (e.g. Roth & Ancoli-Israel, 1999). Meta-analyses (Alvaro et al., 2013; Lovato & Gradisar, 2014) reveal a consistent relationship between sleep and depression, with greater evidence suggesting poor sleep quality precedes the development of depression, rather than depression predicting sleep. The comorbidity between poor sleep and depressive symptoms has been shown specifically among college students (Gress-Smith, Roubinov, Andreotti, Compas, & Luecken, 2015), and the impact of poor sleep on depression may be particularly important among this population, for college students may be at heightened risk for stress and depressive symptoms. Studies suggest incoming undergraduate students experience high levels of depression and anxiety (e.g. Furr, Westefeld, McConnell, & Jenkins, 2001) and that 25% of students reported feeling depressed within the past year, with men equally as likely as women to experience depression (Lindsey, Fabiano, & Stark, 2009). Research suggests poor sleep may contribute to depression among college students, with studies showing sleep quality (e.g. Adams & Kisler, 2013), worsening sleep problems in the first semester of college (Doane, Gress-Smith, & Breitenstein, 2015), and short and long sleep patterns (Buela-Casal, Miró, Iañez, & Catena, 2007) predict depressive symptoms in college.

While the link between sleep and depression is well-established, this research is capturing the impact of sleep only on the *negative* aspect of mental health. The World Health Organization (2003) describes mental health as a state of well-being whereby a person is aware of his or her own abilities, can cope with the normal stresses of life, is able to work productively and fruitfully, and can contribute to his or her community. As such, mental health can be conceptualized two-dimensionally, encompassing both positive (i.e. subjective or psychological well-being) and negative (i.e. psychopathology, such as depression and anxiety) aspects of mental health (Jones, 2013; World Health

Organization, 2004). Thus, research is needed that identifies if sleep also plays a role in the positive aspects of mental health.

Some studies have shown that quality sleep can promote positive aspects of mental health, including subjective well-being (Hamilton, Nelson, Stevens, & Kitzman, 2007). Subjective well-being is the nature in which individuals emotionally and cognitively feel about themselves and how satisfied they are with the quality of their lives (Diener, Suh, Lucas, & Smith, 1999; Jones, 2013). Subjective well-being has shown "health protective biological correlates, including low cortisol output, reduced cardiovascular stress responsivity, and heightened antibody responses to vaccination," (Steptoe, O'Donnell, Marmot, & Wardle, 2008, p. 409), and optimal sleep has been examined as a resource that may promote or improve well-being even after accounting for indicators of depression (Hamilton et al., 2007). Research has linked aspects of well-being with fewer sleep problems (Steptoe et al., 2008) and better sleep quality (Hanson & Ruthig, 2012).

While studies have identified independent links from sleep to positive and negative aspects of mental health, very little research has examined the effects of sleep on both dimensions of mental health within the same model. Further, little research has been devoted to the study of sleep *behaviors* as predictors of mental health. Sleep hygiene behaviors are practices believed to promote sufficient sleep quantity, good sleep quality, and full daytime alertness. Such behaviors typically span four domains which include arousal-related behaviors, sleep scheduling and timing, eating/drinking behaviors, and sleep environment (Gellis & Lichstein, 2009; Kor & Mullan, 2011; LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005; Stepanski & Wyatt, 2003). Research has linked good sleep hygiene behaviors with better sleep quality and/or longer sleep durations in adolescents (LeBourgeois et al., 2005), young adults (Brick, Seely, & Palermo, 2010; Brown, Buboltz Jr., & Soper, 2006), and a national sample of middle-aged adults (Gellis & Lichstein, 2009). Sleep hygiene is related to but separate from sleep measures such as sleep duration and sleep quality. By definition, it promotes good sleep (and, presumably, next day alertness), but it occurs prior to the onset of sleep. Therefore, it is a separable construct from sleep.

A recent study by Barber, Rupprecht, and Munz (2014) found that sleep hygiene indirectly predicted well-being by way of the stressor-appraisal process. This novel study was one of the first to test the impact of sleep hygiene behaviors on well-being and suggested sleep hygiene could play a role in shaping positive mental health. Such findings may yield practical implications for behavioral interventions, such that sleep hygiene behaviors rather than sleep outcomes could be targeted as a modifiable behavior for improving well-being (Barber et al., 2014). Building upon this preliminary evidence, the aim of the present study was to test sleep hygiene as a predictor of mental health, operationalized as both depression and subjective well-being. Barber et al. (2014) called for future research to examine sleep quality within such theoretical models, which is aligned with prior research suggesting poor sleep quality is a strong risk factor for depression (e.g. Alvaro et al., 2013; Lovato & Gradisar, 2014) and more strongly linked to well-being in comparison to sleep quantity (Pilcher, Ginter, & Sadowsky, 1997). The literature suggests that sleep and emotions may be bidirectional, although there is some support for the finding that sleep predicts emotion (Hall, Levenson, & Halser, 2012) and is a stronger predictor of depression, rather than depression influencing sleep (Lovato & Gradisar, 2014). Therefore, the model tested here used sleep measures as predictors of mental health. Within a sample of college students, we proposed the following:

H1: Sleep quality will predict both depression and subjective well-being.

H2: Sleep hygiene will indirectly predict depression and well-being via sleep quality.

2. Method

2.1. Participants

Survey data were used to test a path model of direct and indirect effects of sleep hygiene on both positive and negative dimensions of mental health. Participants (N = 218) were recruited at an urban southeastern university using SONA, a university-specific online recruitment website in which students can sign up online for research studies and experiments (see Table 1 for demographic information). The study was approved by the university's institutional review board, and all participants provided consent prior to the survey. Inclusion criteria required participants to be at least 18 years of age, English-speaking, and currently enrolled at a four-year university. Participants completed a series of questionnaires measuring mental health, sleep, behaviors, and demographic information. One week later, participants completed a second in-person survey measuring depression and subjective well-being, providing a temporal precedence for the present theoretical framework that sleep hygiene behaviors and sleep quality predict mental health. Participants were offered research credits or extra credit in a college course as compensation for their time.

2.2. Measures

Demographic questions included age, year in school, gender, marital status/number of children, residence on or off campus, roommate status, and if the participant had ever been diagnosed with a sleep disorder. One participant self-reported a diagnosis of restless leg syndrome, 6 self-reported a diagnosis of bruxism (i.e. teeth grinding), and 10 participants self-reported a diagnosis of insomnia.

Table 1. Sociodemographic variables of students evaluated

	Sample size (%)	*M* (SD)
Age		20.30 (2.50)
Male	70 (32.1%)	
Year in school		
Freshman	72 (33%)	
Sophomore	60 (27.5)	
Junior	66 (30.3%)	
Senior	20 (9.2%)	
Marital status		
Single	211 (96.8%)	
Married	7 (3.2%)	
Children (Yes)	10 (4.6%)	
Living on campus (Yes)	80 (36.7)	
Residence		
Dorm room	63 (28.9%)	
Apartment	104 (47.7%)	
House	51 (23.4%)	
Race/ethnicity		
White/Caucasian	128 (58.7%)	
Black/African-American	40 (18.3%)	
Asian	7 (3.2%)	
Hispanic/Latino	13 (6%)	
Multi-racial	7 (3.2%)	
Native American	2 (.9%)	
Not reported	21 (9.6%)	

Notes: N = 218; M = mean; SD = standard deviation.

These data were included in final analyses as a covariate to ensure associations were not due to an underlying sleep disorder.

2.2.1. Sleep hygiene

Sleep hygiene behaviors were measured using the Sleep Hygiene Practice Scale (SHPS). The SHPS (Yang, Lin, Hsu, & Cheng, 2010) measures practices of daily life activities and sleep habits that can negatively impact sleep. The scale includes 30 items that ask participants to rate how frequently they engage in each behavioral practice. The scale items cover four hygiene domains, including arousal-related behaviors (11 items; e.g. "Unpleasant conversation prior to sleep"), sleep scheduling and timing (5 items, e.g. "Sleep in on weekends"), eating/drinking behaviors (6 items; e.g. "Drinking a lot during the hour prior to sleep"), and sleep environment (8 items; e.g. "Feeling too hot or too cold during sleep"). Responses, indicated on a six-point Likert scale ranging from 1 (never) to 6 (always), were summed to yield a total score from the four domains, with higher scores indicating worse sleep hygiene. In the present study, internal consistency estimates for the total scale (α = .87), arousal-related behaviors subscale (α = .72), sleep environment subscale (α = .81), and sleep scheduling subscale (α = .72) were reasonable, although internal consistency for the eating/drinking habits subscale (α = .58) was low.

2.2.2. Sleep quality

Global sleep quality was measured via the Pittsburgh Sleep Quality Index (PSQI). The PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a widely accepted, reliable, and validated standardized measure of sleep quality over the "past month." The scale yields measures of sleep duration, as well as discriminates between "good" and "poor" sleepers. The scale includes 19 self-rated questions regarding sleep disturbance, sleep latency, day dysfunction due to sleepiness, sleep efficiency, overall sleep quality, sleep duration, and necessity of medication in order to sleep. Participants in the present study reported an average of 6.94 h of sleep per night (SD = 1.28). For analyses, item scores were calculated to yield a "global sleep score" with higher scores indicating worse sleep quality. Possible scores range from 0 to 21. A global score of "5" or higher indicates a poor sleeper, and 84.4% of the current sample scored within this category.

2.2.3. Positive mental health

Both positive (i.e. subjective well-being) and negative (i.e. depression) characteristics of mental health were measured. Subjective well-being was measured using the BCC Subjective Well-Being Scale (BCC-SWB; Kinderman, Schwannauer, Pontin, & Tai, 2011). The BCC-SWB is a 24-item scale demonstrating via factor analysis three distinct subscales of psychological well-being, physical health and well-being, and relationships. Responses are indicated on a five-point Likert scale ranging from 1 (Never) to 5 (Almost Always). For scoring, item four was reverse scored. The total 24-item scale has shown significant associations with key demographic variables and measures of concurrent validity (Pontin, Schwannauer, Tai, & Kinderman, 2013). A study (Pontin et al., 2013) validated the scale in a sample of 23,341 participants and demonstrated significant correlations with scores on the Goldberg Anxiety and Depression Scales and the List of Threatening Experiences Questionnaire. In the present study, internal consistency estimates for the total scale (α = .95) and psychological well-being subscale (α = .93) were excellent; internal consistency estimates for the physical health well-being subscale (α = .83) and relationships subscale (α = .78) were good. The scale demonstrated very good temporal stability (r = .90) over a seven-day timespan.

Item 14 (Do you feel able to grow and develop as a person?), an item within the psychological well-being subscale, was missing values for 37% of the sample; available data for item 14 significantly correlated with all other items in the psychological well-being subscale (r = .47–.71, p < .001), and the Chronbach's alpha coefficients for the subscale was .92. Therefore, missing values were imputed as the average score of the 11 other items (i.e. items 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 15) in the psychological well-being subscale. After imputing missing values for item 14, items were summed to create a psychological well-being subscore. The physical well-being subscale contains an item pertaining to sleep (Item 2; Are you happy with the quality of your sleep?). To ensure this

item did not overlap with other sleep-related measures, we ran analyses with the total physical well-being subscale (7 items total) and again sans the sleep item (6 items total). The total physical well-being subscale and revised subscale removing the sleep item correlated r = .99. The relationship well-being subscale was generated by summing the remaining five items.

2.2.4. Negative mental health

Depression was measured via the Center for Epidemiologic Studies Depression Scale (CES-D) Short-Form. The CES-D (Radloff, 1977) is one of the most widely used and validated measures of depressive symptoms. The short-form scale includes 10 items pertaining to feelings and behaviors during the past week with Likert response scales ranging from 0 (rarely or none of the time) to 3 (most or all of the time). Items that describe positive experiences were reverse coded, and scores were summed, with higher total scores indicating more depressive symptoms. The CES-D contains an item pertaining to sleep (Item 7; My sleep was restless). To ensure this item did not overlap with other sleep-related measures, we ran analyses with the total 10-item scale and again sans the sleep item; the total scale and revised scale removing the sleep item correlated r = .99. In the present study, the total scale demonstrated good internal consistency (α = .81) and sufficient temporal stability (r = .75) from Time 1 to Time 2 (i.e. seven-day timespan).

2.3. Plan of analysis

The IBM SPSS 23 statistical software program was used to generate descriptive information (see Table 2) and Pearson product–moment correlations among variables of interest. Descriptive information demonstrated that all variables yielded reasonable means and variability. Sleep hygiene, sleep quality, well-being, and depression were all strongly correlated with one another and within the expected direction.

To test hypotheses that sleep quality would predict both depression and subjective well-being, and sleep hygiene would yield indirect effects via sleep quality, analyses were conducted using the MPlus 6.1 statistical software (Muthén & Muthén, 1998/2010). Structural equation modeling was employed to generate effect sizes for direct and indirect pathways, and significance testing for indirect effects was calculated using bootstrapping procedures running 500 samples at 95% confidence intervals. When multiple dependent variables are being examined within the same model, structural equation modeling generates a comprehensive approach by estimating standard errors with the presence of all predictors, mediators, and dependent variables within the same model (Muthén & Muthén, 1998/2010). Further, this approach allowed subjective well-being to be measured as a latent construct, which is appropriate considering the three-factor structure of the BCC-SWB measurement tool. The latent construct of subjective well-being and the manifest variable of depression were allowed to co-vary in the structural equation model.

Table 2. Descriptives and correlations of sleep, sleep hygiene, and mental health

	M	SD	Range	1	2	3	4	5
Sleep hygiene	91.78	18.53	49–144					
Sleep quality	6.69	3.10	1–16	.62*				
Psychological well-being	49.96	7.33	15–60	−.43*	−.46*			
Physical well-being	28.02	4.09	9–35	−.45*	−.45*	.75*		
Relationship well-being	20.26	3.48	5–25	−.28*	−.30*	.73*	.64*	
Depression	7.20	4.76	0–24	.46*	.46*	−.67*	−.61*	−.51*

Notes: *M* = mean; SD = standard deviation.
*p < .001.

3. Results

A full mediation model was first tested (see Figure 1) in which sleep hygiene yielded only indirect paths to mental health outcomes. An alternate partial mediation model was tested in which sleep hygiene yielded both direct and indirect pathways to subjective well-being and depression (see Figure 2). In all models, age, gender, and self-reported sleep disorder were included as covariates. Goodness of fit was examined for both models. Model fit indices included the comparative fix index (CFI) and the Tucker–Lewis index (TLI), two commonly used fit statistics for examining structural equation models. A cut-off of .90 or higher is often used to suggest a good-fitting model; these cut-offs grew out of earlier research (Bentler & Bonett, 1980) suggesting statistics lower than .90 indicate the model can be improved considerably (Lance, Butts, & Michels, 2006). Root mean squared error of approximation (RMSEA) is also commonly used to measure model fit and yields a recommended cut-off of .08 or lower to suggest acceptable fit (Browne & Cudeck, 1993).

3.1. Full mediation model

Model fit indices for the full mediation model (X^2 = 40.19, CFI = .96, TLI = .91, RMSEA = .09) suggested a good-fitting model. Results for the path model are provided in Table 3 (unstandardized regression coefficients). All direct effects were significant at the $p < .001$ level (see Figure 1 for standardized regression coefficients). Sleep hygiene yielded significant indirect effects on both subjective well-being ($\beta = -.30$, $p < .001$) and depression ($\beta = .28$, $p < .001$) via the pathway of sleep quality.

3.2. Partial mediation model

Model fit indices for the partial mediation model (X^2 = 26.40, CFI = .98, TLI = .94, RMSEA = .08) suggested a very good-fitting model. Results for the partial mediation path model are provided in Table 3 (unstandardized regression coefficients). When sleep hygiene was allowed to directly predict

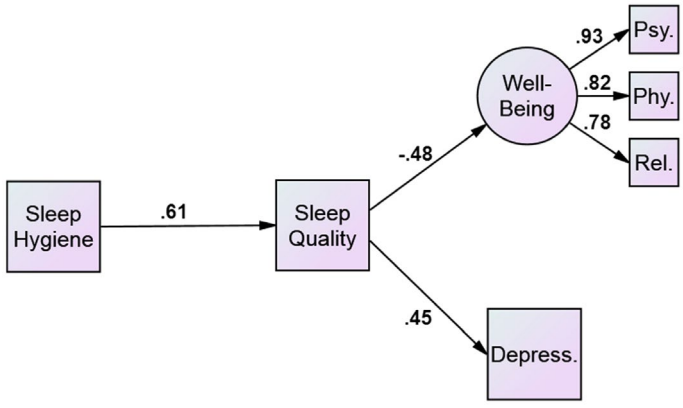

Figure 1. Full mediation model in which sleep hygiene indirectly predicted mental health (operationalized as depression and subjective well-being) via sleep quality.

Note: Path weights are standardized regression weights, all significant at the $p < .005$ level or lower.

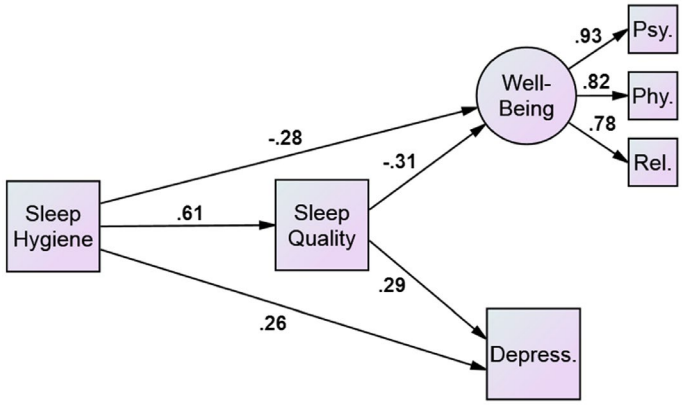

Figure 2. Partial mediation model in which sleep hygiene directly predicted mental health (operationalized as depression and subjective well-being) and yielded indirect effects via sleep quality.

Note: Path weights are standardized regression weights, all significant at the $p < .005$ level or lower.

Table 3. Effects of sleep hygiene and sleep quality on mental health

	Full mediation model			Partial mediation model		
	Sleep quality	Well-being	Depression	Sleep quality	Well-being	Depression
Total R^2	.43	.26	.23	.43	.31	.27
Effects						
Sleep quality						
Direct		−1.08**	.70**		−.69*	.45**
CI		(−1.45, −.71)	(.51, .89)		(−1.08, −.29)	(.22, .67)
Sleep hygiene						
Direct	.10**			.10**	−.10*	.07*
CI	(.08, .12)			(.08, .12)	(−.17, −.04)	(.03, .11)
Indirect		−.11**	.07**		−.07**	.05**
CI		(−.15, −.07)	(.05, .09)		(−.11, −.03)	(.02, .07)

Notes: All pathways are unstandardized regression weights, CI = confidence interval.
*$p < .005$.
**$p < .001$.

subjective well-being and depression, significant direct and indirect pathways emerged for both mental health outcomes. All direct effects were significant at the $p < .005$ level or lower (see Figure 2 for standardized regression coefficients). Sleep hygiene yielded significant indirect effects on subjective well-being ($\beta = -.19$, $p < .001$) and depression ($\beta = .18$, $p < .001$).

To ensure associations between the sleep-related measures and mental health measures were not driven primarily by items related to sleep, we rescored the physical well-being subscale sans the item "Are you happy with the quality of your sleep?" and the CES-D score sans the item "My sleep was restless." The full and partial mediation models were reanalyzed. Both the full mediation model (model (X^2 = 31.86, CFI = .97, TLI = .94, RMSEA = .08) and partial mediation model (X^2 = 19.44, CFI = .99, TLI = .97, RMSEA = .05) were a good fit for the data. All pathways were still statistically significantly and yielded nearly identical path weights.

4. Discussion

Findings from the present study demonstrated that among college students, sleep quality predicted both positive and negative dimensions of mental health in a single model (H1). In other words, after controlling for age, gender, and self-reported sleep disorder, worse sleep quality was associated with greater depressive symptoms and lower subjective well-being. In addition, sleep hygiene yielded both direct and indirect effects on subjective well-being and depression in college students above and beyond the influence of age, gender, and self-reported sleep disorders (H2). Self-regulation theories suggest sufficient sleep is essential in providing the energy needed to effectively manage stress and regulate emotions (Hamilton et al., 2007); therefore, sleep hygiene may indirectly affect mental health by influencing sleep quality. The direct effects of sleep hygiene on depression and subjective well-being are noteworthy; perhaps the achievement of maintaining good, regular sleep hygiene behaviors produces satisfaction that improves well-being and buffers depressive symptoms.

Results generate several key pieces of information that contribute meaningfully to the literature. Firstly, the inclusion of both positive and negative indices of mental health is novel. Since the two components of mental health were allowed to co-vary, significant direct and indirect effects can be viewed as unique associations with each component when controlling for the other. This is an important distinction because it is possible that sleep differentially associates with positive and negative emotions (Fuligni & Hardway, 2006). Psychological well-being yields many protective health benefits for the cardiovascular and immune systems (Steptoe et al., 2008); therefore, research

demonstrating a link between sleep and well-being may inform intervention efforts geared toward the promotion of psychological well-being and good mental health.

Further, the study yielded evidence for *sleep hygiene* as a potential influence on emotional health. While several studies have demonstrated connections between sleep quality and positive emotions in a variety of samples (e.g. Hanson & Ruthig, 2012; Sonnentag, Binnewies, & Mojza, 2008; Steptoe et al., 2008) including college students (Galambos, Dalton, & Maggs, 2009), little work has been reported on associations between sleep hygiene behaviors and positive dimensions of mental health. The present data suggested both direct and indirect pathways between sleep hygiene and positive as well as negative emotions. Findings suggest that good sleep hygiene practices may serve as a protective factor for depressive symptoms in college students and promote high subjective well-being during a critical time period characterized by many life changes, developmental milestones, and identity exploration (Arnett, 2007). Such findings are important, as poor mental health contributes to many negative physical and socio-emotional outcomes, can impair academic performance (Wolfson & Carskadon, 2003), and serves as a risk factor for dropping out of college (Hartley, 2012).

While the present study yielded a novel finding within the realm of college health, several limitations are evident. The current study did not include measures of anxiety. A substantial body of research shows that anxiety is associated with both depression and poor sleep quality (e.g. Alvaro et al., 2013), as well as lower well-being (e.g. Tramonti et al., 2015); therefore, anxiety may serve as a confounding factor in the proposed models. Future studies should include measures of anxiety to test relations with the targeted constructs. All data are self-report; self-reported sleep characteristics may reflect one's *perception* of achieved sleep quality rather than objective measures of sleep latency, disturbances, and continuity. While studies have reported reasonable agreement between self-reported sleep and objective measures of sleep (Gangwisch et al., 2006), findings must be interpreted with caution. Future research can examine sleep hygiene as a predictor of objective measures of sleep quality and quantity and examine the predictive power of said model on mental health. Findings also do not provide evidence of causality. While a temporal precedence does exist, such that sleep hygiene and sleep were measured at an earlier time point than mental health characteristics, a causal relationship was not tested. It is also plausible that depression actually serves as a predictor of poor sleep quality, rather than the relationship tested in the present study in which sleep quality predicts depression. While research suggests poor sleep quality precedes depression (Alvaro et al., 2013; Lovato & Gradisar, 2014), a bidirectional relationship is possible and should be examined in future studies. Lastly, the current study included a sample of college students at a large southeastern university that were majority female (67.9%) and approximately 59% white/Caucasian, which may not be representative of college students in other geographic locations. Future studies should replicate analyses in more diverse college samples.

The present study contributes to this literature by demonstrating associations between self-reported sleep quality, sleep hygiene, subjective well-being, and depression specifically within college students. Results suggest that intervention efforts targeting the improvement of sleep hygiene and sleep quality among college students may yield effects on student well-being, which can improve mental health among this at-risk population. For example, educational programs addressing sleep hygiene have been shown to improve sleep quality over the course of a college semester (Tsai & Li, 2004); so interventions may include health promotion programs within the classroom, student health centers, or campus organizations that target the improvement of sleep hygiene behaviors. Addressing sleep problems in college students could contribute to a reduction in the prevalence of depression and maintenance of positive psychological well-being on college campuses (Galambos, Howard, & Maggs, 2011).

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