RELATIONSHIPS BETWEEN CUMULATIVE CHILDHOOD ADVERSITY AND SLEEP HEALTH: DOES VIGILANCE FOR THREAT PLAY A ROLE?

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Exposure to childhood adversity in the home may be related to poorer sleep, even in samples without sleep disorders or psychiatric illness. Sleep health is a construct that considers dimensions of both nighttime and daytime sleep (i.e., regularity, satisfaction, alertness, timing, efficiency, duration). This study examined the relationship between cumulative childhood adversity (i.e., a sum of different types of adversities) and sleep health, as well as mediators and moderators of this relationship, including vigilance for threat, childhood SES, community adversities, body mass index, and symptoms of depression, anxiety, and PTSD in a sample of 540 healthy undergraduates aged 18-28 years old (50% female; 29% non-white). Online surveys assessed childhood adversity before age 18 and current sleep, mood, vigilance for threat, and health. Survey sleep health was measured using the "RUSATED" scale (Buysse, 2014). A subsample (n=114) completed a laboratory protocol that measured behavioral and physiological vigilance for threat, and a weeklong sleep protocol (actigraphy and daily diaries). Primary analyses examined a second-order latent factor of sleep health that combined survey, actigraphy, and diary measures of the six sleep health dimensions. Supplemental analyses examined the total sleep health score on the RUSATED survey, as well as total scores when RUSATED cut-offs for each sleep dimension were applied to actigraphy and diary data. Structural equation modeling (with bootstrapping for mediation models) and linear regressions were used to examine the relationship between childhood adversity and sleep health. Overall, 52% of the sample reported one or more childhood adversities. Childhood adversity was related to poorer latent sleep health and survey-reported RUSATED sleep health total score after adjustment for sociodemographic, health, and psychosocial covariates. Mediation and moderation hypotheses were largely unsupported, with two exceptions: PTSD partially mediated the relationship between childhood adversity and diary-derived sleep health total score, and low childhood SES moderated the relationship between adversity and survey sleep health total score, but this interaction was not probed as less than 5% of participants reported low SES. The sleep health construct may provide a nuanced way to study sleep patterns and ultimately guide intervention efforts that may mitigate downstream risk of poor health outcomes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PREFACE

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1.0 INTRODUCTION

Evidence suggests that exposure to childhood adversity (e.g., abuse, neglect, domestic violence) may be related to poorer adult sleep. A recent meta-analysis reported increased sleep disorders and disturbances, such as insomnia and nightmares, among those reporting greater exposure to childhood adversity (Kajeepeta, Gelaye, Jackson, & Williams, 2015). However, results suggested that there is limited investigation of associations between childhood adversity and sleep in "normative" populations (i.e., not clinical samples), and, furthermore, the vast majority of the extant literature relies on subjective measures of sleep (versus behavioral measures, such as actigraphy).

An emerging construct in the sleep literature is that of "sleep health" (Buysse, 2014), which involves taking a 24-hour approach to the study of sleep. Sleep health is a multi-dimensional measure that includes characteristics of nighttime sleep (e.g., duration, efficiency, quality, regularity and timing) as well as daytime alertness. This construct is well-suited for investigating variability within multiple related aspects of sleep in "healthy" populations, such as young adults without frank or diagnosed sleep disorders. Importantly, to my knowledge, the only previous study in mid-life adults found associations between self-reported childhood adversity and worse actigraphy- and daily diary-measured sleep health (Brindle et al., 2018).

In addition to the paucity of data on behaviorally-measured sleep in normative samples, the adversity and sleep literature is also limited by a lack of investigation into mechanisms underlying the adversity-sleep relationship. In general, the underlying rationale (albeit currently untested) is that family environments characterized by a lack of safety, security, and nurturing relationships lead individuals to be wary of threat in the social environment, leading to poorer sleep. Consequently, exposure to childhood adversity may influence sleep through increased threat perception, which is antithetical to the feelings of safety and security that are required in order to promote sleep (e.g., Dahl & Lewin, 2002).

The aim of the proposed study was to examine whether individuals who report cumulative childhood adversity (i.e., exposure to *multiple* different types of adversity), through age 18 demonstrate poorer sleep health by survey, actigraphy, and daily diary measures, and whether this relationship is partially mediated by increased vigilance to threat (see Figure 1 for proposed study model). These aims were examined in healthy undergraduates who differed on retrospective report of childhood adversity, with the expectation that cumulative childhood adversity would be associated with poorer sleep health. Participants completed laboratory tasks designed to measure threat perception, as well as a seven-day actigraphy and daily diary protocol in order to record daily information about sleep and threat vigilance. It was hypothesized that those with cumulative childhood adversity would demonstrate increased vigilance for threat, which would partially explain poorer sleep health.

This proposal begins by defining childhood adversity and reviewing the extant literature on childhood adversity and sleep. Sections discuss evidence for the potential explanatory mechanisms of vigilance for threat and the importance of studying relationships between childhood adversity and sleep in healthy young adults. Finally, this paper describes results and conclusions from an investigation into mechanisms linking adversity and poor sleep health.

1.1 Literature Review

A growing body of evidence points to the importance of early stressful experiences, more recently called "adverse childhood experiences" (ACEs), for setting the trajectory of poor mental and physical health across the life course. Henceforth, this paper will use the terms ACEs and childhood adversity interchangeably to refer to this construct. The Centers for Disease Control and Prevention (CDC) define ACEs as family environments that lack safety, stability, or nurturing relationships (2013). However, the concept of childhood adversity is applied more broadly in the literature, and generally indicates exposure to a combination of abuse, neglect, and household challenges (typically defined as domestic violence, substance use, mental illness, or incarceration; Felitti et al., 1998), or poverty. Taken together, these adverse family environments and consequent experiences pose challenges for children and adolescents' cognitive, psychosocial, and physical development. Importantly, data suggest that exposure to ACEs is prevalent in the United States, and furthermore, that the types of adversities are inter-related and often overlap (M. Dong et al., 2004). For example, in a sample of 29,229 adult men and women, over 50% of the sample reported at least one form of childhood adversity and 17% reported four or more adverse experiences (Font & Maguire-Jack, 2015).

The overarching rationale for research on childhood adversity has been quite simple: the more bad things that occur in childhood, the worse the long-term mental and physical health. Review papers have reported associations between various types of adversity and a plethora of poor outcomes in adulthood that span mental health, physical health, and psychosocial domains, including: increased alcohol and drug abuse (Kalmakis & Chandler, 2015; Norman et al., 2012); depression, anxiety, suicidality, and eating disorders (Kalmakis & Chandler, 2015; Norman et al., 2012); inflammation (Baumeister, Akhtar, Ciufolini, Pariante, & Mondelli, 2015), obesity (Danese

& Tan, 2014; Norman et al., 2012), increased health care utilization (Kalmakis & Chandler, 2015); psychosocial outcomes such as lower adult education and income (Font & Maguire-Jack, 2015); risky sexual behaviors (Norman et al., 2012); and finally, sleep disorders such as apnea and narcolepsy (Kajeepeta et al., 2015).

Accordingly, many researchers have turned their attention to sleep as a behavioral pathway that may help explain the relationship between childhood adversity and multiple long-term outcomes of adult disease, particularly cardiometabolic disease, which broadly reflects cardiovascular disease (CVD) and metabolic disorders (e.g., diabetes, metabolic syndrome). Globally, CVD and diabetes are two of the leading causes of death, accounting for 31% and 5.2% of deaths globally in 2011, as well as a combined economic burden exceeding $550 billion in the United States alone (Go et al., 2014). Several previous reviews and meta-analyses have found associations between childhood abuse and neglect and cardiometabolic outcomes, including CVD (Norman et al., 2012; Wegman & Stetler, 2009), obesity (Danese & Tan, 2014), metabolic outcomes (Wegman & Stetler, 2009), and diabetes (Huang et al., 2015). Recently, the focus has shifted to understanding the impact of *cumulative* adversities, which includes exposure to *multiple* different types of adversity (as opposed to just abuse or neglect), including aspects of household dysfunction. Indeed, a recent meta-analysis (Jakubowski, Cundiff, & Matthews, 2018) suggests a small, but significant, effect of the accumulation of adversities from birth to 18 years on adult cardiometabolic outcomes.

Importantly, meta-analytic results suggest that short sleep is a risk factor for poor cardiometabolic health, including hypertension (Meng, Zheng, & Hui, 2013), diabetes (Cappuccio, D'Elia, Strazzullo, & Miller, 2010), metabolic syndrome (Xi et al., 2013), and morbidity and mortality from coronary heart disease and stroke (Cappuccio, Cooper, D'Elia, Strazzullo, & Miller, 2011). Thus, investigating links between adversity and sleep, the focus of the proposed project, may provide intermediate targets for reducing the overall burden of cardiometabolic disease.

1.2 Associations Between Childhood Adversity and Sleep

Considering the broader context of adversity and CM health, an enumerative review of five studies suggested that sleep may mediate relationships between traumatic stress (i.e., typically measured as symptoms of post-traumatic stress disorder; PTSD) and behavioral outcomes in adults (Spilsbury, 2009). Indeed, this suggests that sleep may play an important role in contributing to the burden of disease that results from exposure to traumatic life events. Although the data is limited, the review by Spilsbury (2009) suggests that sleep may be one mechanism underlying the link between trauma and physical health outcomes, however, the proposed project will focus on the relationship between childhood adversity and sleep.

In a recent systematic review, Kajeepeta et al. (2015) discusses the extant literature on childhood adversity and sleep. They identified 30 studies: 28 involved retrospectively-reported adversity and cross-sectional associations with a variety of sleep outcomes and two involved prospective, longitudinal data. Overall, 25 of 28 retrospective studies found associations between adversities and self-reported sleep disorders, including sleep apnea, narcolepsy, nightmare distress, sleep paralysis, and insomnia. In some studies, the strength of the association increased with exposure to greater numbers of adversities. This overall pattern was corroborated by results from two prospective studies, however, it is important to note that these studies did not look at cumulative childhood adversity specifically.

For example, in the Dunedin cohort of 1,037 men and women, Gregory and colleagues (2006) found a link between parent report of family conflict during childhood (i.e., four reports of conflict across child ages 7-15) and insomnia experienced at child age 18, even after controlling for sleep problems at age 9, childhood SES, and self-reported health and depression at age 18. Additionally, in a sample of in 147 females (roughly half experienced sexual abuse during the ages of 6-16 years), Noll and colleagues (2006) found that childhood sexual abuse predicted sleep disturbances 10 years later (i.e., a standardized composite included items such as trouble falling asleep, nighttime awakenings, and not getting enough sleep). Importantly, these associations persisted above and beyond current depression and PTSD symptoms. Consistent with a limitation of the broader literature on childhood adversity and physical health outcomes, Kajeepeta et al. (2015) noted that there was great heterogeneity in the types of adversities measured, and the review included a mixture of studies assessing just one type of abuse (e.g., sexual abuse) versus cumulative measures of adversity. Furthermore, there was great variability in terms of covariates, such that 15 of 28 retrospective studies adjusted for no covariates or only age, while 1 of the 2 prospective studies adjusted only for age.

Although the bulk of the extant literature involves subjective measures of sleep quality, sleep disturbances, or sleep disorders, the Kajeepeta et al. (2015) review included seven studies that involved objectively-assessed sleep, such as actigraphy or polysomnagraphy (PSG). However, all of these studies were conducted in clinical samples, including individuals with diagnosed psychiatric conditions (e.g., alcohol dependence, psychiatric outpatients), medical conditions (e.g., irritable bowel syndrome), or sleep disorders (insomnia). Overall, these studies suggested associations between exposure to childhood adversity and poorer sleep parameters, such as risk and/or severity of insomnia (Brower, Wojnar, Sliwerska, Armitage, & Burmeister, 2012;

Zhabenko, Wojnar, & Brower, 2012), decreased time spent in REM sleep (Heitkemper, Cain, Burr, Jun, & Jarrett, 2011), increased nocturnal arousals (Bader et al., 2007b), decreased actigraphy-assessed total sleep time (Schafer & Bader, 2013) and sleep efficiency (Bader et al., 2007a; Bader et al., 2007b; Schafer & Bader, 2013), as well as increased actigraphy-assessed sleep latency (Bader, Schafer, Schenkel, Nissen, Kuhl, et al., 2007; Schafer & Bader, 2013). Ultimately, although the pattern of associations between adversity and sleep was generally positive, results may not be generalizable to "normative" (i.e., non-clinical) sleeping populations.

Specific to non-clinical samples, there are several studies that have assessed relationships between childhood adversity and sleep duration, sleep quality, and daytime functioning in "normative" sleeping samples, although all of the studies involved self-report measures of sleep. Regarding sleep duration, one large study of adults (N=25,810) found associations between cumulative childhood adversity and risk of reporting "frequent insufficient sleep" in the past 30 days, which persisted beyond adjustment for mental distress (Chapman et al., 2013). With regard to sleep quality, a large representative study of 25,605 Finnish men and women reported associations between increasing numbers of cumulative adversities and poorer self-reported sleep quality (Koskenvuo, Hublin, Partinen, Paunio, & Koskenvuo, 2010), while a study of 19,349 Canadian adults found a positive relationship between cumulative adversity and frequency of troubled sleep (e.g., problems falling asleep or staying asleep; Baiden 2015). Finally, childhood adversity has been related to aspects of poorer sleep-related daytime functioning, such as self-reported daytime sleepiness (Agargun et al., 2003; Cho, Bower, Kiefe, Seeman, & Irwin, 2012; Greenfield, Lee, Friedman, & Springer, 2011) including one large sample of 17,337 American adults (Chapman et al., 2011), as well as greater use of prescription or over-the-counter sleep medications (Greenfield et al., 2011). Together, these results suggest associations between cumulative childhood adversity and self-reported sleep outcomes in large, representative samples of men and women without frank diagnosed sleep disorders or psychiatric conditions.

1.3 Studying Normative Sleep

As discussed, even in non-clinical samples, there is still great variability in terms of sleep parameters, particularly in relation to childhood adversity. An emerging construct in the sleep literature is that of "sleep health" (Buysse, 2014), which involves taking a 24-hour approach to the study of sleep. Sleep health is a multidimensional measure including characteristics of nighttime sleep, such as duration, efficiency, quality, timing within the 24-hour day and regularity (i.e., the variability of nightly sleep timing; Patel et al.,2014), as well measures of daytime alertness or sleepiness, such as daytime napping. This construct is particularly relevant for the proposed project, as it is well-suited for investigating variability within multiple related aspects of sleep in "healthy" populations, such as young adults without sleep disorders.

To my knowledge, only one study in mid-life adults has investigated associations between self-reported childhood adversity and sleep health (Brindle et al., 2018). This study involved 161 mid-life adults (mean age = 60) who retrospectively reported on cumulative childhood adversity. The aforementioned components of the sleep health composite were measured by self-report in daily diaries and actigraphy; each component was dichotomized to indicate good/poor sleep according to established age-specific criteria in the literature. Components were summed to obtain a composite score of 0 to 6, with higher values representing greater sleep health. Results suggested that cumulative childhood adversity was associated with poorer diary-based and actigraphy-based sleep health, after adjustment for age, sex, daily alcohol use, BMI, current stress, lifetime depression history, subjective social standing, and interpersonal support. Regarding individual sleep dimensions, childhood adversity was associated with worse diary-assessed efficiency, but not with any actigraphy-assessed sleep dimension.

Thus, results suggest that greater cumulative adversity may be related to a composite of several health-relevant dimensions of sleep in non-clinical samples. Although no other data, to my knowledge, exists on adversity and timing or regularity of sleep (*cf.* previously discussed evidence on sleep duration, efficiency, quality, and daytime sleepiness), evidence suggests that these sleep parameters are important to study in relation to cardiometabolic-related outcomes, such as insulin resistance (Knutson, Wu, et al., 2017; B. J. Taylor et al., 2016).

1.4 Limitations of the Childhood Adversity-Sleep Literature

Overall, the adversity-sleep literature has several notable limitations. First, despite evidence that retrospectively-reported childhood adversity shows associations with sleep-related disorders and disturbances in adults, the study populations and sleep outcomes of interest have been limited. Specifically, there are very few studies in samples without diagnosed sleep or psychiatric disorders, which limits the ability to generalize findings to sleep health in non-clinical samples. Second, there is a paucity of data on behaviorally-measured sleep (i.e., actigraphy) to complement subjective measurements of sleep in normative samples. Third, studies adjust for a range of covariates, with some adjusting for few or even none at all. As a result, it can be difficult to place findings about adversity and normative sleep in the context of what we already know about both adversity and sleep with cardiometabolic-related outcomes. Ultimately, sleep in non-clinical samples has not been well-studied in the context of childhood adversity, even though it may help us better understand long-term risk for worse cardiometabolic outcomes. Thus, the focus of the proposed study is on the relationship between adversity and sleep in a normative-sleeping healthy sample and potential mechanisms of this relationship.

1.5 Vigilance for Threat

If it is the case that cumulative childhood adversity is associated with worse sleep health, one might question the mechanisms that underlie this relationship. In general, the underlying rationale (albeit currently untested) is that family environments characterized by a lack of safety, security, and nurturing relationships may lead individuals to be wary of threat in the social environment and less secure in one's relationships with others, leading to poorer sleep, a process that inherently requires feelings of safety and security (e.g., Dahl & Lewin, 2002); see Figure 1.

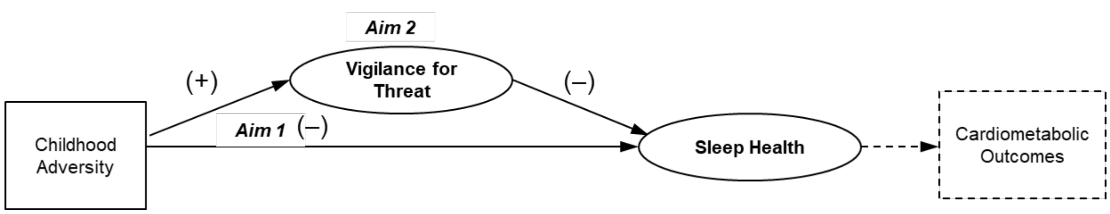

Figure 1. Proposed study model

Note. Broken lines indicate a relationship that is hypothesized in the extant literature but will not be tested in the proposed project. (+) = positive association; (-) = negative association. Threat perception and sleep health are latent factors.

One mechanism that may link exposure to adverse experiences in childhood to sleep problems is exaggerated vigilance for threat. At a basic level, sleep requires a safe and predictable environment, and exposure to childhood adversity may interfere with perceptions of current environments and social experiences. Beginning early in life, some children tend to evaluate certain situations more negatively than others (Crick & Dodge, 1994), which is often related to exposure to family environments and life events that are more chaotic, less predictable, and less stable. This may range from harsh parenting styles to environments that are overtly dangerous, such as abuse or witnessing domestic violence. Over time, children in these environments may begin to view the world as a threatening place that necessitates constant vigilance, and consequently, become likely to appraise social events as threatening, even in the absence of clear evidence of threat (Chen, Langer, Raphaelson, & Matthews, 2004).

1.5.1 Vigilance for Threat and Childhood Adversity

A great deal of the literature on threat perceptions in the context of childhood adversity involves assessing responses to ambiguous stimuli between individuals with a history of adversity and controls. In general, data suggests that exposure to threatening environments (e.g., physical and sexual abuse, neglect, and domestic violence) is associated with alterations in neural pathways that are involved in fear learning (see McCrory, Gerin, & Viding, 2017; Sheridan & McLaughlin, 2014). For example, evidence suggests elevated amygdala reactivity to threatening stimuli, such as angry or fearful faces, in children with histories of institutionalization (Silvers et al., 2017) or maltreatment (McCrory et al., 2013; McCrory et al., 2011). With regard to behavioral data, children with a history of maltreatment also demonstrate different patterns of identifying and responding to angry faces, relative to control children, such that they are faster to label anger in others' faces (Pollak & Sinha, 2002) and more likely to identify anger in faces with ambiguous expressions (Pollak & Kistler, 2002). Prior studies have also reported that children with a history of maltreatment or adversity tend to have a bias toward threat cues (e.g., Briggs-Gowan et al., 2015; Gray, Baker, Scerif, & Lau, 2016; Gulley, Oppenheimer, & Hankin, 2014; Swartz, Graham-

Bermann, Mogg, Bradley, & Monk, 2014), although some evidence suggests a bias *away* from threat (Pine et al., 2005). Additionally, other forms of childhood adversity (e.g., parental loss or divorce) have been associated with attentional vigilance toward cues relevant to loss (Luecken & Appelhans, 2005).

Finally, vigilance for threat has been tested in low- versus high-SES adolescents by having them rate their reactions to a video depicting social scenarios with ambiguous outcomes, such as a teacher discussing suspected cheating on a test, then asking to speak to one student (Chen et al., 2004; Chen & Matthews, 2003; Chen, Matthews, & Zhou, 2007). Across several samples, results indicate that adolescents from lower- vs. higher-SES backgrounds tend to interpret ambiguous scenarios as more threatening (e.g., "He thinks I cheated"). Furthermore, adults who were raised in lower-SES households made more threatening appraisals of ambiguous situations, even controlling for current SES (unpublished data reported in Miller, Chen, & Parker, 2011). This suggests that appraisal tendencies may be shaped by early life experiences and persist in a fairly stable fashion throughout the life span.

1.5.2 Vigilance for Threat and Sleep

Sleep is particularly important to study in the context of threat perception. Sleep and vigilance are oppositional physiological states (Buckley & Schatzberg, 2005; Dahl & Lewin, 2002), thus, one must feel a sense of safety and security in one's environment in order to fall asleep and to stay asleep throughout the night. The topic of arousal/vigilance and sleep has received considerable study in the context of PTSD-related sleep disturbances in children, with data indicating that exposure to traumatic experiences (e.g., maltreatment, war-related violence, and displacement) impacts children's ability to reduce arousal before bedtime and to self-soothe to fall asleep (Charuvastra & Cloitre, 2009).

Although there is no data on vigilance for threat and sleep outside of the context of PTSD, several studies have examined associations between sleep and perceptions of neighborhood safety, from which we may infer vigilance for threat. Data suggest associations between greater perceived neighborhood crime and safety concerns and worse sleep, including fewer days of adequate sleep in children (Singh & Kenney, 2013) and shorter and poorer quality sleep and increased daytime sleepiness in adults (Desantis et al., 2013; Hale et al., 2013; Hill, Burdette, & Hale, 2009; Johnson et al., 2017). However, some data suggests associations between *exposure* to violence, not merely perceptions, and risk of reporting short and interrupted sleep (Johnson et al., 2017). Overall, there is an association between perceived or actual exposure to threatening of unsafe environments and deleterious effects on sleep parameters.

1.5.3 Vigilance for Threat and Health Outcomes

Vigilance for threat is important to study in the context of childhood adversity and sleep, because have been further linked to poorer cardiovascular health outcomes. Increased threat interpretations in adolescents during ambiguous (but not negative) situations were related to greater laboratory-measured DBP and HR reactivity (Chen et al., 2004), as well as greater ambulatory SBP when interacting with others, particularly with friends (Chen et al., 2007). Furthermore, college males who were primed to attend to threat-relevant statements demonstrated significantly higher SBP and DBP responses during subsequent stressors, relative to males who were assigned to search for statements that were positive or neutral (Gump & Matthews, 1998).

1.5.4 Interim Summary

Given the aforementioned evidence, it was expected that individuals exposed to childhood adversity would demonstrate greater vigilance to threat during the day. This would negatively impact their ability to feel safe and secure, conditions that are necessary for the promotion of sleep, and partially explain the link between adversity and poor sleep health.

1.6 Investigating Adversity and Sleep in College Students

The present study investigates the relationship between childhood adversity and sleep in a sample of undergraduate students. Consistent with the broader literature, the extant data in college samples primarily involves sleep disturbances. For example, evidence suggests associations between abuse or witnessing violence in the family and higher frequencies of nightmares and related distress (e.g., Agargun et al., 2003; Chambers & Belicki, 1998; Haj-Yahia & de Zoysa, 2008), as well as sleep apnea and narcolepsy (Chambers & Belicki, 1998). Most relevant to the proposed study, Ramsawh and colleagues (2011) found an association between childhood adversity and sleep quality in college students, particularly in males.

There are several reasons why college students represent a particularly important group in which to examine the relationship between adversity and sleep. First, sleep is very poor in this group. Data suggests that adults aged 18 – 25 need approximately 7-9 hours of sleep at night (Hirshkowitz et al., 2015), however, only about 30% of college students report obtaining at least 8 hours (Lund, Reider, Whiting, & Prichard, 2010). Furthermore, survey results from over 90,000 male and female college students found that on at least 3-5 days a week, only half reported "getting enough sleep to feel rested in the morning" and over 40% reported feeling "tired, dragged out, or sleepy during the day" (American College Health Association, 2012). Second, data suggests that short or poor sleep during college is related to worse proximal outcomes, such as decreased academic performance and increased depressive symptoms (for a review, see Hershner & Chervin, 2014) and poorer self-rated health (Steptoe, Peacey, & Wardle, 2006). Ultimately, college may represent a period in which young adults are more vulnerable to the effects of poor sleep, and it is important to investigate risk factors, such as childhood adversity, that may lead to worse sleep in this group.

1.7 Potential Confounders

The present study measured potential correlates of childhood adversity and poor sleep in order to strengthen confidence that exposure to adversity has a unique impact on sleep, above and beyond concurrent psychosocial, behavioral, and health factors in adulthood. Exposure to childhood adversity has been associated with elevated depressive and anxiety symptoms in meta-analytic findings (Norman et al., 2012), as well as with PTSD symptoms in clinical (Cloitre et al., 2009) and epidemiological samples (Koenen, Moffitt, Poulton, Martin, & Caspi, 2007). Additionally, meta-analytic evidence suggests that short or poor sleep is associated with depression (Zhai, Zhang, & Zhang, 2015) and anxiety (Baglioni et al., 2016), while sleep disturbances are a hallmark of PTSD symptoms (Germain, 2013).

Meta-analyses also indicate associations between childhood adversity and obesity (e.g., Danese & Tan, 2014), as well as with smoking and alcohol use (Norman et al., 2012), and epidemiological data suggests associations with physical inactivity (Felitti et al., 1998). Indeed, meta-analytic results find associations between short sleep and obesity (Cappuccio et al., 2008), and one large epidemiological sample found that short sleepers, particularly males, are more likely to be physically inactive, smoke, and drink alcohol heavily (Strine & Chapman, 2005).

Finally, data suggests that childhood socioeconomic status (SES) is a correlate of both sleep problems (Tomfohr, Ancoli-Israel, & Dimsdale, 2010b) and poor cardiometabolic outcomes in adulthood (S. Cohen, Janicki-Deverts, Chen, & Matthews, 2010), and individuals from adverse family environments tend to have lower SES (Evans, 2004). Of relevance, there is little consistency in the literature concerning how (or if) studies include childhood SES in their definition of childhood adversity.

1.8 Statement of Purpose

Although childhood adversity is associated with sleep disorders and disturbances, little data exists in non-clinical samples. The proposed project investigated the hypothesis that exposure to cumulative childhood adversity would be associated with poorer sleep health (i.e., a latent factor including indicators of short, inefficient, and low quality sleep; later and more variable sleep timing; and more daytime napping) measured by survey as well as across a 7-day actigraphy and daily diary protocol in healthy undergraduate students. Furthermore, it was expected that increased vigilance to threat (measured via survey, daily diary, behavioral and physiological measures) would partially explain the relationship between childhood adversity and sleep. Over time, it is possible that poor sleep demonstrated in young adults may lead to poor cardiometabolic outcomes, as outlined in Figure 1, although it was not the purpose of the proposed study to assess these outcomes.

The proposed project has several positive and novel features. First, it will shed light on the impact of childhood adversity on several aspects of sleep, as well as relevant mechanisms, in a healthy, non-clinical sample. Examining naturalistic sleep patterns in important, as changes in sleep duration, efficiency, and quality, as well as daytime characteristics, have been associated with long-term cardiometabolic health, even in individuals without frank diagnosed sleep disorders and disturbances. Second, it includes both objective and subjective measurements of sleep. This is particularly important, given recent data that suggests differential associations between retrospectively-assessed adversity and subjective versus objective measurement of psychosocial and physical health outcomes (Reuben et al., 2016). Third, it includes multi-method assessment of the hypothesized mediator (vigilance for threat). Fourth, this study adjusts for known correlates of both adversity and sleep, which will allow us to determine if childhood adversity contributes unique variance to poor sleep in young adults. Finally, studying mechanisms of the adversity-sleep relationship in a young adult sample may provide intermediate targets for intervention, which may have a positive downstream influence on reducing the prevalence of cardiometabolic diseases.

1.9 Specific Aims and Hypotheses

1.9.1 Primary Analyses

Specific Aim 1: Examine whether cumulative childhood adversity is associated with worse adult sleep health.

Hypothesis 1: Cumulative childhood adversity will be associated with worse sleep health.

Specific Aim 2: Examine vigilance for threat as a cross-sectional mediator of the association between cumulative childhood adversity and worse adult sleep health.

Hypothesis 2: Survey, daily diary, physiological, and behavioral measures of vigilance for threat will partially explain the relationship between cumulative childhood adversity and worse sleep health. Accordingly, it is expected that cumulative childhood adversity will be associated with the following: self-reporting greater vigilance for threat in social situations via (a) retrospective survey and (b) prospective daily diary-reported interactions across one week; (c) demonstrating increased cardiovascular reactivity in response to challenging laboratory tasks; (d) rating standardized social scenarios with ambiguous outcomes as more threatening; (e) responding differently to threatening stimuli on an attention bias task (i.e., demonstrating an attentional bias either *towards* or *away* from threat cues), compared to individuals with no history of childhood adversity. A specific directional hypothesis was not made for (e), given that both patterns have been reported in the literature using similar paradigms to that in the present study (Zvielli, Bernstein, & Koster, 2014).

1.9.2 Exploratory Analyses

Exploratory Aim 1: Examine whether the relationship between cumulative childhood adversity and adult sleep health is stronger in those who also report witnessing violence or living in an unsafe neighborhood.

Exploratory Aim 2: Examine the contribution of low childhood SES to poor sleep health in the context of childhood adversity.

Exploratory Aim 3: Examine the contribution of putative confounding variables (i.e., BMI and symptoms of depression, anxiety, and PTSD) to poor sleep health in the context of childhood adversity.

2.0 METHODS

2.1 Participants

Undergraduate males and females between ages 18-30 were recruited from the University of Pittsburgh between November 2017 and June 2018 to participate in a study on "Childhood Experiences and Adult Sleep". The study aimed to recruit participants across the full range of exposure to childhood adversity, with the overarching aim to obtain balanced groups of individuals with 0, 1, and 2+ exposures. For the purposes of this study, "balanced" refers to relatively similar proportions of race and sex across levels of adversity, and not necessarily equal numbers. Participants were recruited from the Introduction to Psychology undergraduate subject pool, in which students receive course credit for participating in research studies, or from other undergraduate psychology courses. Exclusion criteria were as follows: less than 18 or greater than 30 years of age; engaging in overnight or shift work; having a diagnosed sleep disorder; using medications for sleep, depression, anxiety, or blood pressure; using marijuana ≥10 times in the past month; or consuming ≥ 5 (males) or ≥ 4 (females) alcoholic drinks at the same time or within a couple of hours of each other in the past month.

2.2 Procedure

Approval for all study procedures was obtained from the University of Pittsburgh Human Research Protection Office. The study involved two phases of data collection: an online survey (Phase I) and a laboratory study and weeklong sleep protocol (Phase II); see Figure 2.

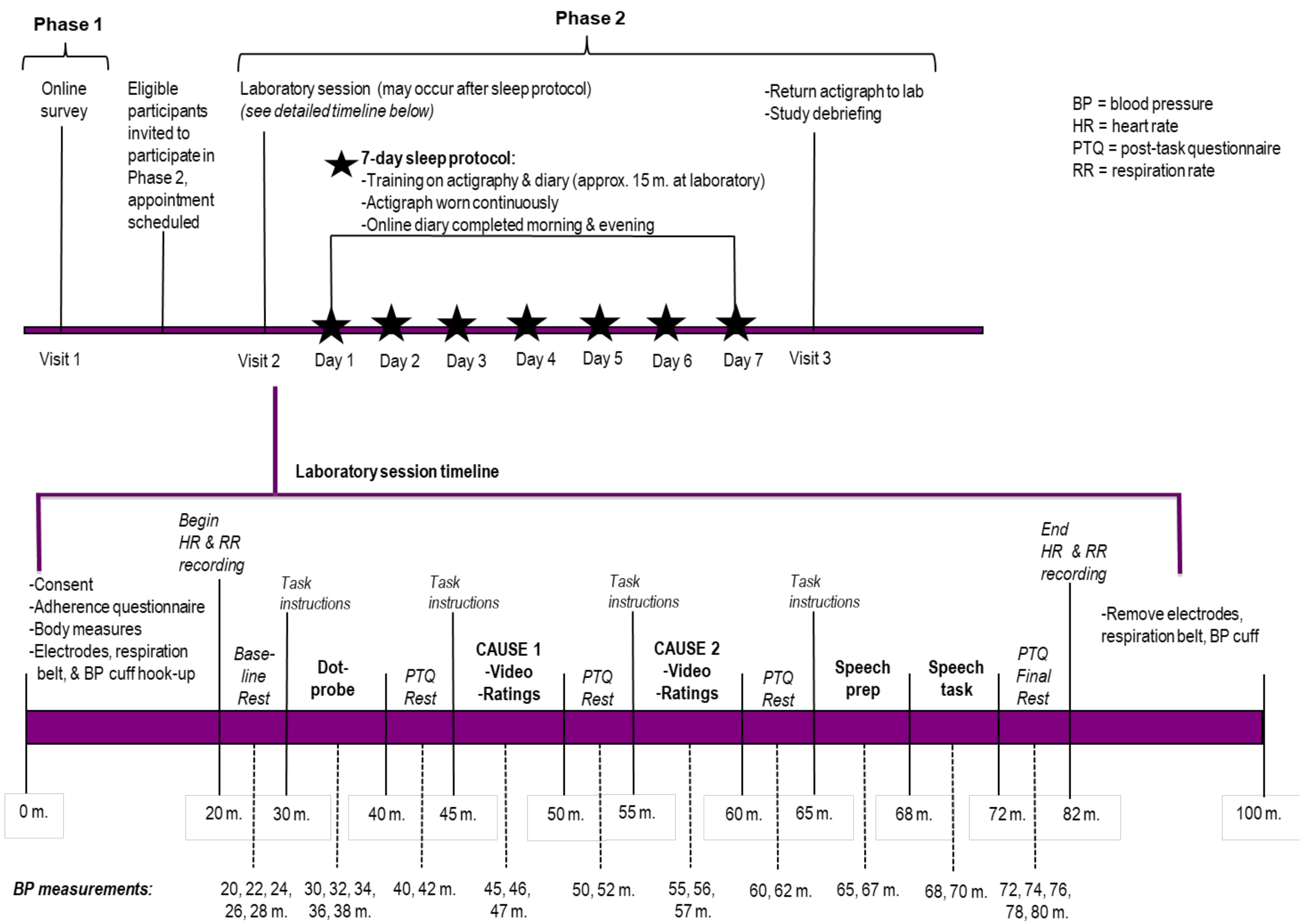

Figure 2. Phase I and Phase II study timeline

2.2.1 Phase I: Online Recruitment Survey

Participants were invited to complete an online survey (Qualtrics; Provo, UT) and to self-screen that they met study inclusion/exclusion criteria prior to clicking on a link that took them to an online consent form. Participants were able to start the survey after clicking to consent and confirming they were at least 18 years old. The survey terminated for participants who did not consent or who were less than 18 years old. Participants were able to complete the online survey at their convenience from any device with internet access, although they were advised to use a computer to ensure optimal display of all survey items. The median length of time to complete the survey was 32 minutes, with 88% of the sample completing the survey in 60 minutes or less. At the conclusion of the survey, participants viewed a list of community resources, including Pitt Student Health, Pitt Counseling Center, the University of Pittsburgh Clinical Psychology Center, and re:solve crisis hotline. Participants indicated whether they wanted to be contacted via e-mail regarding their eligibility to participate in the Phase II laboratory/sleep study. Names and e-mail addresses of interested participants were copied to a tracking document without subsequent labeling of group (control vs. adversity). Eligible and interested participants were invited to participate in Phase II via e-mail.

2.2.2 Phase II: Laboratory Visit and Sleep Protocol

The start of laboratory visits ranged from 8:00am – 6:00pm, depending on participant and experimenter availability, and lasted for 90-120 minutes, which varied due physiological equipment and/or computer malfunction. Of the 114 participants who completed Phase II, 61

(53.5%) started the visit before 12:00pm, 39 (34.2%) started between 12:00-4:00pm, and 14 (12.3%) started after 4:00pm. Visits were conducted on both weekdays and weekends to provide maximum flexibility, however, visits were not conducted during winter break, spring break, or finals week, due to anticipated changes in sleep schedules. Prior to beginning any research procedures, participants signed written informed consent and confirmed that they still met all Phase I inclusion/exclusion criteria and that they followed Phase II pre-testing instructions, i.e., avoiding caffeine, tobacco, and exercise for 3 hours prior to the laboratory visit.

Figure 2 displays the laboratory session timeline. Participants were set up with the physiological monitoring equipment before being seated upright in a comfortable lounge chair in a separate, quiet room. After a 10-minute baseline of watching a non-narrative nature video, participants completed three tasks: (1) a visual probe detection or "dot probe" task (12 min, broken into 3 blocks of 4-min; see Appendix A); (2) watching two video vignettes (4 min each) of ambiguous social scenarios and rating their cognitive and emotional interpretations of each video (Appendix B.1-B.3); and (3) a speech task in which they were instructed to describe a recent anxiety-provoking situation that impacted their sleep (3 min speech preparation, 4 min speech delivery; Appendix C and D). The speech was audio-recorded and participants were told that it would be later coded for clarity and style. Each task was followed by a 5-min recovery period, during which participants watched a non-narrative nature video. Participants were informed of each task's end by an experimenter who was seated in a separate room. The experimenter did not interact with participants during task or rest periods, with the exception of the speech task – the experimenter provided standardized prompts if participants were unable to speak for the required 4-minute duration. The speech task was followed by a 10-minute final rest period of watching a non-narrative nature video. At the beginning of each rest period, participants rated task demand

and stressfulness on a 5-point Likert-type scale (1 = *not at all* to 5 = *very*) for the dot probe, CAUSE videos, and speech tasks. Participants answered several additional questions about the speech, including whether they: (1) felt they captured the event in their speech; (2) felt almost as strongly during their speech as during the situation; (3) started feeling bodily reactions; and (4) felt nervous, anxious, or tense (Appendix E).

Systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse rate (PR) were monitored during the laboratory protocol using a CARESCAPE Dinamap V100 Vital Signs Monitor (GE Medical Systems Information Technologies, Inc.) with a standard occluding cuff placed on the participant's non-dominant arm. Heart rate (HR) was monitored continuously collected from electrocardiogram (ECG) signals using a modified lead II configuration; collection followed procedures by Jennings et al. (1981). Participants were also fitted with a respiratory band, which was wrapped tightly enough to allow only the experimenter's index and middle fingers to fit underneath. HR and the signal for the respiratory belt was transduced by Biopac Systems (Goleta, CA) modules (ECG and RSP modules of 100C series). After calibration of the recording equipment, participants began the baseline rest period. SBP, DBP, and PR collection occurred every two minutes during the 10-minute baseline and final rest periods, twice during each task (including each block of the dot-probe task), and twice during the 5-minute between-task rest periods. Measures were not taken during the first five minutes of the baseline rest period to allow participants time to acclimate to the recording equipment.

After the final rest period, recording devices were removed and participants were trained on the sleep protocol, which involved wearing an actigraph continuously and completing online morning/evening sleep diaries for one week. At the end of the protocol, participants returned the watch to the laboratory and received study de-briefing and compensation. Trained undergraduate research assistants contributed to various portions of Phase II.

2.2.3 Study Compensation

Study compensation reflected the recruitment method. Psychology subject pool participants received 1 hour of research credit for Phases I and 3 hours of research credit for Phase II; participation in both study phases fulfilled the research credit requirement for Introduction to Psychology. Participants who did not need research credit were provided monetary payment. The total payment for completion of Phases I and II ranged between $40-75, split between the online survey ($5-10), laboratory visit ($20-30), and sleep protocol ($15-35). The range in total compensation reflects two separate increases during the recruitment period (i.e., from $40 to $50 to $75), aimed at increasing motivation for participation in Phase II prior to the end of the academic calendar. Of the 114 individuals who participated in Phase II, a total of 75 (66%) were compensated via research credit hours only, while 5 (4%), 22 (19%), and 12 (11%) participants received $40, $50, or $75 payment, respectively.

2.3 Measures

2.3.1 Online Recruitment Survey

2.3.1.1 Demographic and health information

Participants reported demographic characteristics (e.g., age, race, sex), diagnosed sleep or medical conditions, current medications, whether they were currently living at home or on campus, and height (in) and weight (lbs), which were used to compute BMI [i.e., (lbs / in^2)*703]. The 2017 CDC Youth Risk Behavior Surveillance System (YRBSS) was used to assessed frequency of smoking cigarettes, using marijuana, or having at least one drink of alcohol in the past 30 days on a 7-point scale, ranging from 0=0 days to 6=all 30 days; this scale also assessed frequency of exercising for at least 60 minutes in the past seven days on an 8-point scale, ranging from 0=0 days to 7=all 7 days.

2.3.1.2 Childhood SES

Participants completed a six-item questionnaire about childhood SES drawn from the Study of Women's Health Across the Nation (e.g., Matthews et al., 2016), which included: (1) mother's and father's highest education level in six categories (1=less than high school, 6=postgraduate degree), (2) whether their family owned a car or (3) owned a home when they were children or teenagers, (4) whether their childhood family ever received public assistance, and (5) whether their childhood family ever had difficulty paying for food or rent or (6) difficulty making ends meet. Participants responded yes/no to items 2-6; items were reverse-scored as needed to reflect lower SES. Parents' education level was categorized such that having at least one parent with a high school degree or less was coded as 1 and having at least one parent with more than a high school education was coded as 0. Items were summed to form a composite variable, such that higher values reflected lower SES (range = 0-5).

2.3.1.3 Adverse childhood experiences (ACEs)

Participants' exposure to adversity in the home before age 18 was assessed using 21 items adapted from the 2017 CDC Behavioral Risk Factor Surveillance System Questionnaire ACE module and Kaiser Permanente ACE Study (Felitti et al., 1998). The ACE questionnaire measures exposure to abuse, neglect, and household challenges (e.g., mental illness, incarceration) involving parents, caregivers, or other adults in the home. Sexual abuse was assessed as *any* exposure, including outside of the family/home environment; see Table 1 for items and scoring criteria. Responses were dichotomized to reflect yes/no exposure and the total score (possible range = 0-10) reflects the number of ACEs that met scoring criteria. Internal consistency was high; Cronbach's alpha = .839.

Table 1. Adversity questionnaire items and measurement

Category	Description	Scoring	Citation
Abuse			
Emotional (2 items)	*How often did a parent, step-parent, or other adult in the household …* (1) Swear at you, insult you, or put you down? OR (2) Act in a way that made you afraid that you might be physically hurt?	Possible response: Never, sometimes, **often, very often**.	(1)
Physical (2 items)	*How often did a parent, step-parent, or other adult in the household …* (1) Push, grab, slap, or throw something at you? OR (2) Ever hit you so hard that you had marks or were injured?	Possible response: Never, sometimes, **often, very often**.	(1,3)
Sexual (4 items)	*How often did an adult or person at least 5 years older ever …* (1) Touch or fondle you in a sexual way? (2) Have you touch their body in a sexual way? (3) Attempt oral, anal, or vaginal intercourse with you? OR (4) Actually have oral, anal, or vaginal intercourse with you?	Possible response: Never, **once, more than once.**	(1)
Neglect			
Emotional (2 items)	*Did you feel that …* (1) No one in your family loved you or thought you were important or special? OR (2) Your family didn't look out for each other, feel close to each other, or support each other?	Possible response: Never, sometimes, **often, very often.**	(2)
Physical (3 items)	*Did you feel that …* (1) You didn't have enough to eat, had to wear dirty clothes, and/or had no one to protect you? (2) Your parents were too drunk/high to take care of you? OR (3) There was no one to take you to the doctor if you needed it?	Possible response: Never, sometimes, **often, very often**.	(2)
Household Challenges			

<u>Substance abuse</u> (2 items)	*Have you ever lived with anyone who …* (1) Was a problem drinker or alcoholic? OR (2) Used illegal street drugs or who abused prescription medication?	Possible response: **Yes** or No.	(1,4)
<u>Mental illness</u> (2 items)	(1) Was a household member depressed or mentally ill? OR (2) Did a household member attempt suicide?	Possible response: **Yes** or No.	(1)
<u>Criminal household member</u> (1 item)	(1) Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?	Possible response: **Yes** or No.	(1,3)
<u>Parental marital discord</u> (1 item)	(1) Were your parents ever separated or divorced?	Possible response: **Yes** or No.	(2,4)
<u>Domestic violence</u> (2 items)	*How often was your mother (or step-mother) …* (1) Ever slapped, hit, kicked, punched, or beat up? OR (2) Ever threatened with, or hurt by, a knife or gun?	Possible response: Never, **sometimes, often, very often**.	(1,2)

Note. Adverse Childhood Experiences questionnaire developed by Felitti et al. (1998). Items drawn from: 1 = Felitti et al. (1998); 2 = Su et al., 2014; 3 = Centers for Disease Control and Prevention (CDC). *Behavioral Risk Factor Surveillance System Survey ACE Data*. Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2015; 4 = (Cronholm et al., 2015). For each sub-category of adversity, **bolded** responses indicate the threshold for exposure. For adversity sub-types with multiple questions (e.g., emotional abuse, physical abuse, etc.), individuals were required to meet the threshold for adversity on at least one item to be counted as exposed to that type.

2.3.1.4 Expanded ACEs

The 6-item "Expanded ACEs" supplement (Cronholm et al., 2015; Wade et al., 2016) was used to measure community-level indicators of childhood adversity before age 18. Three items were drawn from this scale: witnessing violence, neighborhood cohesion, and neighborhood safety; see Table 2 for items and scoring criteria. For analytic purposes, participant responses on the two neighborhood safety items were collapsed such that "unsafe/low cohesion neighborhood" reflected meeting criteria on at least one item.

Table 2. Expanded ACEs questionnaire items and measurement

Item	Description	Scoring
Witnessed violence	*"How often, if ever, did you see or hear someone being beaten up, stabbed, or shot in real life?"*	Possible response: **Many times (3), a few times (2)**, once (1), never (0)
Neighborhood safety	*"Did you feel safe in your neighborhood?"*	Possible response: Very often (4), often (3), **sometimes (2), rarely (1), never (0)**
Neighborhood cohesion	"*Did you feel people in your neighborhood looked out for each other, stood up for each other, and could be trusted?"*	Possible response: Very often(4), often(3), **sometimes (2), rarely (1), never (0)**

Note. ACE = adverse childhood experiences. Items drawn from Expanded ACE supplement (Cronholm et al., 2015).

2.3.1.5 Sleep health

The 6-item RUSATED sleep health questionnaire (Buysse, 2014) is a multi-dimensional scale used to query "typical" sleep patterns, including: daytime alertness and nocturnal sleep regularity, satisfaction, timing, efficiency, and duration. Items were measured on a 3-point scale ranging from 0 (*rarely/never*) to 2 (*usually/always*) and were summed to obtain a total sleep health score from 0 (poor) to 12 (good); see Table 3 for items. Cronbach's alphas = .613 and .656 for the N=540 and N=114 samples, respectively.

Table 3. Sleep health dimensions and measurement

Sleep Dimension	Measurement	Scoring and Data Reduction	Citation
Regularity			
Survey	"Do you wake up at about the same time (within 1 hour) every day?"	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Actigraphy/Diary	SD of sleep midpoint (min)	7-day average of SD of sleep midpoint; higher values = less regularity of timing. Square root transformation prior to analysis.	(1,2)
Satisfaction			
Survey	"Are you satisfied with your sleep?"	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Diary	"How would you rate the quality of your sleep last night?"	Rating: 1 (*Very Poor*) to 5 (*Very Good*); 7-day average of daily responses.	n/a
Alertness			
Survey	"Do you stay awake all day without dozing or napping?"	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Actigraphy/Diary	Proportion of days with at least one actigraphy [*diary*] daytime nap across study period (minimum nap duration = 15 min).	Proportion = sum of days with actigraphy [*diary*] naps/sum of days with actigraphy [*diary*] data. (Note: denominator limited to 6 days to ensure equal opportunity to capture actigraphy, given differences in time of day that participants received/returned the watch)	(4)
Timing			
Survey	"Is the middle of your nighttime sleep between 2:00 a.m. and 4:00 a.m.?"	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Actigraphy/Diary	Mean of sleep midpoint, i.e., clock time halfway between "tried to fall asleep" and "woke up". (midnight=0 min).	7-day average of sleep midpoint; higher values = later average timing of sleep.	(1,2)
Efficiency			
Survey	"Do you spend less than 30 minutes awake at night?" (includes latency + periods of wakefulness after sleep onset)	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Actigraphy/Diary	Percentage of time in bed that is actually spent sleeping = Duration [*see definition below*] / Time in bed × 100).	7-day average of calculated efficiency. Natural log transformation prior to analysis [Ln(100-Efficiency+1)]; i.e., higher values=*lower* efficiency	n/a
Duration			
Survey	"Do you sleep between 7 and 9 hrs per day?"	Rating: 0 (*Rarely/Never*) to 2 (*Always*).	(3)
Actigraphy/Diary	Time (hrs) asleep between sleep onset and offset, excluding latency and periods of wakefulness after sleep onset.	7-day average of calculated duration.	n/a

Note. Survey refers to the 6-item RUSATED questionnaire. 1 = Patel et al. (2014); 2 = Brindle et al. (2018); 3 = Buysse (2014); 4 = Jakubowski et al. (2016). SD = standard deviation.

2.3.1.6 Vigilance for threat

The 10-item Social Vigilance Questionnaire (SVQ; J. Ruiz, personal communication, April 22, 2017; Ruiz et al. (2017)), is a novel scale used to measure vigilance for threat. Individuals report how they "generally behave in social situations" using a 5-point scale (1=*Not at all* to 5=*Extremely/very much)*, i.e., *"I watch other people to determine if they have bad intentions"*. Item responses were averaged to provide an overall score ranging from 1-5. Exploratory and confirmatory factor analyses (J. Ruiz, *in prep*) indicate acceptable loadings on an overall "Total Vigilance" factor (ranging from .60-.94) and adequate model fit in an initial sample of 3,260 college students, as well as in an independent community sample (N=300), CFI > .95 and RMSEA = .07-.09. For the present study, Cronbach's alpha = .885.

2.3.1.7 Psychosocial questionnaires

Participants reported current symptoms of depression, anxiety, and PTSD. The Center for Epidemiological Studies-Depression (CES-D; Radloff, 1977) scale was used to measure depressive symptoms over the previous two weeks; total scores range from 0-60, with scores ≥ 16 suggestive of depression. One item pertaining to restless sleep was removed prior to calculating the total score to reduce confounding with the sleep outcomes. Anxiety symptoms were assessed using the 20-item State Trait Anxiety Inventory (STAI-X2; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983); total scores range from 20-80, with higher scores indicating greater "trait-level" anxiety. PTSD symptoms were assessed using the 6-item Abbreviated PTSD Checklist – Civilian version (PCL-C; Lang & Stein, 2005; Lang et al., 2012), indicating frequency of experiencing each symptom in the past month; total scores range from 5-30, with scores ≥ 14 indicative of PTSD. The abbreviated version does not include items related to sleep disturbance. Cronbach's alphas for the CES-D (restless sleep removed), STAI-X2, and PCL-C were .741, .598, and .853, respectively.

2.3.2 Physiological Measures

Baseline levels of SBP, DBP, and PR were calculated as the mean of the three measures taken during the initial rest period. Reactivity was calculated separately for SBP, DBP, and PR by regressing average task levels on initial rest levels and saving the standardized residuals. These residuals were then averaged across the four tasks (i.e., dot probe, CAUSE videos, speech prep, speech) to create both task reactivity indices and overall SBP, DBP, and PR reactivity indices. Averaging across stress tasks has been recommended in order to increase reliability of estimates (Kamarck, Jennings, & Manuck, 1993). Thus, physiological outcomes included resting baseline levels, task levels, and reactivity indices for SBP, DBP, and PR, respectively. Although HR and respiration data were collected during the protocol, these data were not used for the current project and will not be discussed further.

2.3.3 Behavioral Measures

2.3.3.1 Dot probe

The dot probe task is a widely-used computer-based assessment of attention bias. The present task is similar to that used by other studies in the child maltreatment and attention bias literature and provides a measure of bias toward or away from threatening social stimuli (e.g., Pine et al., 2005). In the task, three blocks of 72 pairs of actors with different facial expressions (24 Angry/Neutral pairs, 24 Happy/Neutral pairs, and 24 Neutral/Neutral pairs) were presented on the screen and were followed by an arrow in the previous location of one of the faces; participants indicated whether the arrow was pointing up or down (see Appendix A for additional information).

Measures include accuracy and latency (ms) to respond to the arrow, from which an attention bias score is computed (see Data Reduction).

2.3.3.2 CAUSE videos

Participants watched two brief videos (Chen & Matthews, 2003) that depicted ambiguous social situations. Video 1 showed a teacher discussing a cheating incident in class then asking to speak with one student ("Billy"); Video 2 showed an attentive saleswoman approaching a teenager browsing in a department store with a backpack. Participants completed a 6-item questionnaire (Chen et al., 2007) after each video and were asked to respond as if the situation had just happened to them. Participants used a 5-point scale from 1 (*not at all*) to 5 (*very*) to rate the likelihood that the intentions of the teacher/saleswoman, respectively, were hostile (i.e., accuse Billy of cheating/suspecting the teen stole clothing), benign/positive (i.e., congratulate Billy on his test score/help the teen with her shopping), or neutral (i.e., ask if Billy saw anything during the test/wanting to make a sale). Participants also rated how stressed, scared, and calm they would be using the same scale. Responses for parallel items were averaged across the two questionnaires. See Appendices B.1-B.3 for each scenario and the questionnaires.

2.3.3.3 Speech

Participants prepared and gave a speech about a time when they felt extremely anxious and it impacted their sleep. The speeches were audiotaped and later coded for content and emotional expression; behavioral coding data were not analyzed for the present study.

2.3.4 Actigraphy

Participants wore an Actiwatch-2 (Philips Respironics, Inc., Murrysville, PA) on the non-dominant wrist continuously over seven days and nights. Actigraph devices record patterns of movement, acceleration, and light, from which periods of sleep and wake can be inferred. Participants were instructed to press an event marker to note when they "tried to fall asleep" and "woke up" for nocturnal sleep episodes and daytime naps. Watches were configured to collect data over 60-second epochs. Stored data were downloaded into the Actiware software program (version 6.09; Philips Respironics, Inc.) for processing and analysis. Major and minor rest intervals were set using the following sources of information, listed in order of priority: (1) **event markers**, when within 30 minutes of auto-scored rest period *and* consistent with information from diary, light, and/or activity (< 40 counts) sources; (2) **auto-score**, when event markers were not within 30 minutes of the auto-scored period *and* the auto-score was consistent with light + activity + diary data (i.e., within 30 min); or (3) **diary** report of "tried to fall asleep" and "woke up" if auto and markers were not consistent with light/activity pattern OR there were no event markers. In this study, the "auto-score" refers to the medium threshold (default) in the scoring program to detect one major sleep period of at least 3 hours. Event markers were used to set the majority of rest intervals. Minor rest intervals (i.e., naps) were scored only when a nap was reported that day in the diary *and* a minor rest interval was identified in the actogram based on event markers, light patterns, and/or low activity; however, the time of day and nap duration in the actogram and diary did not have to match exactly. All subsequent sleep variables were calculated from data within these set major and minor rest periods.

As shown in Table 3, actigraphy was used to measure five of the six dimensions of sleep health: (1) **timing** = mean of calculated sleep midpoint, i.e., clock time halfway between "tried to fall asleep" and "woke up" (midnight = 0 min); (2) **regularity** = standard deviation of calculated sleep midpoint; (3) **alertness** = proportion of days with at least one daytime nap across the study period (minimum nap duration = 15 min); (4) **duration** = hours asleep between sleep onset and offset, excluding latency and periods of wakefulness after sleep onset; and (5) **efficiency** = percentage of time in bed that was actually spent sleeping; i.e., calculated duration / time in bed × 100). Sleep quality cannot be measured via actigraphy. Nightly values and an average value across the seven nights of observation for each participant were calculated and maintained in the dataset for analysis. The actiwatch has been used extensively in research studies and has been validated against PSG measures for nocturnal sleep episodes (Kushida et al., 2001; Tryon, 2004).

2.3.5 Daily Diary

Web-based sleep diaries (Qualtrics) were used to administer morning (Appendix F) and evening (Appendix G) sleep diaries. In the evening sleep diary, participants reported exercise duration, timing, and intensity; minutes of daytime napping; consumption of caffeine, alcohol, cigarettes; over-the-counter medications; and mood. Thirteen participants (11.4%) reported taking over-the-counter medications (e.g., allergy, cold, or flu; antibiotics; immunosuppressants) on at least one day during the study period; thus, a "daytime medication" variable (yes/no) was tested with sleep parameters in bivariate correlations to determine necessity of including as a covariate. Participants also reported vigilance for threat in daily social interactions using three items based on the SVQ (Ruiz et al., 2017): (1) *Did you pay extra attention to people who might say something negative about you?;* (2) *Did you feel like someone had negative intentions toward you?;* and (3) *Did you pay extra attention to voice tones, facial expressions, or body language that seemed to be negative or disapproving toward you?* Participants responded using a 5-point scale from 1 (*almost* *never*) to 5 (*almost always*). Daily responses to each item were averaged across the weeklong period for use in analyses.

Morning sleep diaries queried sleep quality (i.e., "How would you rate the quality of your sleep last night?") rated on a 5-point scale from 1 (*very poor*) to 5 (*very good*), and aspects of the prior night's sleep, i.e., time tried to fall asleep and awoke, minutes it took to fall asleep (latency), minutes awake after sleep onset. Daily diaries were used to measure all six dimensions of sleep health. Nightly values and an average value for each participant across the seven nights of observation were calculated as described for actigraphy (see above).

2.3.6 Data Reduction

2.3.6.1 Nocturnal sleep dimensions

A minimum of four days of good data was required for inclusion in actigraphy and diary analyses. This was based on previous recommendations of at least three days of actigraphy data in adults (Littner et al., 2003) and five days in youth (Acebo et al., 1999) in order to obtain reliable estimates. Nights when participants reported taking medications to help with sleep (i.e., melatonin, NyQuil) were removed before computing average actigraphy and diary sleep dimensions; this accounted for four nights of data across four different participants. Due to watch malfunction, actigraphy data was not available for two participants, while one of these participants was also removed from diary analyses due to unreliable data. Overall, over 90% of participants provided seven days of usable actigraphy and diary data. *Weeklong averages for actigraphy and diary sleep dimensions were the values used in all confirmatory factor analyses and latent sleep models.*

2.3.6.2 Daytime napping

Given differences in the time of day that participants presented to the laboratory to receive/return the actigraph, naps taken on the first and last days of the sleep protocol were removed from computation of the proportion of days with actigraphy- and diary-measured naps. This provided an equivalent opportunity for actigraphy and diary naps across the weeklong study period. The number of days with nap episodes greater than 15 minutes in duration was divided by the number of days of good data (a maximum of 6 days), to create a proportion of days napped across the study period.

2.3.6.3 RUSATED cut-off criteria applied to actigraphy/diary data (supplemental analyses)

For use in *only* supplemental analyses, daily values for actigraphy- and daily diary-assessed sleep dimensions (i.e., regularity, satisfaction, alertness, timing, efficiency, duration) were coded using the criteria provided in the RUSATED survey. Accordingly, each night of actigraphy and diary data for each participant was scored yes/no for meeting the corresponding RUSATED cut-off; for example, yes/no slept between 7 and 9 hours (duration) or yes/no stayed awake without napping (alertness); refer to Table 3 for RUSATED survey cut-offs. Yes/no responses were summed to create an overall number of days that participants met the cut-off for each sleep dimension (separately for actigraphy and diary data), and the actigraphy and diary sums were further coded: 0 = 0-1 days, 1 = 2-4 days, and 2 = 5-7 days. The 0-2 coding was used to mimic the survey response options for frequency of meeting RUSATED cut-offs for each sleep dimension (i.e., 0 = rarely/never, 1 = sometimes, 2 = usually/always). Finally, the scores (0-2) for each actigraphy and diary sleep dimension were summed to create a 0-12 sleep health total score, consistent with the RUSATED survey total score. Given that satisfaction cannot be measured by actigraphy, responses for diary-measured satisfaction were added to the actigraphy sleep health total score to obtain comparable total scores across measures.

2.3.6.4 Dot probe

Of the 114 participants who completed the dot probe task, 89 (78.1%) participants provided full data (i.e., 3 blocks of 216 trials). Due to computer malfunction, 13 (11.4%) participants had partial data (i.e., n=12 with 2 blocks/144 trials; n=1 with 1 block/72 trials) while data for 9 (7.9%) participants were fully missing. An additional 3 (2.6%) participants demonstrated accuracy < 60% on the task and were excluded from further analysis, consistent with other studies (e.g., Perez-Edgar et al., 2011); each reported zero ACEs. Thus, 102 (89.5%) participants had full or partial data available to compute threat bias scores for analysis.

Threat bias scores were derived using response time (RT) data collected from the task. Prior to calculating bias scores, all RT data were cleaned following published procedures (Price et al., 2015). First, individual trials on which participants provided an inaccurate response to the stimuli were excluded, which applied to only 841 (4.0%) of 21,024 experimental trials across all participants. Then, a Winsorizing procedure was used to eliminate extreme RT values, such that values outside 1.5 interquartile ranges from the 25th or 75th percentiles of a given distribution of values were rescaled to the last valid value within that range. Winsorizing was performed in two stages: 1) within each individual's distribution of data across the experiment (e.g., mean RTs per condition; 2.9% of raw data) and 2) across all individuals (2.7% of participants rescaled). Mean RT and bias scores were computed from these rescaled distributions. For the present study, the contrast of interest is response time (RT) to the arrow on Angry/Neutral trials; data involving the Happy/Neutral and Neutral/Neutral pairs will not be discussed further. Consistent with prior research (e.g., Mogg & Bradley, 1999; Pine et al., 2005), threat bias was calculated as: mean RT (neutral face/probe on same side of the screen) – mean RT (angry face/probe on same side of the screen). Thus, a positive value indicates the tendency to monitor the emotional stimulus, while a negative value indicates the tendency to avoid the emotional stimulus (Pine et al., 2005).

3.0 STATISTICAL ANALYSES

3.1 Power Calculation

Effects for the relationship between cumulative childhood adversity and sleep health were derived from the only known study to assess this relationship in a normative healthy sample (Brindle et al., 2018). Although that study was conducted in a middle-aged sample with a history of depression (N=161), it is the closest known approximation of the present study. Brindle and colleagues found that individuals with a history of childhood adversity reported poorer sleep health ($f^2 = 0.06$) via a composite of daily diary-assessed sleep parameters. Based on this effect size, $\alpha = .05$ and power = .80, a power analysis (G*Power 3.1.9.2; Faul, Erdfelder, Buchner, & Lang, 2009) generated a recommended sample size of 104 participants to detect the direct effect of adversity on sleep health (Hypothesis 1).

Mediation analyses (Hypothesis 2; Exploratory Hypotheses 1 and 2), require a more stringent sample size requirement. Fritz and MacKinnon (2007) suggest a minimum sample size of 148 participants to achieve .8 power for effects that are at least half-way between standard criteria (J. Cohen, 1988) for "small" and "medium" (i.e., $\alpha = 0.26$ and $\beta = 0.26$). Based on the review of the extant literature, associations between adversity and threat (α paths) and between sleep and threat (β paths) typically range from small to halfway between small and medium. Under those parameters, Fritz and MacKinnon (2007) suggest samples of at least 300-400 participants, depending on the exact size of both α and β paths and the method used to test mediation. To amplify power to find hypothesized direct and indirect effects, study recruitment aimed for at least 400 participants with survey data and at least 100 participants with laboratory and actigraphy/daily diary data.

3.2 Analytic Approach

Analyses were conducted with SPSS v. 23 and Mplus v. 7.31 (Muthen & Muthen, 2012). Data were checked for normality and outliers, and when necessary, skewed variables were natural log transformed or square root transformed prior to analysis. In order to achieve normal distributions, age and BMI were natural log transformed, and total ACEs [ln(ACEtotal+1)] and sleep efficiency [ln(100-Efficiency+1)] were natural log transformed after adding 1. Note that higher efficiency values reflect *worse* efficiency. Actigraphy- and diary-assessed sleep regularity, low childhood SES, depressive and PTSD symptoms, and two diary measures of vigilance (i.e., diary items 2 and 3) were square root transformed prior to analyses. Descriptive analyses were conducted to provide means and frequencies of all variables. Bivariate correlations were conducted among all primary variables. Univariate regressions were conducted between total ACEs and all primary study variables and are presented with descriptive results in respective tables.

Age, race (White=0, Non-white=1), and sex (Female=0, Male=1) were included as covariates in all models. All observed sleep health variables (i.e., first-order sleep health indicators or RUSATED sleep health total score) and mediators (i.e., indicator variables for latent threat mediators or observed mediator variables) were regressed onto covariates.

Hypothesis 1: Cumulative childhood adversity will be associated with worse sleep health. Hypothesis 1 was tested using structural equation modeling (SEM) by regressing a latent factor of sleep health on childhood adversity. Maximum likelihood estimation was used to produce model parameters. See Confirmatory Factor Analysis section for model fit criteria. In addition to covariates of age, race, and sex, additional analyses tested the association between adversity and latent sleep health in separate models after further adjustment for BMI, childhood SES, depressive symptoms, anxiety symptoms, PTSD symptoms, alcohol use, and marijuana use, respectively; additional covariates were identified based on theory or from consistent significant associations with sleep variables in bivariate correlations.

Hypothesis 2: Survey, daily diary, physiological, and behavioral measures of vigilance for threat will partially explain the relationship between cumulative childhood adversity and sleep health. Hypothesis 2 tested for mediation, or the presence of a significant indirect effect between childhood adversity and latent sleep health via threat perception; mediators included both observed variables and latent factors as shown in Figure 3, Panels A and B, respectively.

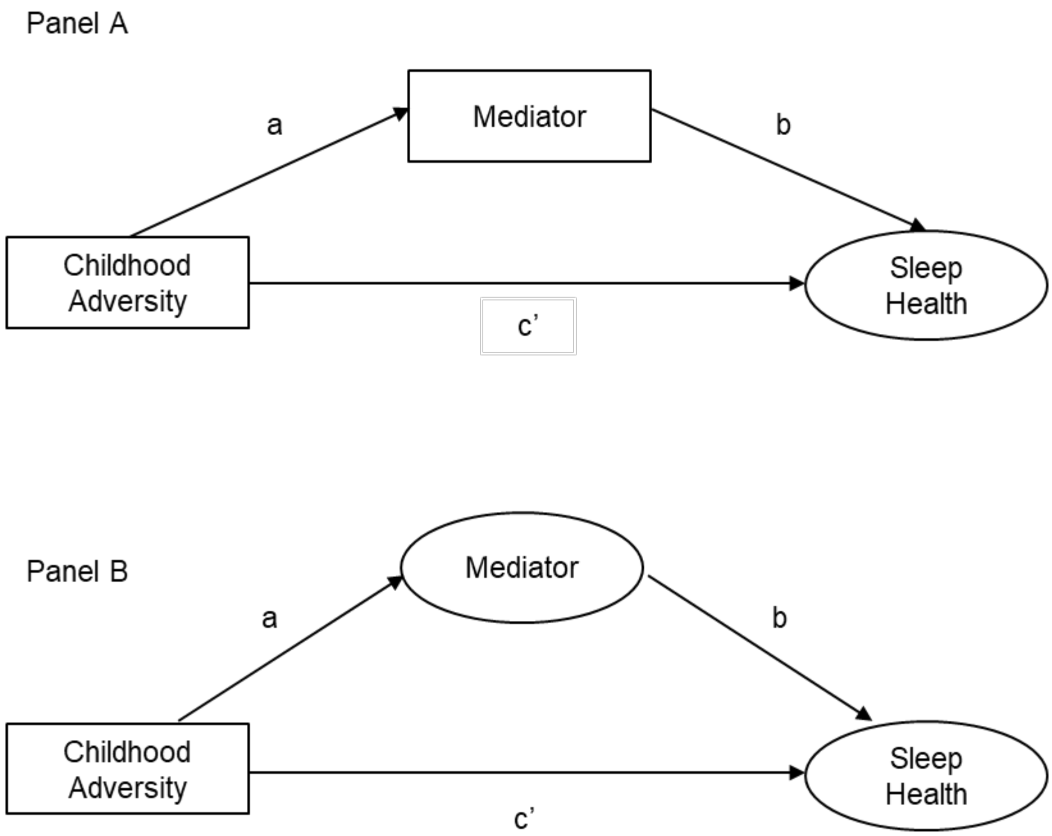

Figure 3. Hypothesized mediation models for observed (panel A) and latent (panel B) mediator variables

Note. Boxes represent observed mediator variables. Circles represent latent mediator variables. Tested mediators include: survey, behavioral, physiological, and daily diary measures of vigilance for threat; depressive, anxiety, and PTSD symptoms; body mass index.

Indirect effects were estimated using bootstrapping procedures with 5,000 resamples (Preacher & Hayes, 2008). In the bootstrapping method, the sample is treated as a population, from which a large number of random samples of size N are drawn with replacement. For each sample, the indirect path (*a* x *b*) is estimated and saved, and this procedure is repeated to create a sampling distribution of the mediated effect. This sampling distribution is used to produce the significance test of the mediated effect and confidence interval estimates. To compute path *a*, the independent variable was childhood adversity and the dependent variable was vigilance for threat. To compute path *b*, the independent variable was vigilance for threat and the dependent variable was latent sleep health. Path c’ reflects the association between childhood adversity and latent sleep health controlling for the effect of the mediator. See Confirmatory Factor Analysis section for model fit criteria.

Exploratory Aim 1: Examine whether the relationship between cumulative childhood adversity and poor sleep health is stronger in those who also report witnessing community violence or living in an unsafe neighborhood. To address Exploratory Aim 1, two interaction terms were created involving cumulative adversity in the home X witnessing violence and cumulative adversity in the home X perceived neighborhood safety. Two separate analyses were run, which involved regressing latent sleep health on each interaction term and the respective main effects.

Exploratory Aim 2: Examine the contribution of childhood SES to poor sleep health in the context of childhood adversity. Childhood SES was treated several ways in analytic models: (a) as a covariate, to determine if the effect of cumulative adversity on poor sleep persisted above and beyond any effect of low childhood SES on sleep; (b) the low childhood SES score was added to the cumulative adversity score to determine if there was an additive effect of adversity and low childhood SES on poor sleep health; and (c) the low childhood SES score was treated as a potential modifier of the relationship between cumulative adversity and poor sleep health (i.e., an interaction term was created between mean-centered childhood adversity and mean-centered low childhood SES and latent sleep health was regressed on this interaction term as well as the respective mean-centered main effects).

Exploratory Aim 3: Examine the contribution of relevant confounding variables (i.e., BMI, depressive symptoms, anxiety symptoms, PTSD symptoms) to poor sleep health in the context of childhood adversity. BMI, depressive symptoms, anxiety symptoms, and PTSD symptoms were treated several ways in analytic models: (a) each variable was treated as a potential confounder of the adversity-sleep relationship and was added to analytic models to determine if the effect of cumulative adversity on poor sleep persists above and beyond the effect of each respective covariate on sleep; (b) each variable was treated as a separate pathway variable partially explaining the relationship between adversity and poor sleep health (see analytic plan in Hypothesis 2), and (c) each variable was treated as a potential moderator of the relationship between cumulative adversity and poor sleep health. Four mean-centered interaction terms were created between childhood adversity and BMI, depressive symptoms, anxiety symptoms, and PTSD symptoms, respectively, and latent sleep health was regressed on each mean-centered interaction term and the respective mean-centered main effects (Figure 4).

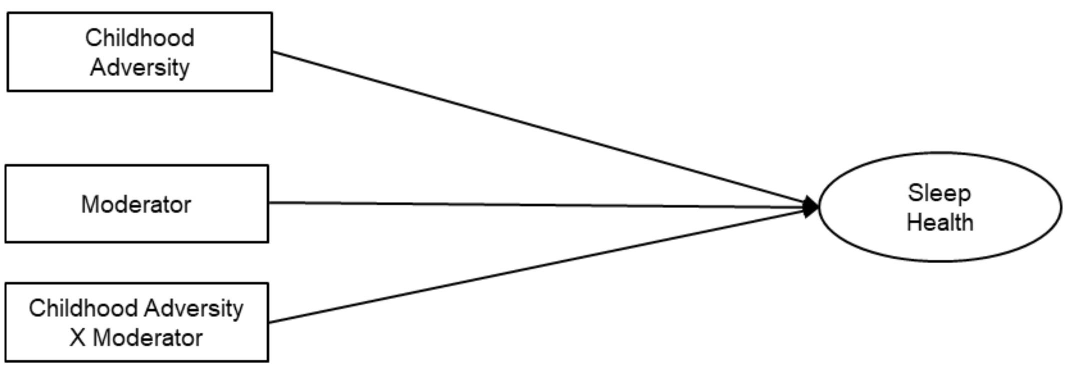

Figure 4. Hypothesized moderation models

Note. Seven moderators will be tested: (1) low childhood SES; (2) witnessing violence in the community or (3) unsafe neighborhood/low neighborhood cohesion (i.e., Expanded ACEs); (4) depressive, (5) anxiety, and (6) PTSD symptoms; (7) body mass index.

Supplemental Analyses. All above-described analyses for Hypotheses 1-2 and Exploratory Aims 1-3 were repeated using four versions of the RUSATED sleep health total score: (1) survey total score in the N=540 full sample; (2) survey total score in the N=114 subsample;

and total scores when RUSATED cut-offs were applied to (3) actigraphy (N=112) and (4) daily diary (N=113) sleep dimensions.

3.3 Preliminary Analyses

3.3.1 Confirmatory Factor Analysis (CFA)

For all measured sleep dimensions and threat vigilance variables, CFAs were conducted on the item covariance matrix using Mplus v. 7.31 (Muthen & Muthen, 2012). Note that for all CFAs and latent factors of sleep health, actigraphy and diary indicators refer to average values for each sleep dimension derived from weeklong ambulatory assessment (see Table 3). Model fit was assessed using several fit indices, including χ^2, the root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker– Lewis index (TLI). Importantly, while the χ^2 test is a widely-used measure of fit in SEM, it may overestimate lack of fit with larger sample sizes and large numbers of model parameters (Bollen, 1989). Acceptable model fit was defined the following criteria: RMSEA < .08, CFI > .90, TLI > .90 (Bentler, 1990; Hu & Bentler, 1999). Good model fit was defined by the following criteria: χ^2 tests with $p > .05$, CFI > .95, TLI > .95, RMSEA < .05, SRMR < .08 (Hu & Bentler, 1999). Maximum likelihood estimation was used to produce model parameters.

3.3.1.1 Latent sleep health outcomes

While the stated aim of this study was to create a higher-order factor of sleep health that would incorporate indicators across survey, actigraphy, and diary sources and be used as the outcome in all primary and exploratory hypotheses, such a model had not been tested in the literature. As shown in Table 4, CFA was conducted to assess model fit of several plausible models, including: (a) separate within-method factors that included indicators of sleep dimensions measured by RUSATED survey (Models 1-2), weeklong actigraphy assessment (Model 3), and weeklong diary assessment (Model 4); and (b) a single second-order factor of sleep health (Model 5) that incorporated survey, actigraphy, and diary indicators of individual sleep dimensions into one model. Figures 5 and 6 demonstrate each of these models.

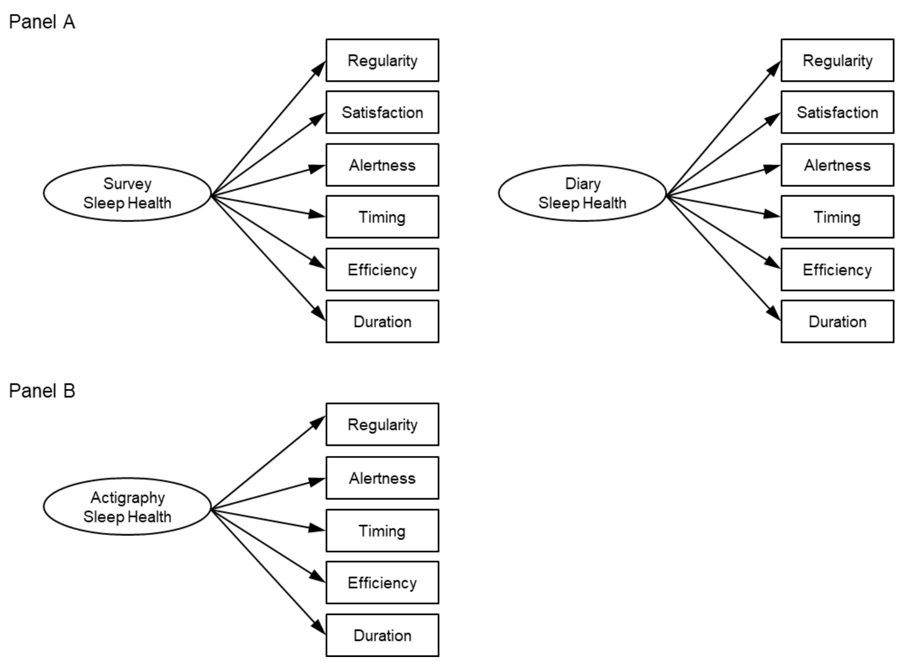

Figure 5. Possible latent sleep health factors by measurement type

Note. Survey and diary were used to assess all six dimensions of sleep health (Panel A), while actigraphy (Panel B) was used to measure only five of the six sleep dimensions (i.e., not satisfaction). Survey indicators represent participant responses on the RUSATED survey regarding how often they met cut-offs for each sleep dimension; 0 = rarely/never, 1 = sometimes, 2 = usually/always. Actigraphy and diary sleep indicators represent average continuous values for each sleep dimension across the weeklong ambulatory sleep protocol.

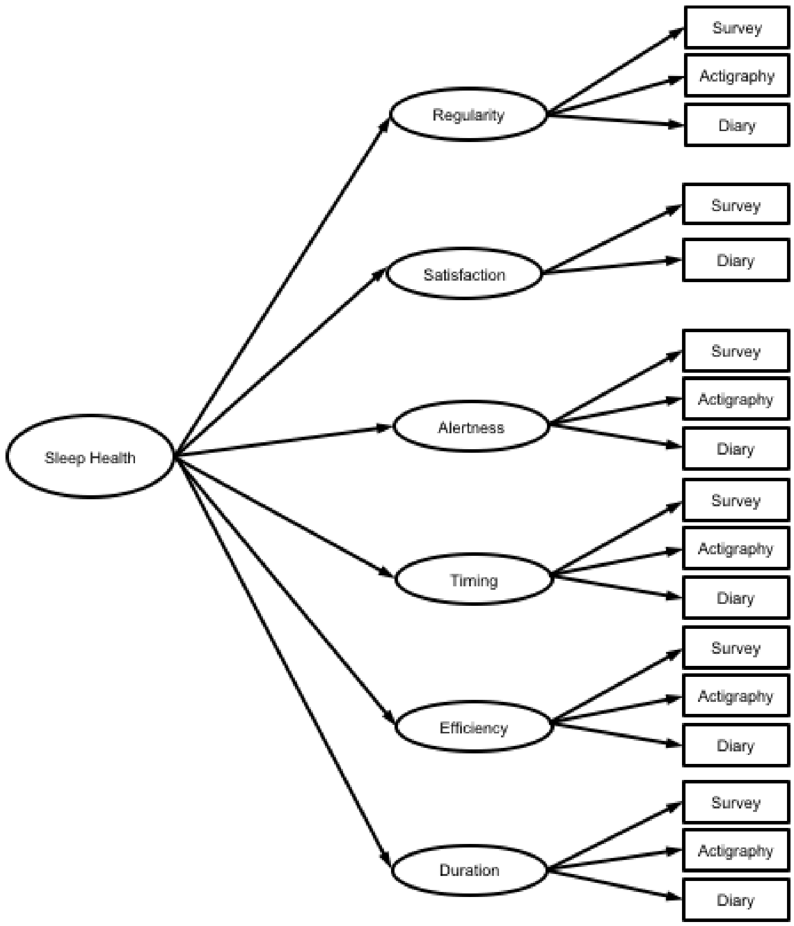

Figure 6. A priori second-order latent factor of sleep health

Note. Model fit indices and factor loadings could not be computed as the model demonstrated a non-positive definite latent covariance matrix. All sleep health indicators were correlated within-method (i.e., within survey, actigraphy, and diary methods). The paths from the first-order factors of Regularity, Satisfaction, Alertness, Timing, Efficiency and Duration to their respective survey-measured indicators were fixed to 1 for all analyses. Survey indicators represent participant responses on the RUSATED survey regarding how often they met cut-offs for each sleep dimension on a 3-point scale. Actigraphy and diary sleep indicators represent average continuous values for each sleep dimension across the weeklong ambulatory sleep protocol.

As shown in Table 4, results indicated poor fit for Models 1-5. Thus, a revised second-order model (Model 6) was conducted in which four first-order parameters of Regularity, Satisfaction/Efficiency, Alertness, and Duration served as indicators for a single second-order factor. As shown in Figure 7, the first-order factors for Regularity and the combined Satisfaction/Efficiency included survey, actigraphy, and diary sleep indicators; in contrast, the first-order factors for Alertness and Duration included only survey and actigraphy sleep indicators. All first-order factors were allowed to freely correlate and sleep health indicators were correlated within-method (i.e., within survey, actigraphy, and diary methods). As shown in Table 4, CFI, RMSEA, and SRMR values suggested good fit. As a result, Model 7 was used in all primary and exploratory analyses. The interested reader can find potential explanations for poor fit for Models 1-6 in Appendix H.

Table 4. Summary of fit statistics for plausible sleep health factor models

Model Description	N	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	Model Fit Decision	Standardized Loadings, β (SE)[a]
Within-method single factor models											
1. Survey	540	43.93	9	.000	.90	.83	.085	[.061, .111]	.04	Poor	--
1a. Survey *(with modification indices)*	540	23.05	8	.003	.96	.92	.059	[.032, .088]	.03	Acceptable	Reg=.323 (.05) Satis=.710 (.04) Alert=.411 (.05) Timing=.324 (.05) Eff=.273 (.05) Dur=.665 (.04)
2. Survey	114	11.80	9	.223	.97	.95	.052	[.000, .125]	.05	Acceptable	Reg=.327 (.10) Satis=-.648 (.08) Alert=.570 (.08) Timing=.463 (.09) Eff=.235 (.11) Dur=.743 (.07)
3. Actigraphy	112	22.91	9	.006	.83	.71	.117	[.058, .177]	.069	NPD	--
4. Diary	113	154.38	15	.000	.000	.000	.287	[.247, .329]	.198	Poor	--
Second-order factor models											
5. A priori second-order factor	540	275.28	78	.000	.79	.63	.149	[.130, .168]	.127	NPD	--
6. Final second-order factor	540	56.39	31	.004	.95	.89	.039	[.022, .055]	.064	Good	*See Figure 7*

Note. Model 1a represents model fit statistics following correlation of RUSATED survey items regularity and timing. Models 3 and 4 included indicators of actigraphy and diary sleep, respectively, from the weeklong ambulatory sleep protocol. Model 5 represents a priori expectation. Model 6 represents the fit statistics following revision of Model 5. Standardized factor loadings are provided only for models that converged and provided reliable estimates, with the exception of Model 6, which is presented in Figure 7. Acceptable model fit was defined as: RMSEA < .08, CFI > .90, TLI > .90 (Bentler, 1990; Hu & Bentler, 1999). Good model fit was defined as: χ^2 tests with $p > .05$, CFI > .95, TLI > .95, RMSEA < .05, SRMR < .08 (Hu & Bentler, 1999). Reg = regularity; Satis = satisfaction; Alert = alertness; Eff = efficiency; Dur = duration; $\chi 2$ = chi-square fit statistic; CFA = confirmatory factor analysis; CFI = comparative fit index; CI = confidence interval; *df* = degrees of freedom; NPD = not positive definite latent variable covariance matrix; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; TLI = Tucker-Lewis index.

[a]For all standardized estimates, $p<.001$, with the exception of Model 2 (N=114) Efficiency ($p=.026$).

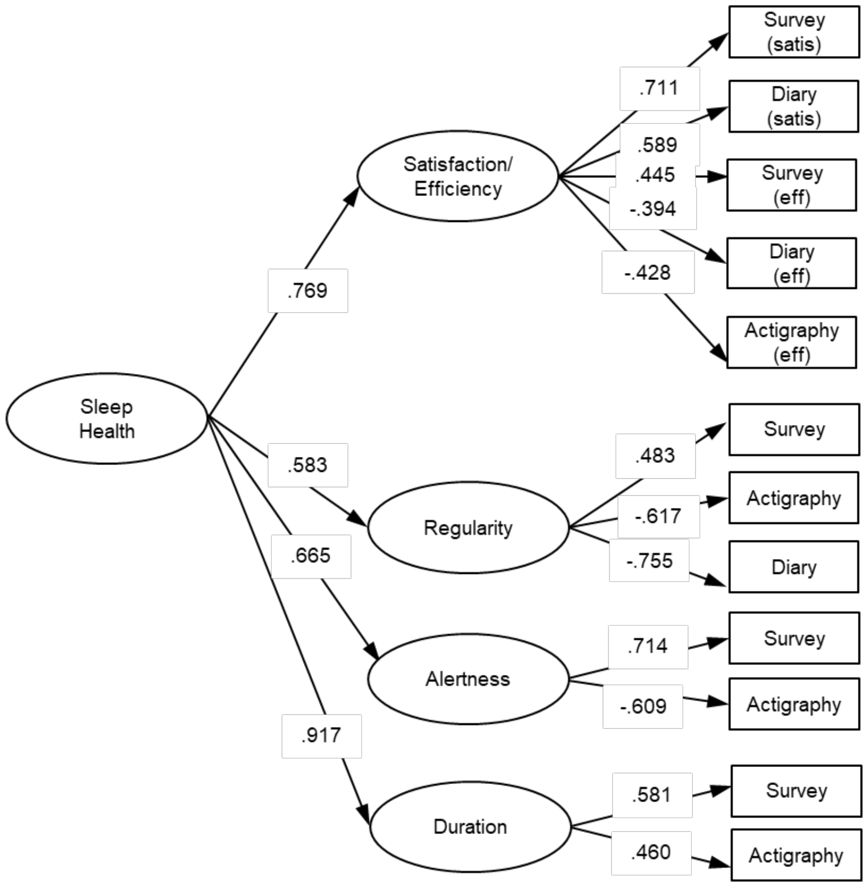

Figure 7. Revised second-order latent factor of sleep health for use in all primary and exploratory analyses

Note. Survey indicators represent participant responses on the RUSATED survey regarding how often they met cut-offs for each sleep dimension on a 3-point scale. Actigraphy and diary sleep indicators represent average continuous values for each sleep dimension across the weeklong ambulatory sleep protocol. For survey, actigraphy, and diary indicators, higher values = better sleep. Model fit indices were as follows, $\chi^2(df) = 59.39$ (31), $p = .004$, CFI = .95, TLI = .89, RMSEA [90% CI] = .039 [.022, .055], SRMR = .064. All sleep health indicators were correlated within-method (i.e., within survey, actigraphy, and diary methods), however, for visual simplicity these correlations are not displayed. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1 for all analyses; the path from the first-order factor Satisfaction/Efficiency to survey-measured satisfaction was fixed to 1 for all analyses. $\chi2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; satis = satisfaction; eff = efficiency.

3.3.1.2 Latent vigilance for threat mediators

Behavioral, physiological, and daily diary indicators of vigilance for threat were also subjected to CFA; see Table 5 for all measured indicators.

Table 5. Measured indicators of vigilance for threat

Vigilance for Threat Indicators	N
Survey Measure	
SVQ total score	540
Behavioral Measures	
Dot probe threat bias score	114
CAUSE ratings	114
Physiological Measures	
Cardiovascular reactivity (residualized scores)	
Average SBP reactivity (across all tasks)	114
Average DBP reactivity (across all tasks)	114
Average PR reactivity (across all tasks)	114
Task levels (SBP, DBP, PR)	
Dot probe	114
CAUSE	114
Speech preparation	114
Speech delivery	114
Daily Diary Measures	
Diary 1 - Did you pay extra attention to people who might say something negative about you?	113
Diary 2 - Did you feel like someone had negative intentions toward you?	113
Diary 3 - Did you pay extra attention to voice tones, facial expressions, or body language that seemed to be negative or disapproving toward you?	113

Note. Cardiovascular reactivity reflects average task levels regressed on baseline levels for SBP, DBP, PR, respectively. CAUSE ratings and physiology averaged across Billy and Shopping videos. SVQ = Social Vigilance Questionnaire.

As previously mentioned, Fritz and MacKinnon (2007) suggest samples of at least 300-400 participants to test mediation using SEM. Thus, to amplify statistical power to find hypothesized indirect effects of vigilance for threat, I aimed to create latent threat factors that included the SVQ survey, as it was the only measure of vigilance completed by the full sample of

N=540 participants; the behavioral and physiological measures of threat were completed only by the N=114 subsample at the laboratory visit. Surprisingly, results indicated poor fit and/or low standardized factor loadings for all CFA models that included the SVQ variable, except for the SVQ + Daily Diary threat model. Thus, CFAs were repeated but excluded the SVQ from all models and several additional models demonstrated good fit; see Table 6 for retained models and standardized loadings. For the interested reader, Appendix I.1 provides fit statistics for all 26 tested CFA models and Appendix I.2 provides the decision process used to retain models.

Table 6. Fit indices and standardized loading estimates of retained vigilance latent factor models

Model	N	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	Model Fit Decision	Standardized Loadings, β (SE)[d]
<u>Models with SVQ</u>											
13a. SVQ + Diary items	540	.65	2	.722	1.00	1.02	.000	[.000, .061]	.015	Good	SVQ=.33 (.10) Diary 1=.96 (.03) Diary 2=.74 (.05) Diary 3=.91 (.03)
<u>Models **without** SVQ</u>											
3b. CAUSE ratings[ab]	114	7.68	4	.104	.99	.96	.090	[.000, .185]	.036	Good	Hostile=.58 (.07) Benign= -.37 (.09) Calm= -.73 (.05) Scare=.77 (.05) Stress=.93 (.03)
8b. Dot probe physiology[c]	113	0	0	0	1.00	1.00	.000	[.000, .000]	0	Just-identified	SBP=.61 (.17) DBP=.43 (.14) PR=.46 (.14)
9b. CAUSE physiology[c]	114	0	0	0	1.00	1.00	.000	[.000, .000]	0	Just-identified	SBP=.64 (.12) DBP=.56 (.11) PR=.55 (.11)
11b. Speech physiology[c]	112	0	0	0	1.00	1.00	.000	[.000, .000]	0	Just-identified	SBP=.90 (.10) DBP=.50 (.09) PR=.66 (.09)

Note. CFA = confirmatory factor analysis; CFI = comparative fit index; χ2 = chi-square fit statistic; *df* = degrees of freedom; *p* = p-value; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; β (SE) = standardized coefficient (standard error). Good model fit was defined as: χ^2 tests with $p > .05$, CFI > .95, TLI > .95, RMSEA < .05, SRMR < .08 (Hu & Bentler, 1999). [a]Bivariate correlations (Table 20) indicated that the "Neutral" CAUSE item was weakly correlated with the five other CAUSE items, *r*s=.01-.19, while the majority of correlations among the remaining five items were .33 or greater. Given low correlations and the fact that the "Neutral" item did not provide meaningful information about level of threat, Neutral was removed from the final CFA model. [b]Modification indices suggested improvement in model fit if benign item was correlated with hostile; fit statistics reflect that correlation. [c]Physiology refers to residualized values of SBP, DBP, and PR (i.e., task levels of SBP, DBP, and PR regressed on baseline levels of SBP, DBP, and PR, respectively).[d]For all standardized estimates, $p<.05$, with the exception of Dot probe DBP ($p=.002$) and Dot probe PR ($p=.001$).

4.0 RESULTS

4.1 Recruitment

A total of 637 individuals opened the online survey, and of these, 590 consented to participate, were at least 18 years of age, and completed all measures necessary to determine study eligibility (Figure 8). Based on their survey responses, 50 (8.5%) participants were deemed ineligible and were not invited to Phase II nor were their data used in any analyses (Figure 8). Compared to the 540 eligible participants, the ineligible participants (n=47) were more likely to be male and to report at least one ACE (i.e., 65.5% vs. 52.0%), poorer sleep health (M = 6.2 vs. M = 7.1), and more depressive (M = 18.7 vs. M = 13.6), anxiety (M = 46.2 vs. M = 41.1), and PTSD symptoms (M = 13.6 vs. M = 11.7); all χ^2 and *t*-tests $p<.05$ (data not shown); these elevated symptoms are not surprising, given that a third of ineligible participants reported using psychiatric medications. However, no differences emerged regarding age, race, vigilance for threat, or self-reported BMI.

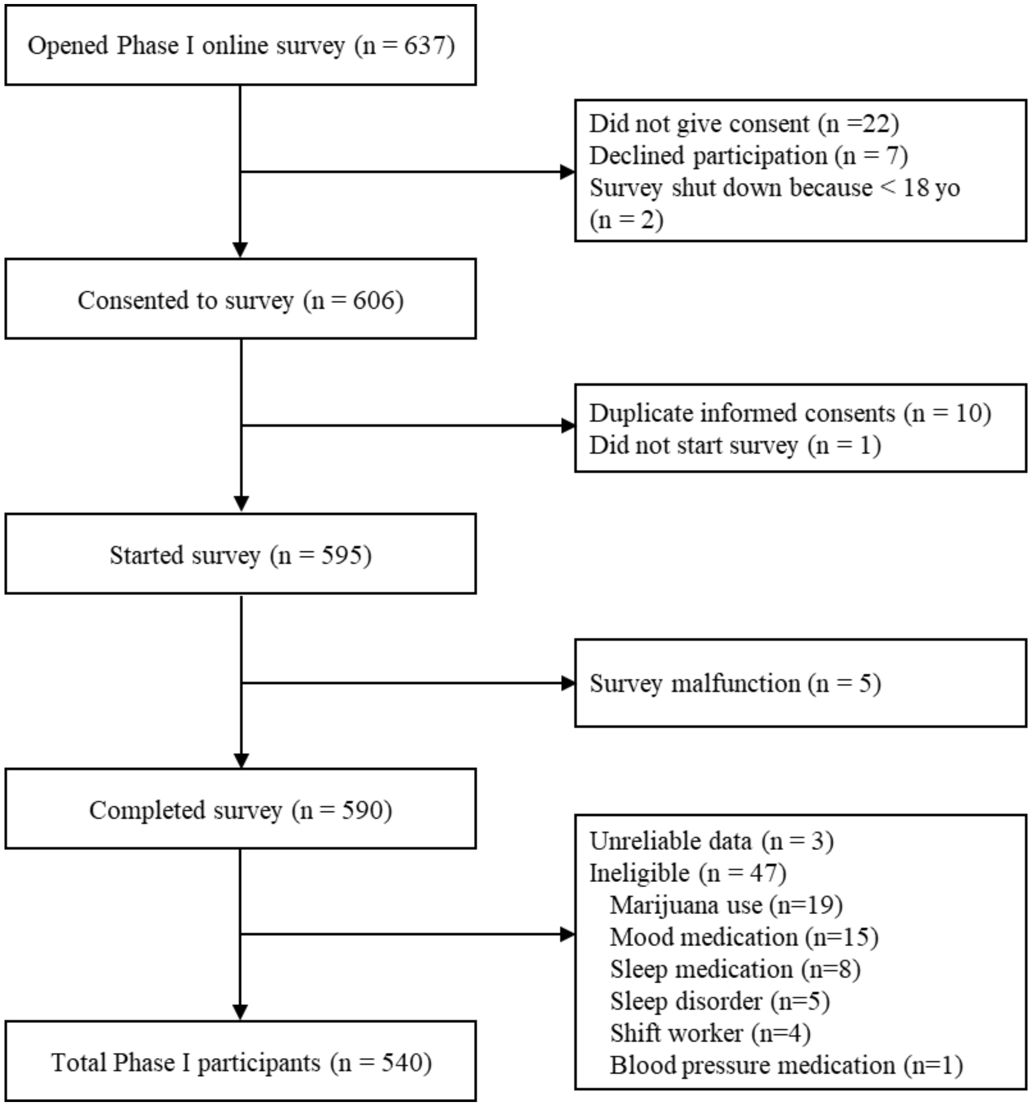

Figure 8. Participant flow diagram for Phase I online survey

Of the 540 eligible participants, 402 (74.4%) expressed interest in participating in Phase II, and 114 (28.4%) of interested participants completed the laboratory study and weeklong sleep protocol (see Figure 9). Participants who completed the laboratory protocol were more likely to be older, male, non-white, report lower childhood SES and more total ACEs compared to the 426 participants who were eligible but chose not to participate (see Table 7). No differences emerged regarding BMI; sleep health; vigilance for threat; exercise; symptoms of depression, anxiety, or PTSD; or use of alcohol, cigarettes, or marijuana.

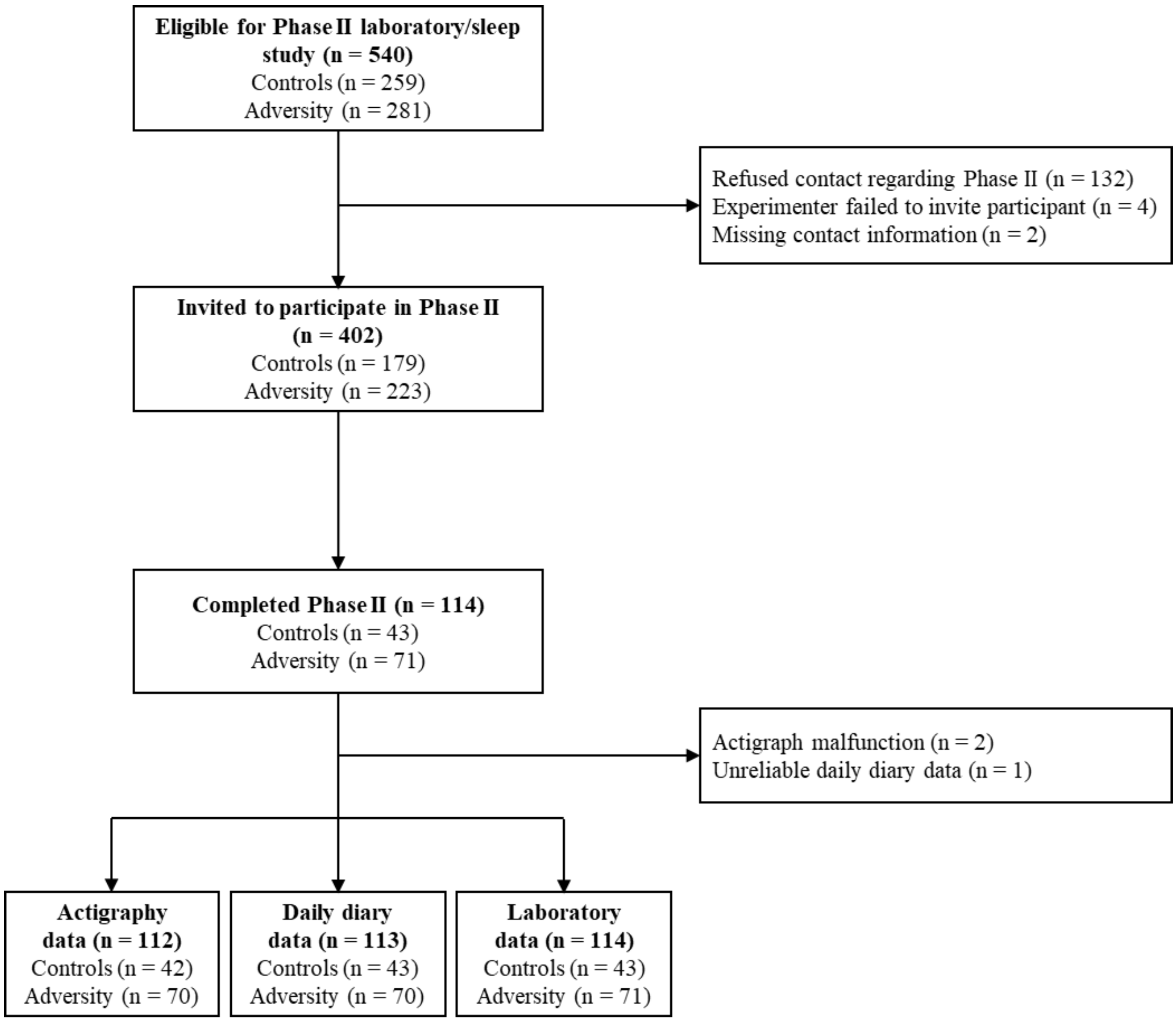

Figure 9. Participant flow diagram for Phase II laboratory/sleep study

Table 7. Characteristics of Phase I and Phase II samples, presented as *M (SD)*, *range* or (N) %

	Phase I (N=540)		Did not participate in Phase II (N=426)		Participated in Phase II (N=114)		*t* or χ^2	*p*
	M (SD) or *N* (%)	Range	*M (SD)* or *N* (%)	Range	*M (SD)* or *N* (%)	Range		
Age	18.76 (1.08)	18-28	18.68 (.90)	18-23	19.04 (1.56)	18-28	-3.02	.003
Male	272 (50.4%)		227 (53.3%)		69 (60.5%)		6.86	.01
Race							7.48	.01[a]
White/Caucasian	395 (70.4%)		321 (75.4%)		74 (61.4%)			
Asian/Pacific Islander	99 (17.6%)		71 (16.7%)		28 (23.7%)			
Black/African American	27 (5.0%)		19 (4.5%)		8 (7.0%)			
Mixed	17 (3.1%)		14 (3.3%)		3 (2.6%)			
American Indian	2 (0.4%)		1 (0.2%)		1 (0.9%)			
Living on campus	521 (96.5%)		411 (96.5%)		110 (96.5%)		.000	.63
Low Childhood SES								
Total score, *M (SD)*	4.69 (.68)		4.72 (.65)		4.55 (.79)		2.27	.02
(low SES) 4	1 (0.2%)		1 (0.2%)		0 (0.0%)			
3	12 (2.2%)		8 (1.9%)		4 (3.5%)			
2	26 (4.8%)		17 (4.0%)		9 (7.9%)			
1	77 (14.3%)		56 (13.1%)		21 (18.4%)			
(high SES) 0	424 (78.5%)		344 (80.8%)		80 (70.2%)			
Cigarette smoker, past month *(0-6 score)*								
Rating, *M (SD)*	.12 (.55)		.12 (.55)		.12 (.55)		-.05	.38
0 days	503 (93.1%)		398 (93.4%)		105 (92.1%)			
1-2 days	23 (4.3%)		16 (3.8%)		7 (6.1%)			
3-5 days	7 (1.3%)		6 (1.4%)		1 (0.9%)			
6-9 days	3 (0.6%)		3 (0.7%)		--			
10-19 days	2 (0.4%)		2 (0.5%)		--			
20-29 days	1 (0.2%)		--		1 (0.9%)			
All 30 days	1 (0.2%)		1 (0.2%)		--			
Alcohol, past month *(0-4 score)*								

Rating, *M (SD)*	1.19 (1.23)		1.22 (1.27)		1.09 (1.18)		1.02	.29
0 days	223 (41.3%)		176 (41.3%)		47 (41.2%)			
1-2 days	115 (21.3%)		83 (19.5%)		32 (28.1%)			
3-5 days	108 (20.0%)		90 (21.1%)		18 (15.8%)			
6-9 days	62 (11.5%)		50 (11.7%)		12 (10.5%)			
10-19 days	32 (5.9%)		27 (6.3%)		5 (4.4%)			
Marijuana, past month *(0-3 score)*								
Rating, *M (SD)*	.36 (.80)		.39 (.84)		.26 (.63)		1.16	.25
0 days	428 (79.3%)		335 (78.6%)		93 (81.6%)			
1-2 days	54 (10.0%)		40 (9.4%)		14 (12.3%)			
3-5 days	32 (5.9%)		27 (6.3%)		5 (4.4%)			
6-9 days	26 (4.8%)		24 (5.6%)		2 (1.8%)			
Exercise, past week *(0-7 score)*								
Rating, *M (SD)*	3.14 (2.00)		3.19 (2.00)		2.97 (2.00)		1.02	.44
0 days	55 (10.2%)		42 (9.9%)		13 (11.4%)			
1 day	71 (13.1%)		54 (12.7%)		17 (14.9%)			
2 days	95 (17.6%)		77 (18.1%)		18 (15.8%)			
3 days	98 (18.1%)		70 (16.4%)		28 (24.6%)			
4 days	74 (13.7%)		63 (14.8%)		11 (9.6%)			
5 days	74 (13.7%)		62 (14.6%)		12 (10.5%)			
6 days	35 (6.5%)		28 (6.6%)		7 (6.1%)			
7 days	38 (7.0%)		30 (7.0%)		8 (7.0%)			
BMI, *Mdn* (IQR)	22.80 (20.93, 24.89)	16.30-42.81	22.76 (21.01, 25.04)	16.30-42.81	23.02 (20.52,24.62)	16.83-30.89	1.27	.21
SVQ total	1.96 (.76)	0-4	1.94 (.79)	0-4	2.00 (.67)	.33-3.75	-.73	.47
Depressive symptoms (w/o sleep item)	13.59 (9.81)	0-47	13.53 (10.01)	0-47	13.81 (9.10)	1-44	-.65	.52
Anxiety symptoms	41.13 (10.96)	20-73	41.03 (11.10)	20-73	41.52 (10.48)	24-73	-.43	.67
PTSD symptoms	11.67 (4.71)	6-30	11.52 (4.85)	6-30	12.23 (4.14)	6-25	-1.78	.08
Sleep Health total	7.07 (2.50)	0-12	7.04 (2.47)	0-12	7.20 (2.64)	1-12	-.62	.54

Note. p-values reflect comparison between groups who did (N=114) vs. did not (N=426) participate in Phase II. ACE = adverse childhood experiences; BMI = $(lbs/in^2)*703$; Mdn = Median. IQR = Interquartile Range (25th, 75th percentiles); SVQ = Social Vigilance Questionnaire.

[a] Race comparison reflects white vs. non-white.

4.2 Sample Characteristics

4.2.1 Phase I

The Phase I sample included 540 undergraduates; participants were on average 18 years old and the sample was 50% male and 70% white. This is almost identical to the demographics of the Introduction to Psychology subject pool, which was approximately 50% male and 71% white across the fall and spring terms of the recruitment period. Less than 5% of the Phase I sample reported low childhood SES, a composite score that reflected low parental education (less than high school degree), family never owning a car and/or home, family ever receiving public assistance, or family having difficulty paying for food/rent or making ends meet. The sample was relatively healthy, which was to be expected as the sample was recruited to be free of major medical or psychiatric illnesses. Average BMI was in the "normal weight" category (< 24.9) and almost all participants (92%) denied smoking cigarettes in the past month. Approximately 58% and 21% of the sample reported using alcohol or marijuana, respectively, at least once in the past month. Approximately 90% of the sample reported exercising at least once in the past week. Overall, mean depressive and PTSD symptoms were below clinical cut-offs, although 35% and 29% of the sample did report levels of depression and PTSD above cut-off scores, respectively. Participants reported low to moderate levels of anxiety and low levels of vigilance, with total vigilance scores reflecting levels between "almost never" and "rarely".

4.2.2 Phase II

The Phase II subsample included 114 undergraduates; participants were on average 19 years old and the sample was 61% male and 61% white. Less than 5% of the sample reported low childhood SES. The sample was healthy, with average BMI was in the "normal weight" category and average resting SBP and DBP in the "normotensive" range (i.e., SBP < 120 mmHg and DBP < 80 mmHg). Rates of exercise and using cigarettes, alcohol, and marijuana were almost identical to those in the Phase I sample. Overall, mean depressive and PTSD symptoms were below clinical cut-offs, although 39% and 367% did report levels above cut-off scores, respectively. Participants reported low to moderate levels of anxiety and low levels of social vigilance, with total vigilance scores reflecting levels between "rarely" and "sometimes".

4.2.3 Childhood Adversity

The distribution of ACEs for Phase I and Phase II samples is presented in Table 8. In the Phase I sample, the total number of adversities reported by participants ranged from 0-9 out of a possible 10 types, while the total number reported by participants in the Phase II sample ranged from 0-8 adversities. Overall, 281 (52.0%) and 71 (62.3%) of participants reported at least 1 adversity and in the Phase I and II samples, respectively. For both samples, parental mental illness and parental substance abuse were the most frequent types of experiences, while physical neglect and having a parent/caregiver who served or was sentenced to serve time in a jail, prison, or a correctional facility were the least frequent experiences (Table 8). The Phase II subsample reported a greater prevalence of each type of adversity, compared to the Phase I sample, except for parent/caregiver in jail, prison, or correctional facility. Table 9 shows correlations between ACE subtypes. Almost all ACEs were correlated, however, having a parent in jail, prison, or a correctional facility was correlated with the fewest types. Appendix J displays prevalence of meeting the threshold for each of the 21 items on the ACE questionnaire.

Table 8. Frequencies of total number and type of ACEs in Phase I and Phase II samples

ACE Total	**Phase I (N=540)**	**Phase II (N=114)**
0	259 (48.0%)	43 (37.7%)
1	137 (25.4%)	26 (22.8%)
2	57 (10.6%)	18 (15.8%)
3	42 (7.8%)	12 (10.5%)
4	20 (3.7%)	6 (5.3%)
5	16 (3.0%)	6 (5.3%)
6	2 (0.4%)	1 (0.9%)
7	3 (0.6%)	--
8	3 (0.6%)	2 (1.8%)
9	1 (0.2%)	--
ACE Type	**Phase I (n=281)**	**Phase II (n=71)**
Emotional abuse	62 (11.5)	19 (16.7)
Physical abuse	22 (4.1)	7 (6.1)
Sexual abuse	40 (7.4)	14 (12.3)
Emotional neglect	52 (9.6)	20 (17.5)
Physical neglect	16 (3.0)	6 (5.3)
Domestic violence	46 (8.5)	14 (12.3)
Substance abuse	100 (18.5)	27 (23.7)
Mental illness	151 (28.0)	40 (35.1)
Jail, prison, correctional facility	23 (4.3)	4 (3.5)
Parents separated or divorced	91 (16.9)	23 (20.2)

Note. ACE = adverse childhood experiences. ACE total reflects N (%) of individuals who reported exposure to each listed total number of ACEs; no individuals reported exposure to all 10 possible types of ACEs. ACE type refers to N (%) in participants who reported at least 1 ACE.

Table 9. Bivariate correlations among ACEs and Expanded ACEs (N=540)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
ACE											
1. Emotional abuse	--										
2. Physical abuse	.54**	--									
3. Sexual abuse	.14**	.12**	--								
4. Emotional neglect	.47**	.31**	.17**	--							
5. Physical neglect	.35**	.30**	.20**	.28**	--						
6. Domestic violence	.27**	.27**	.19**	.17**	.22**	--					
7. Substance abuse	.23**	.22**	.12**	.22**	.28**	.11*	--				
8. Mental illness	.19**	.10*	.08	.30**	.18*	.08	.29**	--			
9. Jail, prison, correctional facility	.04	.05	.08	.06	.02	.17**	.32**	.18**	--		
10. Parents separated/divorced	.09*	.06	.06	.19**	.16**	.08	.24**	.15**	.10*	--	
Expanded ACE											
11. Witness violence	.11*	.14**	.14**	.09*	.08*	.09*	.07	.02	.02	.01	--
12. Unsafe neighborhood/low neighborhood cohesion	.12**	.09*	.11*	.23**	.10*	.22**	.10*	.17**	.04	.13**	.14**

Note. ACE = Adverse childhood experiences.
*p<.05. **p<.001

4.2.4 Expanded Adversity

As shown in Table 10, Expanded ACEs were prevalent in both Phase I and Phase II samples, although Phase II participants reported a greater exposure to witnessing violence and unsafe/low cohesion neighborhood. Importantly, of the participants in Phases I and II who reported no exposure to ACEs in the family/home environment, over 15% and 18% of those participants did report exposure to witnessing violence and unsafe/low cohesion neighborhood, respectively. The prevalence of exposure to Expanded ACEs increased for those who also reported 1+ ACEs in the family/home environment (see Table 10). As shown in Table 9, meeting criteria for unsafe neighborhood/low cohesion was significantly and positively correlated with all family/home ACEs, while witnessing violence was correlated only with ACEs measuring abuse, emotional neglect, or domestic violence, but not household challenges, i.e., parental mental illness, substance abuse, jail or incarceration, or separation/divorce.

Table 10. Frequencies of reporting Expanded ACE types for Phase I and II samples

	Overall		0 ACEs (family/home)		1+ ACEs (family/home)	
Expanded ACE Type, N (%)	**Phase I (N=540)**	**Phase II (N=114)**	**Phase I (n=259)**	**Phase II (n=43)**	**Phase I (n=281)**	**Phase II (n=71)**
Witnessed violence	101 (18.7)	25 (21.9)	39 (15.1)	8 (18.6)	62 (22.1)	17 (23.9)
Unsafe neighborhood/ low cohesion	161 (29.8)	42 (36.8)	49 (18.9)	9 (20.9)	112 (39.9)	33 (46.5)

Note. ACEs refer to adversities experienced in the family/home environment as measured by the ACE questionnaire. Columns for 0 ACEs and 1+ ACEs reflect the N (%) of participants who reported Expanded ACEs within each group of home/family ACEs. ACE = Adverse childhood experiences.

4.2.5 Survey-Measured Sleep Health

As shown in Table 11, the average score on the RUSATED sleep health survey for Phase I and Phase II samples was 7.07 (SD = 2.50) and 7.20 (SD = 2.64), respectively, on the 12-point scale.

Table 11. Survey sleep health responses for Phase I and II samples

	N	*M (SD)*	Range	B (SE)	β	*p*
Phase I						
RUSATED total score	540	7.07 (2.50)	0-12	-.85 (.18)	-.21	<.001
RUSATED sleep dimensions						
Regularity	540	1.27 (.65)	0-2	-.08 (.05)	-.08	.077
Satisfaction	540	1.06 (.67)	0-2	-.24 (.05)	-.22	<.001
Alertness	540	1.25 (.73)	0-2	-.08 (.05)	-.07	.134
Timing	540	1.09 (.77)	0-2	-.09 (.05)	-.07	.116
Efficiency	540	1.13 (.79)	0-2	-.20 (.06)	-.16	<.001
Duration	540	1.27 (.69)	0-2	-.16 (.05)	-.14	.001
Phase II						
RUSATED total score	114	7.20 (2.64)	1-12	-.72 (.38)	-.18	.058
RUSATED sleep dimensions						
Regularity	114	1.25 (.64)	0-2	.02 (.09)	.03	.793
Satisfaction	114	1.08 (.67)	0-2	-.27 (.10)	-.25	.006
Alertness	114	1.15 (.76)	0-2	-.15 (.11)	-.13	.169
Timing	114	1.23 (.76)	0-2	-.05 (.11)	-.04	.638
Efficiency	114	1.21 (.78)	0-2	-.19 (.11)	-.16	.088
Duration	114	1.24 (.74)	0-2	-.09 (.11)	-.08	.408

Note. Values for B(SE), β, and *p* reflect results from univariate regressions between lnACEtot and RUSATED total score and each sleep dimension. ACE total was natural log transformed [ln(ACEtotal+1)] prior to use in univariate analyses. For all RUSASTED results, higher scores indicate better sleep health. Possible range for RUSATED total score = 0-12. For RUSATED sleep dimensions, 0-2 reflect response options for frequency of meeting sleep health criteria: 0=rarely/never, 1=sometimes, 2=usually/always. B(SE) = unstandardized coefficient (standard error); β = standardized coefficient; *p* = p value.

Figure 10 demonstrates that less than half of Phase I and II participants reported "usually/always" meeting RUSATED cut-offs for each sleep dimension. The poorest sleep dimension was satisfaction; less than 30% of both samples reported "usually/always" feeling satisfied with their sleep. See Appendices K and L for frequency of responses to the six sleep health parameters for Phase I and II, respectively.

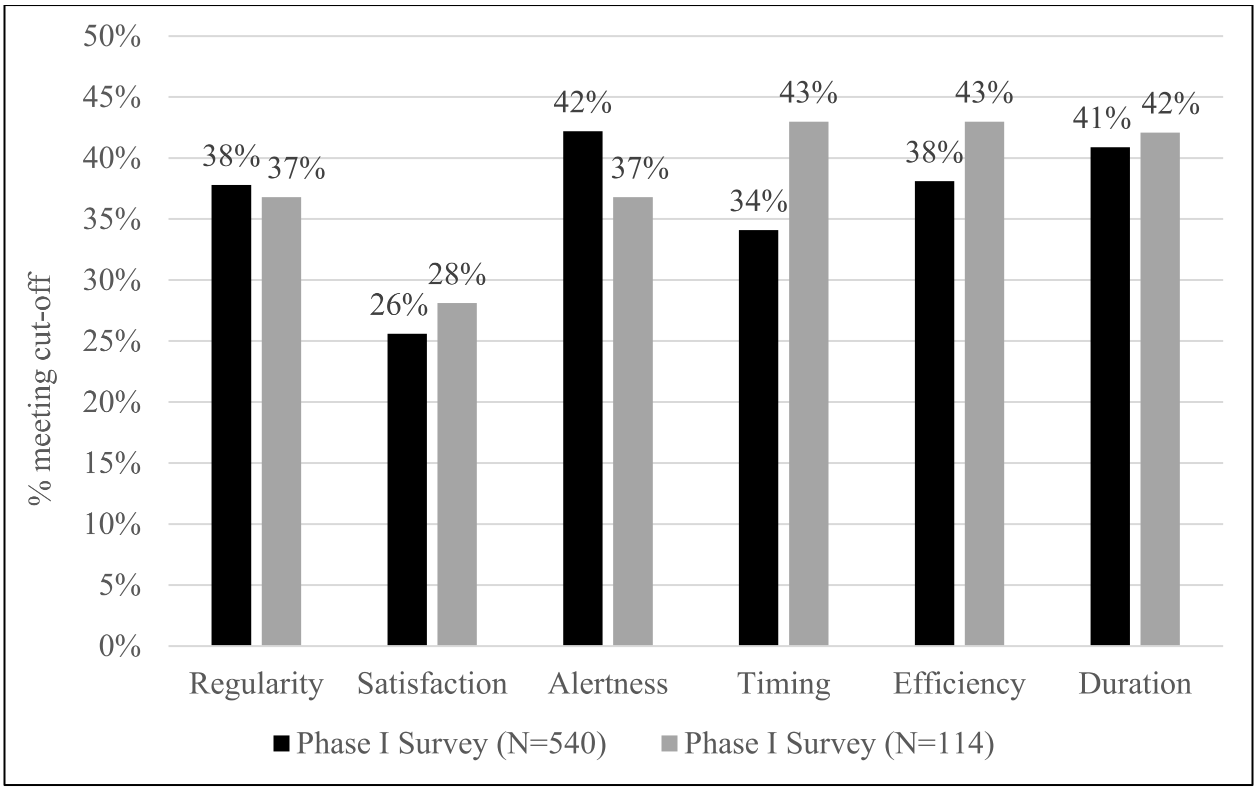

Figure 10. Frequency of participants who "usually/always" met RUSATED cut-offs for survey-assessed sleep dimensions

Note. Values reflect the percentage of individuals for the Phase I and Phase II samples who self-reported they "usually/always" met RUSATED sleep health cut-offs (Buysse, 2014) for each sleep dimension. This figure does not show the percentage of participants who reported meeting criteria "rarely/never" or "sometimes".

4.2.6 Actigraphy-Measured Sleep Health

Table 12 shows average actigraphy-assessed sleep characteristics. Mean sleep duration was 6.23 hours across the 112 participants who completed the weeklong protocol. Average timing of sleep (i.e., sleep midpoint) was approximately 5:00am. Mean within-person variability in sleep midpoint (i.e., regularity) across the study was 55.96 minutes. Mean sleep efficiency was 82.38%. On average, participants demonstrated actigraphy-assessed naps on 21% of days.

Table 12. Ambulatory sleep health dimensions for Phase II sample

Sleep Health Dimension	N	*M (SD)*	Range	B (SE)	β	p
Regularity						
Actigraphy (min)	112	55.96 (24.95)	9.09-149.36	.26 (.24)	.10	.291
Diary (min)	113	39.82 (21.93)	7.51-167.69	.12 (.24)	.05	.624
Satisfaction						
Diary	113	3.48 (.63)	2.14-5.00	-.07 (.09)	-.08	.428
Alertness						
Actigraphy proportion of days napped	112	.21 (.22)	.00-.83	.07 (.03)	.21	**.028**
Diary proportion of days napped	113	.25 (.24)	.00-.83	.07 (.03)	.18	.059
Timing						
Actigraphy (min)	112	311.08 (70.71)	131.36-495.21	1.84 (10.35)	.02	.859
Diary (min)	113	208.51 (29.91)	117.86-295.00	.41 (4.26)	.01	.926
Efficiency						
Actigraphy (%)	112	82.38 (5.97)	52.89-91.58	.02 (.04)	.05	.620
Diary (%)	113	95.16 (3.41)	80.93-99.82	.08 (.08)	.10	.304
Duration						
Actigraphy (hrs)	112	6.23 (.93)	3.03-8.16	-.11 (.14)	-.08	.400
Diary (hrs)	113	7.05 (.96)	4.39-9.13	-.07 (.14)	-.05	.635

Note. Values for B(SE), β, and *p* reflect results from univariate associations between lnACEtot and each actigraphy or diary sleep dimension. ACE total [ln(ACEtotal+1)] and actigraphy and diary sleep efficiency [ln(100-Efficiency+1)] were natural log transformed prior to analysis. Note that higher values for sleep efficiency reflect *poorer* sleep prior to use in univariate analyses. Regularity = SD of sleep midpoint (min); higher values reflect more variability in sleep timing. Diary satisfaction rated on a 5-point scale *(1=very poor* to *5= very good*); only diary satisfaction is shown, as satisfaction cannot be measured by actigraphy. Actigraphy and diary alertness reflect proportion of days during the study period with at least one nap of 15 min in duration. Timing = mean of sleep midpoint (midnight = 0 min); higher values reflect later timing. B(SE) = unstandardized coefficient (standard error); β = standardized coefficient; *p* = p value

4.2.7 Diary-Measured Sleep Health

Table 12 shows average diary-reported sleep characteristics. Mean sleep duration was 7.05 hours across the 113 participants who completed the weeklong protocol. Average timing of sleep (i.e., sleep midpoint) was approximately 3:30am. Mean within-person variability in sleep midpoint (i.e., regularity) was 39.82 minutes. Participants reported high sleep efficiency (95.16%). On average, participants reporting napping on 25% of days across the study period. Participants reported "average" to "good" sleep quality.

4.2.8 Vigilance for Threat

4.2.8.1 Cardiovascular stress responses

Table 13 provides values for SBP, DBP, and PR for each task. The speech task elicited the greatest absolute changes in SBP, DBP, and PR, followed by speech preparation, dot probe, and the CAUSE videos. Participants demonstrated significant reactivity for SBP, DBP, and PR during the dot probe, preparation, and speech tasks; one exception was that SBP did not increase significantly above baseline during the dot probe task (see Figures 11-13). In contrast, the CAUSE videos task did not elicit significant reactivity for SBP, DBP, or PR values (Figures 11-13). Mean change from baseline to average task levels was 5.48 (SD = 4.50) mmHg for SBP, 5.18 (SD = 3.51) mmHg for DBP, and 5.14 (SD = 4.99) for PR. Each of these change values reflected significant average increases in SBP, DBP, and PR.

Table 13. Physiological results for Phase II sample

	N	*M* (*SD*)	Range	B (SE)	β	p
SBP, mmHg						
Baseline levels	114	108.56 (8.69)	88.00-138.00	-.87 (1.26)	-.07	.493
Task levels						
Average Task SBP	114	114.04 (9.37)	90.50-147.44	-1.04 (1.36)	-.07	.446
Dot-probe	113	109.24 (9.19)	87.50-139.25	-1.11 (1.34)	-.08	.410
CAUSE	114	108.34 (8.33)	91.50-131.75	-1.52 (1.20)	-.12	.208
Speech prep	113	113.02 (10.88)	88.00-145.50	-.20 (1.59)	-.01	.902
Speech task	112	126.15 (13.24)	98.00-179.00	-2.39 (1.93)	-.12	.220
Average SBP change from baseline	114	5.48 (4.50)	-5.29-19.13	-.17 (.66)	-.03	.791
DBP, mmHg						
Baseline levels	114	60.44 (5.48)	52.33-83.67	.39 (.80)	.05	.624
Task levels						
Average Task DBP	114	65.63 (6.77)	52.64-90.96	.66 (.98)	.06	.503
Dot-probe	113	61.12 (5.54)	52.17-80.20	.47 (.81)	.06	.562
CAUSE	114	60.33 (5.16)	51.75-77.75	.66 (.75)	.08	.379
Speech prep	113	65.88 (9.67)	51.00-128.00	1.20 (1.41)	.08	.396
Speech task	112	75.48 (10.17)	54.50-106.50	-.49 (1.50)	-.03	.746
Average DBP change from baseline	114	5.18 (3.51)	-2.03-15.29	.27 (.51)	.05	.598
Pulse Rate, bpm						
Baseline levels	113	69.54 (9.47)	43.33-99.33	1.73 (1.38)	.12	.210
Task levels						
Average Task PR	114	74.56 (10.59)	43.00-110.13	2.78 (1.52)	.17	.069
Dot-probe	112	71.47 (10.10)	42.00-103.75	2.67 (1.46)	.17	.071
CAUSE	114	69.91 (9.98)	42.00-104.75	2.96 (1.42)	.19	.040
Speech prep	113	74.72 (11.77)	45.00-111.00	2.45 (1.70)	.14	.154
Speech task	112	82.77 (14.82)	54.00-158.00	2.35 (2.17)	.10	.281
Average PR change from baseline	113	5.14 (4.99)	-6.46-22.48	.89 (.73)	.12	.221

Note. Values for B(SE), β, and *p* reflect results from univariate associations between lnACEtot and each physiological variable. ACE total was natural log transformed [ln(ACEtotal+1)] prior to use in univariate analyses. B(SE) = unstandardized coefficient (standard error); β = standardized coefficient; *p* = p value; ACE = adverse childhood experiences; bpm = beats per minute; DBP = diastolic blood pressure; mmHg = millimeter of mercury; PR = pulse rate; SBP = systolic blood pressure.

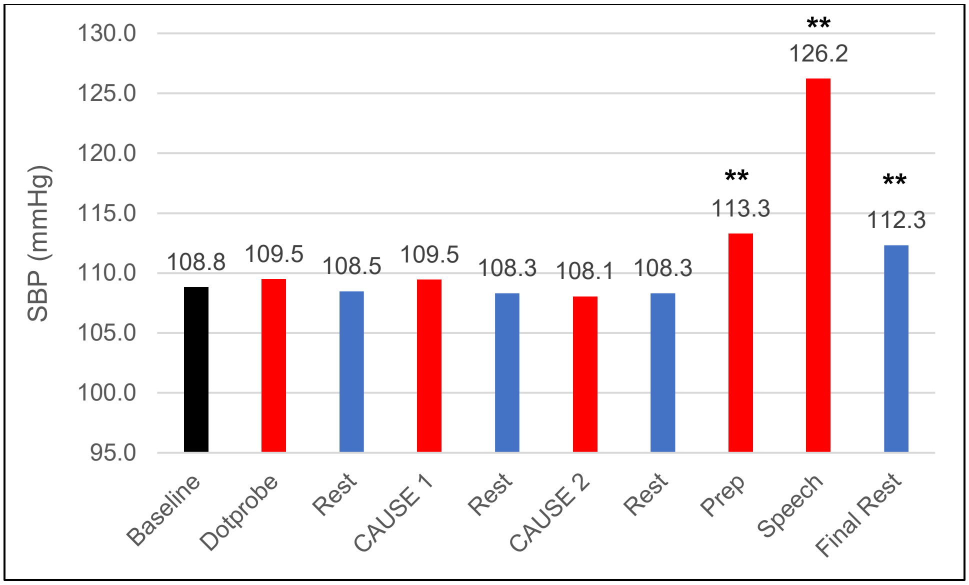

Figure 11. Systolic blood pressure (SBP) throughout laboratory session for N=114 subsample

Note. Asterisks indicate significant change from baseline. Red bars = task periods; Blue bars = rest periods.
**p<.001

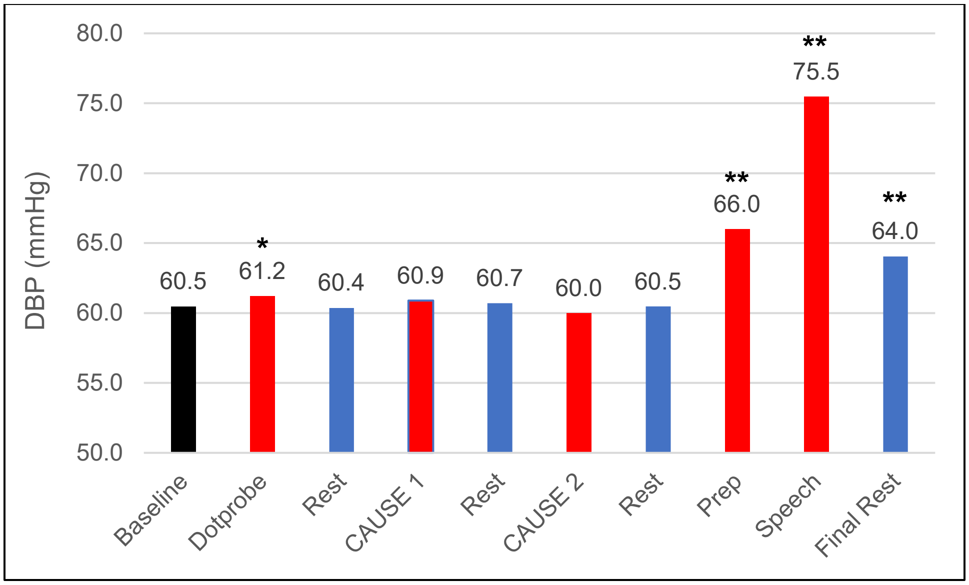

Figure 12. Diastolic blood pressure (DBP) throughout the laboratory session for N=114 subsample

Note. Asterisks indicate significant change from baseline. Red bars = task periods; Blue bars = rest periods. *p<.05, **p<.001

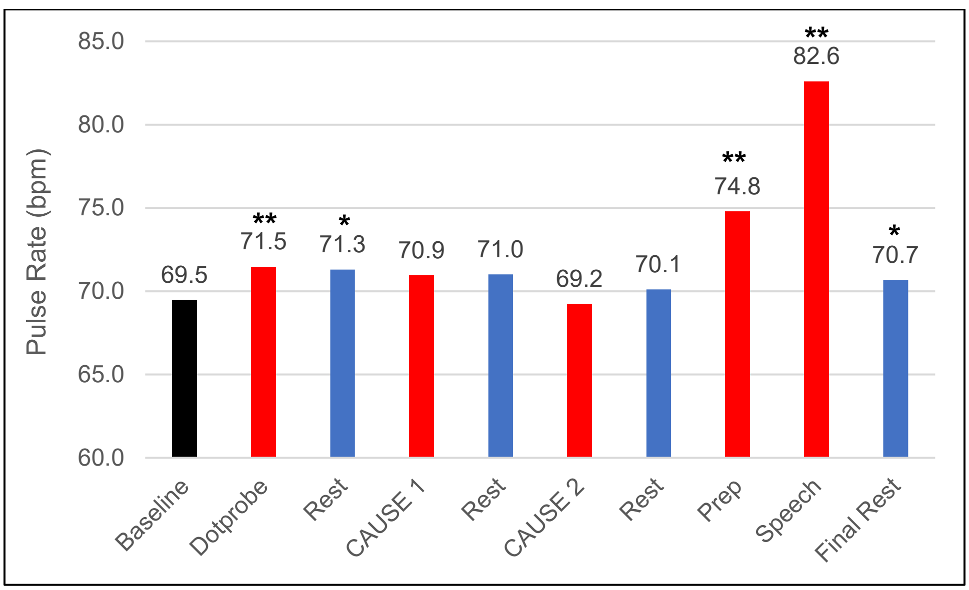

Figure 13. Pulse rate (PR) throughout laboratory session for N=114 subsample

Note. Asterisks indicate significant change from baseline. Red bars = task periods; Blue bars = rest periods. *p<.05, **p<.001

4.2.8.2 Dot probe

Table 14 provides results for the dot probe task. Participants were highly accurate, responding to 96% of the probes correctly. Average response time across all trials was 544.59 ms. Regarding threat bias, 57 (55.9%) and 45 (44.1%) of participants demonstrated a bias toward vs. away from the threatening stimuli, respectively, $\chi^2(2)=1.59$, $p=.451$.

Table 14. Dot probe results for Phase II sample

	N	***M* (*SD*)**	Range	B (SE)	β	p
% Accuracy	102	.96 (.03)	.85 - 1.00	.004 (.005)	.07	.470
Mean RT (ms)	102	544.59 (57.75)	419.06 - 544.59	-1.56 (8.89)	-.02	.861
Threat Bias	102	1.86 (23.96)	-65.02 - 48.98	-.31 (3.69)	-.01	.934

Note. Values for B(SE), β, and *p* reflect results from univariate associations between lnACEtot and each dot probe variable. ACE total was natural log transformed [ln(ACEtotal+1)] prior to use in univariate analyses. B(SE) = unstandardized coefficient (standard error); β = standardized coefficient; *p* = p value; ACE = adverse childhood experiences; RT = response time (milliseconds).

4.2.8.3 CAUSE video ratings

Table 15 provides results regarding the CAUSE ratings. On average, participants were most likely to interpret hostile and neutral intentions and feeling stressed in response to the videos.

Table 15. CAUSE video ratings for Phase II sample

CAUSE items	N	***M* (*SD*)**	Range	B (SE)	β	p
Hostile	114	3.45 (.82)	1.50-5.00	-.10 (.12)	-.08	.398
Benign/positive	114	2.73 (.81)	1.00-5.00	.24 (.12)	.19	.044
Neutral	114	3.58 (.84)	1.00-5.00	-.10 (.12)	-.08	.391
Calm	114	2.62 (.88)	1.00-5.00	.06 (.13)	.05	.635
Scared	114	2.69 (.79)	1.00-5.00	-.02 (.11)	-.02	.848
Stressed	114	3.34 (.84)	1.50-5.00	.02 (.12)	.01	.887

Note. CAUSE items rated on a 5-point scale = 1 (*not at all likely*) to 5 (*very likely*). B(SE), β, and p-values reflect unstandardized and standardized univariate associations between lnACEtot and CAUSE items. ACE total [ln(ACEtotal+1)] was natural log transformed prior to use in univariate analyses. ACE = adverse childhood experiences. B (SE) = unstandardized beta (standard error); β = standardized coefficient; *p* = p-value.

4.2.8.4 Daily diary ratings

Table 16 shows average responses for diary measures of threat; overall, results reflect daily vigilance "almost never" to "rarely".

Table 16. Daily diary measures of vigilance for threat for Phase II sample

	N	*M* (*SD*)	Range	B (SE)	β	*p*
1. Did you pay extra attention to people who might say something negative about you?	113	1.51 (.53)	1.00-3.14	.10 (.08)	.12	.216
2. Did you feel like someone had negative intentions toward you?	113	1.38 (.48)	1.00-3.57	.07 (.03)	.23	.014
3. Did you pay extra attention to voice tones, facial expressions, or body language that seemed to be negative or disapproving toward you?	113	1.58 (.68)	1.00-4.86	.05 (.04)	.12	.195

Note. Items measured on a 5-point scale = 1 (*almost never*) to 5 (*almost always*). B(SE), β, and p-values reflect unstandardized and standardized univariate associations between lnACEtot and each sleep item. ACE total [ln(ACEtotal+1)] was natural log transformed prior to use in univariate analyses. ACE = adverse childhood experiences; B(SE) = unstandardized beta (standard error); β = standardized coefficient; *p* = p-value.

4.2.9 Laboratory Post-Task Ratings

As shown in Table 17, participants found the speech task to be more demanding and stressful than the dot probe and CAUSE videos tasks. Regarding the speech task, on average participants reported that they felt the speech captured their event, made them feel anxious, and made them feel bodily reactions (e.g., sweating) "moderately" to "quite a bit".

Table 17. Post-task questionnaire results for Phase II sample

	N	*M* (*SD*)	Range	B (SE)	β	*p*
Demanding						
Dot-probe	102	1.66 (.75)	1-4	.06 (.12)	.05	.597
CAUSE Videos	114	1.20 (.55)	1-4	.12 (.08)	.14	.125
Speech	114	3.12 (1.02)	1-5	.17 (.15)	.11	.265
Stressful						
Dot-probe	102	1.61 (.77)	1-5	.07 (.11)	.06	.542
CAUSE Videos	114	1.40 (.76)	1-4	.10 (.11)	.08	.390
Speech	114	3.18 (1.16)	1-5	.16 (.17)	.09	.337
Speech-specific items						
Captured event	114	3.61 (.77)	1-5	.14 (.11)	.12	.215
Felt almost as strongly as event	114	2.61 (.99)	1-5	.02 (.14)	.01	.901
Bodily reactions (e.g., sweating, pounding heart)	114	2.64 (1.15)	1-5	.29 (.16)	.17	.079
Felt nervous, anxious, tense	114	3.11 (1.02)	1-5	.34 (.15)	.22	.020

Note. "Demanding" and "Stressful" were measured on a 5-point scale = 1 (*not at all demanding/stressful*) to 5 (*very demanding/stressful*). Speech-specific items were measured on a 5-point scale = 1 *(not at all)* to 5 *(extremely).* B(SE), β, and p-values reflect unstandardized and standardized univariate associations between lnACEtot and each post-task questionnaire item. ACE total [ln(ACEtotal+1)] was natural log transformed prior to use in univariate analyses. ACE = adverse childhood experiences; B(SE) = unstandardized beta (standard error); β = standardized coefficient; *p* = p-value.

4.3 Primary Analyses

4.3.1 Bivariate Correlations

Bivariate correlations were conducted across childhood adversity, demographic, health, psychosocial, vigilance for threat, and sleep variables (Table 18).

Table 18. Bivariate correlations among childhood adversity, demographic, health, psychosocial, and sleep variables

	N	1	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1. ACE	540	--																			
2. Age	540	.04	--																		
3. Sex	540	**-.15**	.02	--																	
4. Race	540	**.09**	-.01	-.05	--																
5. Day med	114	.06	-.60	**-.23**	**-.23**	--															
6. SES (low)	540	.33	.09	-.05	**.16**	-.06	--														
7. BMI	540	-.07	.07	**.10**	-.02	.16	.02	--													
8. Cigarettes	540	.07	.04	.05	-.02	-.08	-.05	-.02	--												
9. Alcohol	540	**-.11**	**.09**	.02	**-.19**	.14	**-.13**	.06	**.21**	--											
10. Exercise	540	-.07	-.04	**.14**	-.06	.05	-.06	.07	.02	.02	--										
11. Marijuana	540	.03	-.04	.08	-.07	.06	-.05	.01	**.26**	**.39**	.04	--									
12. CES-D	540	**.34**	**.11**	**-.23**	**.09**	.00	**.11**	.00	.07	-.03	**-.11**	.05	--								
13. PTSD	540	**.41**	**.11**	**-.23**	**.11**	.10	.08	-.02	**.12**	.01	**-.12**	**.05**	**.72**	--							
14. STAI	537	**.34**	.07	**-.28**	**.11**	.08	.08	-.01	.07	-.04	**-.12**	.02	**.85**	**.73**	--						
RUSATED Survey Sleep Dimensions																					
15. Regularity	540	-.08	**.11**	-.00	.04	-.11	.05	.04	-.02	**-.12**	**.16**	-.04	-.06	**-.07**	-.08	--					
16. Satisfaction	540	**-.22**	-.04	**.11**	**-.11**	.07	**-.10**	-.01	-.07	.01	.07	-.02	**-.40**	**-.36**	**-.42**	**.24**	--				
17. Alertness	540	-.07	.07	.06	**-.15**	-.03	-.04	.01	-.05	**-.13**	.01	**-.12**	**-.14**	**-.10**	**-.12**	**.17**	**.26**	--			
18. Timing	540	-.07	**.11**	-.04	-.02	-.08	-.03	.04	-.03	**-.12**	.04	**-.11**	**-.12**	**-.10**	**-.09**	**.29**	**.19**	**.16**	--		
19. Efficiency	540	**-.16**	-.05	-.01	.01	-.03	-.03	.06	-.02	-.06	.00	**-.16**	**-.25**	**-.18**	**-.21**	.05	**.23**	**.14**	**.18**	--	
20. Duration	540	**-.14**	-.00	**.14**	**-.14**	-.04	-.06	.02	-.08	-.04	-.02	.03	**-.23**	**-.25**	**-.25**	**.20**	**.48**	**.29**	**.24**	**.11**	--
Actigraphy Sleep Dimensions																					
21. Regularity (less)	112	.10	-.05	.06	.08	-.00	.02	-.01	-.00	.10	-.06	-.08	.03	.05	-.06	-.28	-.17	**-.19**	**-.30**	-.05	**-.26**
22. Alertness (more napping)	112	**.21**	-.09	-.08	.16	.10	-.09	.01	.03	-.11	-.07	-.01	.07	.10	-.02	**-.30**	**-.27**	**-.48**	**-.21**	-.07	**-.26**
23. Timing (later)	112	.02	**-.31**	-.18	.17	.00	-.06	.01	.08	**.21**	**-.21**	.14	.07	.13	.05	**-.38**	-.16	**-.24**	**-.42**	-.04	-.07
24. Efficiency (low)	112	.05	-.03	.06	.11	-.05	-.03	.02	.09	.14	-.05	-.01	**.20**	.09	.06	-.09	-.18	-.16	.10	-.18	-.27
25. Duration	112	-.08	-.08	.10	**-.33**	.18	.06	-.04	-.09	-.00	.13	.04	-.18	-.06	.01	**.23**	.18	**.30**	.10	.11	**.34**
Diary Sleep Dimensions																					
26. Regularity (less)	113	.05	-.05	.06	-.06	.05	-.02	-.01	.03	.14	.13	.17	.14	.09	.07	**-.30**	**-.30**	**-.24**	**-.30**	**-.23**	-.14
27. Satisfaction	113	-.08	-.02	-.10	**.21**	-.03	-.00	.11	-.08	.04	.05	.07	**-.34**	**-.30**	**-.33**	.03	**.49**	**.23**	.01	.18	**.34**
28. Alertness	113	.18	-.06	-.07	.11	.09	-.11	-.01	.01	-.08	-.03	.00	.08	.11	-.01	**-.33**	**-.30**	**-.44**	-.15	-.11	**-.19**

(more napping)																					
	N	1	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
29. Timing (later)	113	.02	-.16	-.06	**-.25**	.27	-.04	.02	-.61	.19	-.02	.12	-.17	-.08	-.04	.02	.10	.19	.07	.03	**.29**
30. Efficiency (low)	113	.10	-.01	-.02	.00	-.03	.06	-.02	.03	-.05	.02	-.09	**.38**	**.23**	**.34**	-.01	**-.31**	.05	-.13	**-.33**	-.12
31. Duration	113	-.05	-.07	.03	**-.36**	**.19**	.00	-.03	-.07	.14	.10	.03	**-.20**	-.08	-.04	.15	.18	**.24**	.13	.07	**.31**
Sleep Health 0-12 Total Scores[a]																					
32. Survey	540	**-.21**	.06	.07	**-.10**	-.06	.08	.05	-.07	**-.13**	.07	**-.12**	**-.34**	**-.30**	**-.33**	**.53**	**.67**	**.58**	**.60**	**.51**	**.64**
33. Survey	114	-.18	.10	.08	**-.20**	-.06	-.03	-.01	-.07	.01	.00	-.10	**-.34**	**-.32**	**-.24**	**.48**	**.69**	**.66**	**.64**	**.46**	**.72**
34. Actigraphy	112	-.09	.17	-.06	-.09	-.05	-.11	-.02	-.12	-.03	.00	.01	**-.26**	**-.24**	**-.19**	**.38**	**.55**	**.44**	**.30**	.17	**.42**
35. Diary	113	-.14	.15	.09	.05	.02	-.13	.05	-.09	.02	-.04	-.04	**-.27**	**-.27**	**-.25**	**.34**	**.50**	**.45**	**.32**	**.25**	**.29**

Note. Age, BMI, ACE total [ln(ACEtotal+1)], and actigraphy and diary sleep efficiency [ln(100-Efficiency+1)] were natural log transformed prior to analysis. Actigraphy and diary sleep regularity, childhood SES, marijuana use, and total depressive and PTSD symptoms were square-root transformed prior to analysis. Regularity = SD of sleep midpoint (min); higher values reflect more variability in sleep timing. Diary satisfaction rated on a 5-point scale *(1=very poor* to *5=very good*); only diary satisfaction is shown, as satisfaction cannot be measured by actigraphy. Actigraphy and diary alertness = proportion of days during the study period with at least one nap of 15 min in duration. Timing = mean of sleep midpoint (midnight = 0 min); higher values reflect later timing. For efficiency, higher values = *lower* sleep efficiency. ACE = adverse childhood experiences total score; Day med = yes/no took daytime medications that may impact sleep; Race (1=non-white); Sex (1=Male). Bolded items reflect $p<.05$. Red items reflect $p<.10$.

[a]Reflects survey, actigraphy, and diary-derived RUSATED sleep health total scores (0-12); higher=better sleep health.

4.3.1.1 Childhood adversity and demographics, health, psychosocial, and sleep variables

Individuals who reported more childhood adversity were more likely to be female and non-white and report lower childhood SES, lower BMI, less alcohol use, and higher levels of depressive, anxiety, and PTSD symptoms. Childhood adversity was associated with poorer sleep on all six on RUSATED survey sleep health dimensions except alertness. Regarding weeklong actigraphy and diary averages, reporting more childhood adversity was associated with less alertness; i.e., more actigraphy- and diary-assessed daytime napping. Childhood adversity was unrelated to any other actigraphy- or diary-measured sleep dimension.

4.3.1.2 Survey, actigraphy, and diary sleep variables

As shown in Table 19, actigraphy and diary measures of sleep were generally correlated, except for timing. Actigraphy and diary measures of alertness (i.e., napping) were highly correlated (r = .93), as the scoring of actigraphy naps was partly dependent on the presence of a diary-reported nap. There were large correlations between the RUSATED survey sleep health total score and total scores when the RUSATED cut-offs were applied to actigraphy (r = .61) and diary (r = .58) data, while the actigraphy and diary total scores were even more strongly correlated with each other (r = .76).

Table 19. Bivariate correlations among actigraphy and daily diary sleep variables

	N	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.
Actigraphy Sleep Dimensions																
20. Regularity (less)	112	--														
21. Alertness (more napping)	112	.18	--													
22. Timing (later)	112	**.19**	**.21**	--												
23. Efficiency (low)	112	.14	.07	.11	--											
24. Duration	112	**-.21**	**-.35**	**-.25**	**-.56**	--										
Diary Sleep Dimensions																
25. Regularity (less)	113	**.46**	**.22**	**.34**	**.24**	**-.23**	--									
26. Satisfaction	113	.08	-.15	-.10	-.30	.16	**-.22**	--								
27. Alertness (more napping)	113	.16	**.93**	**.21**	.07	**-.33**	**.24**	-.14	--							
28. Timing (later)	113	**-.23**	-.13	.15	-.17	**.66**	-.07	.02	-.10	--						
29. Efficiency (low)	113	-.11	.03	.11	**.24**	-.07	.09	**-.42**	.05	-.05	--					
30. Duration	113	-.14	**-.30**	**-.22**	**-.19**	**.82**	-.12	.11	**-.26**	**.77**	**-.25**	--				
Sleep Health 0-12 Total Scores[a]																
31. Survey	540	**-.34**	**-.43**	**-.35**	**-.24**	**.34**	**-.41**	**.35**	**-.41**	**.19**	**-.26**	**.30**	--			
32. Survey	114	**-.34**	**-.43**	**-.35**	**-.24**	**.34**	**-.41**	**.35**	**-.41**	**.19**	**-.26**	**.30**	--	--		
33. Actigraphy	112	**-.39**	**-.52**	**-.46**	**-.43**	**.47**	**-.42**	**.49**	**-.47**	**.21**	**-.30**	**.41**	**.61**	**.61**	--	
34. Diary	113	**-.24**	**-.55**	**-.42**	**-.23**	**.38**	**-.48**	**.49**	**-.55**	.18	**-.40**	**.38**	**.58**	**.58**	**.76**	--

Note. Actigraphy and diary sleep efficiency [ln(100-Efficiency+1)] were natural log transformed prior to analysis. Actigraphy and diary sleep regularity were square-root transformed prior to analysis. Regularity = SD of sleep midpoint (min); higher values reflect more variability in sleep timing. Diary satisfaction rated on a 5-point scale *(1=very poor* to *5= very good*); only diary satisfaction is shown, as satisfaction cannot be measured by actigraphy. Actigraphy and diary alertness = proportion of days during the study period with at least one nap of 15 min in duration. Timing = mean of sleep midpoint (midnight = 0 min); higher values reflect later timing. For efficiency, higher values = *lower* sleep efficiency. Bolded items reflect p<.05. Red items reflect p<.10.

[a]Reflects survey, actigraphy, and diary-derived RUSATED sleep health total scores (0-12); higher=better sleep health.

4.3.1.3 Vigilance for threat variables

There were no correlations between childhood adversity and any physiological variables, with the exception of more adversity being related to higher PR during the CAUSE task (Table 13). Childhood adversity was unrelated to average accuracy, response time, or threat bias score on the dot probe task (Table 14). On the CAUSE task, childhood adversity was related to reporting more benign/positive interpretations but was unrelated to all other items (Table 15). On the speech task, childhood adversity was related to feeling more anxious during the speech (Table 17). Regarding daily diary measures of vigilance, adversity was related only to "feel[ing] like someone had negative intentions toward you" (item 2). Finally, adversity was unrelated to ratings of demand/stressfulness for each task (Table 17).

Correlations among vigilance for threat variables (Table 20) indicated that the SVQ was unrelated to all behavioral and physiological items. However, the SVQ did demonstrate significant positive relationships with diary vigilance, likely because the three diary items were based off of the SVQ survey. The diary items were highly correlated with each other (rs = .67-.86). Five of the six CAUSE items were significantly correlated with each other, with the exception of "Neutral". Overall there were few correlations between physiological measures and behavioral or diary measures. Regarding physiological measures, SBP, DBP, and PR were typically correlated within-task (i.e., for the dot probe), but inconsistently correlated across tasks.

Table 20. Bivariate correlations among vigilance for threat variables

	N	1	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.
Survey																							
1. SVQ	540	--																					
Behavioral																							
2. Dot bias	102	-.00	--																				
3. C-Hostile	114	.02	.01	--																			
4. C-Benign	114	-.12	.06	**-.60**	--																		
5. C-Neutral	114	-.11	-.01	-.10	**.19**	--																	
6. C-Calm	114	-.07	.09	**-.46**	**.41**	.02	--																
7. C-Scare	114	-.01	-.04	**.44**	**-.22**	.01	**-.55**	--															
8. C-Stress	114	.12	-.02	**.53**	**-.33**	-.06	**-.68**	**.72**	--														
Diary																							
9. Diary 1	113	**.29**	-.13	-.14	.00	**.19**	**-.20**	.01	.12	--													
10. Diary 2	113	.18	-.11	-.05	.08	.10	-.15	-.02	.08	**.71**	--												
11. Diary 3	113	**.26**	-.15	-.06	-.02	**.21**	**-.19**	.01	.16	**.86**	**.67**	--											
Psychophys																							
12. ZD-SBP	113	.02	.03	-.17	.14	**.21**	.06	-.08	**-.21**	-.01	.04	-.03	--										
13. ZD-DBP	113	-.10	-.07	.02	.15	**.19**	.07	.08	-.13	-.06	-.01	-.11	**.26**	--									
14. ZD-PR	112	-.03	-.01	.01	.06	-.09	-.01	-.06	-.02	-.03	.12	.04	**.28**	**.20**	--								
15. ZC-SBP	114	.04	.06	-.13	.08	.05	-.01	-.18	-.09	-.01	-.13	.02	**.50**	.17	**.21**	--							
16. ZC-DBP	114	.02	-.07	.05	.10	-.06	.01	-.02	.01	-.03	-.05	.05	.06	**.43**	.12	**.36**	--						
17. ZC-PR	113	-.13	.04	.12	-.05	-.05	-.08	-.05	.01	.01	.09	.08	.17	.15	**.62**	**.35**	**.31**	--					
18. ZP-SBP	113	.13	-.16	-.06	-.01	.14	.06	-.12	-.04	-.03	.04	-.01	**.21**	.08	.14	**.20**	.01	.10	--				
19. ZP-DBP	113	.07	-.08	-.13	.16	.07	.10	-.09	-.06	-.00	.04	.02	-.01	**.22**	-.08	.09	**.22**	-.07	**.31**	--			
20. ZP-PR	112	.07	.03	.16	-.04	.02	-.08	.09	.13	.01	.09	.02	-.02	-.02	**.39**	-.06	-.08	**.40**	**.34**	.07	--		
21. ZS-SBP	112	.03	-.11	-.02	.04	.14	-.10	.05	.01	-.09	-.03	-.08	**.31**	.07	.10	**.22**	**-.07**	-.01	**.43**	.12	**.23**	--	
22. ZS-DBP	112	-.02	.01	.06	-.03	.12	-.03	.01	.02	-.08	.03	-.12	-.11	**.21**	.06	.06	.13	.09	**.25**	**.34**	.14	**.45**	--
23. ZS-PR	111	.12	.03	**.20**	-.11	.09	**-.19**	.12	**.21**	-.06	-.03	-.04	.00	-.11	.12	.02	-.02	**.20**	**.31**	.03	**.50**	**.60**	**.33**

Note. Diary items 2 and 3 were square-root transformed prior to analysis. Diary 1 = "Did you pay extra attention to people who might say something negative about you?" Diary 2 = "Did you feel like someone had negative intentions toward you?" Diary 3 = "Did you pay extra attention to voice tones, facial expressions, or body language that seemed to be negative or disapproving toward you?" C = CAUSE videos; D = dot probe; DBP = diastolic blood pressure; P = prep; PR = pulse rate; Psychophys = psychophysiology; S = speech; SBP = systolic blood pressure; SVQ = Social Vigilance Questionnaire total score; Z = residualized reactivity variable (i.e., task level regressed on baseline SBP, DBP, or PR, respectively). Bolded items reflect p<.05. Red items reflect p<.10.

4.3.1.4 Sex and race

As shown in Table 18, females reported greater exposure to childhood adversity. Males reported higher BMI, more exercise, marginally more marijuana use, and lower symptoms of depression, anxiety, and PTSD. There were few consistent relationships between sex and individual sleep health dimensions on the RUSATED survey or continuous weeklong averages for actigraphy or diary. Sex was also not related to sleep health using the RUSATED survey total score, or actigraphy or diary total scores (i.e., when the RUSATED cut-offs were applied to actigraphy/diary data). Non-white participants reported lower childhood SES, less alcohol and marijuana use, higher levels of psychosocial symptoms; poorer sleep satisfaction, less alertness, and shorter survey-measured sleep duration; later timing, shorter duration, and poorer satisfaction by weeklong actigraphy and diary measures; and lower sleep health total score on the RUSATED survey, but not on actigraphy or diary total scores.

4.3.2 Hypothesis 1: Cumulative Childhood Adversity Will Be Associated With Worse Sleep Health

The structural equation model with direct effects from childhood adversity to adult sleep health, controlling for age, race, and sex, is presented in Figure 14. Only significant standardized path coefficients are displayed; unstandardized coefficients are provided in Table 21. The model demonstrated good fit to the data. More childhood adversity was associated with worse latent sleep health.

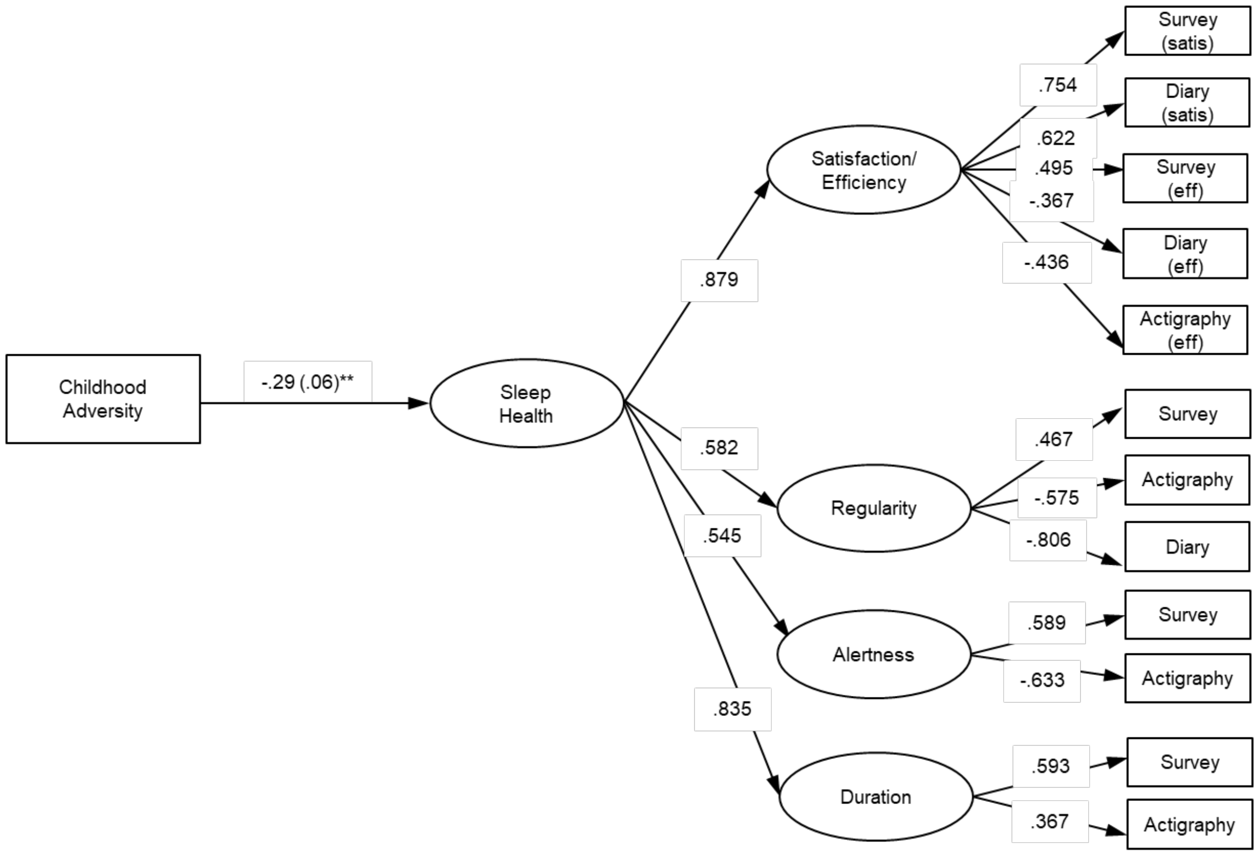

Figure 14. Structural equation model depicting the association between childhood adversity and poor latent sleep health

Note. Survey indicators represent participant responses on the RUSATED survey regarding how often they met cut-offs for each sleep dimension on a 3-point scale. Actigraphy and diary sleep indicators represent average continuous values for each sleep dimension across the weeklong ambulatory sleep protocol. For survey, actigraphy, and diary indicators, higher values = better sleep. Model fit indices were as follows, $\chi^2(df)$ = 74.98 (42), p = .001, CFI = .94, TLI = .84, RMSEA [90% CI] = .038 [.024, .052], SRMR = .057. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1; the path from the Satisfaction/Efficiency first-order factor to survey-measured satisfaction was fixed to 1. Coefficients for all survey, actigraphy, and diary sleep indicators regressed on age, sex, and race, respectively, are not displayed as these variables were included as covariates. $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual; satis = satisfaction; eff = efficiency.
**p<.001.

Table 21. Structual equation model results with unstandardized path coefficients and latent factor loadings, adjusted for age, sex, and race

	B (SE)	*p*
Path model		
ACE → Latent sleep health	-.50 (.11)	<.001
Second-order latent factor		
Sleep Health		
Regularity	.17 (.05)	.001
Satisfaction/Efficiency	.42 (.08)	<.001
Alertness	.23 (.07)	.001
Duration	.33 (.07)	<.001
First-order latent factors		
Regularity		
Survey	1.0	
Actigraphy	-3.13 (.78)	<.001
Diary	-4.38 (1.32)	.001
Satisfaction/Efficiency		
Survey satisfaction	1.0	
Diary satisfaction	.78 (.18)	<.001
Survey efficiency	.78 (.17)	<.001
Actigraphy efficiency	-.22 (.08)	.01
Diary efficiency	-.47 (.15)	.001
Alertness		
Survey	1.0	
Actigraphy	-.31 (.13)	.017
Duration		
Survey	1.0	
Actigraphy	.81 (.39)	.038

Note. Model fit indices were as follows, $\chi^2(df)$ = 74.98 (42), p = .001, CFI = .94, TLI = .84, RMSEA [90% CI] = .038 [.024, .052], SRMR = .057. This model is displayed in Figure 14. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1 for all analyses; the path from the first-order factor Satisfaction/Efficiency to survey-measured satisfaction was fixed to 1 for all analyses. Coefficients for all sleep health indicators regressed on age, sex, and race, respectively, are not displayed as these variables were included as covariates. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual.

As shown in Table 22, the relationship between childhood adversity and poor sleep health persisted after additional adjustment for health (i.e., BMI, alcohol use, marijuana use; Models 2, 7, 8) and psychosocial covariates (i.e., depressive symptoms, anxiety symptoms, and PTSD symptoms; Models 4-6) in separate analyses. Results also suggested that the relationship between adversity and poor latent sleep health held after adjustment for all demographic and health covariates, plus depressive symptoms (Model 9), anxiety symptoms (Model 10), and PTSD symptoms (Model 11). When all covariates (including all psychosocial symptoms) were included in the same model (Model 12), the relationship between childhood adversity and poor latent sleep health became marginal, likely due to multi-collinearity among the psychosocial variables (rs = .72-.85, ps<.001).

Table 22. Model results for the relationship between ACE and worse latent adult sleep health after adjustment for covariates (separate models)

Adjusted for age, sex, race + [*covariate*]	N	Unstandardized Path Coefficients		Model Fit Statistics						
		B (SE)	*p*	χ^2	*df*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR
Model 1: age, sex, race	540	-.50 (.11)	<.001	74.98*	41	.94	.84	.038	[.024, .052]	.057
Model 2: + *childhood SES*	540	-.52 (.12)	<.001	75.09*	42	.94	.82	.038	[.024, .052]	.052
Model 3: + *BMI*	540	-.50 (.11)	<.001	75.56*	42	.94	.82	.038	[.024, .052]	.055
Model 4: + *depressive symptoms*	540	-.25 (.11)	<.001	73.28*	42	.95	.85	.037	[.022, .051]	.049
Model 5: + *anxiety symptoms*	537	-.29 (.12)	.014	68.28*	42	.96	.88	.034	[.018, .048]	.047
Model 6: + *PTSD symptoms*	540	-.24 (.12)	.047	73.59*	42	.95	.84	.037	[.023, .051]	.049
Model 7: + *alcohol*	540	-.54 (.11)	<.001	73.48*	42	.95	.84	.037	[.023, .051]	.052
Model 8 + *marijuana*	540	-.47 (.11)	<.001	77.36*	42	.94	.82	.039	[.025, .053]	.055
Model 9: + *childhood SES, BMI, depressive symptoms, alcohol, marijuana*	540	-.27 (.13)	.038	78.02*	42	.95	.78	.040	[.026, .053]	.041
Model 10: + *childhood SES, BMI, anxiety symptoms, alcohol, marijuana*	537	-.31 (.13)	.017	73.75*	42	.95	.81	.038	[.023, .051]	.039
Model 11: + *childhood SES, BMI, PTSD symptoms, alcohol, marijuana*	540	-.27 (.13)	.041	78.18*	42	.94	.77	.040	[.026, .054]	.041
Model 12: all listed covariates	540	-.25 (.14)	.081	75.55*	42	.95	.77	.039	[.024, .052]	.037

Note. For Models 2-8, sleep health indicators were regressed on covariates of age, sex, and race, and the additional noted covariate (i.e., childhood SES, BMI, depressive symptoms, anxiety symptoms, PTSD symptoms, alcohol use, marijuana use), respectively. Models 9-11 reflect adjustment for age, sex, race, and the set of listed covariates. Coefficients for age, sex, and race are not displayed. ACE = adverse childhood experiences (total score); BMI = body mass index; χ2 = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual.
*p<.001

4.3.3 Hypothesis 2: Survey, Daily Diary, Physiological, and Behavioral Measures of Vigilance for Threat Will Partially Explain the Relationship between Cumulative Childhood Adversity and Sleep Health

Tests of indirect effects from childhood adversity to adult sleep health are presented in Table 23. Only latent factors that demonstrated good model fit (see Table 6) and, for physiological measures, only tasks that also demonstrated significant reactivity were analyzed as putative mediators of vigilance for threat; consequently, the CAUSE latent factor was not analyzed given that participants did not demonstrate significant reactivity for SBP, DBP, or PR values (see Figures 11-13), even though the latent factor demonstrated good model fit. Ultimately, four latent mediators of vigilance for threat were tested (SVQ + daily diary threat, CAUSE ratings, dot probe reactivity, speech reactivity), in addition to observed mediators for the SVQ survey and the dot probe threat bias score.

As shown in Table 23, while fit was acceptable or good for all models, no significant indirect effects emerged for any putative vigilance for threat mediator. Table 23 also shows results regarding individual path effects (a, b, c'). Across all models, results for path a (childhood adversity → vigilance) suggest that childhood adversity was related to increased SVQ survey total score and latent factor of SVQ + daily diary variables, but adversity was unrelated to the dot probe bias score, latent CAUSE ratings, latent dot probe reactivity, or latent speech reactivity. Results for path b (mediator → latent sleep health) indicated that all vigilance mediators were unrelated to latent sleep health. Results for path c' across all models (relationship between adversity and sleep health controlling for the mediator) indicated significant relationships between childhood adversity and poor latent sleep health controlling for each vigilance mediator.

Table 23. Unstandardized indirect effects from bootstrapped analysis (5,000 resamples) of ACE → [Mediator] → worse latent adult sleep health

		Unstandardized Indirect Effects		Model Fit Statistics								Individual Path Effects
Mediator	N[a]	Estimate	[95% CI]	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	B (SE), *p*
Threat Vigilance												
Model 1: SVQ survey	540	-.02	[-.07, .02]	106.96	53	.000	.91	.78	.043	[.031, .055]	.068	a: .19 (.05), p<.001 b: -.12 (.11), p=.283 c: -.47 (.15), p=.002
Model 2: Dot probe bias	102	-.01	[-.08, .06]	90.58	53	.001	.93	.84	.036	[.023, .049]	.060	a: -.50 (.16), p=.490 b: .01 (.01), p=.459 c': -.49 (.15), p=.001
Model 3: SVQ + Diary threat[a]	540	-.09	[-.24, .06]	191.59	94	.000	.89	.78	.044	[.035, .053]	.075	a: .12 (.05), p=.022 b: -.77 (1.1), p=.504 c': -.43 (.15), p=.004
Model 4: CAUSE ratings	114	.01	[-.06, .08]	168.80	109	.000	.93	.87	.032	[.022, .041]	.068	a: -1.2 (3.7), p=.741 b: -.16 (.40), p=.695 c': -.50 (.16), p=.001
Model 5: Dot probe reactivity	114	.06	[-.21, .34]	123.44	85	.004	.93	.87	.029	[.017, .040]	.063	a: .09 (.15), p=.545 b: .70 (1.40), p=.502 c': -.60 (.22), p=.007
Model 6: Speech reactivity	114	.003	[-.09, .10]	113.49	85	.021	.95	.91	.025	[.010, .036]	.065	a: -.10 (.16), p=.531 b: -.03 (.29), p=.910 c': -.50 (.16), p=.001
Health/Psychosocial												
Model 7: BMI	540	.00	[-.02, .02]	82.80	53	.006	.95	.87	.032	[.018, .045]	.055	a: -.02 (.10), p=.161 b: -1.0 (.18), p<.001 c': -.50 (.15), p=.001
Model 8: Depressive symptoms[b]	540	-.29	[-.46, -.12]**	85.56	53	.003	.96	.89	.034	[.020, .046]	.059	a: .68 (.09), p<.001 b: -.43 (.11), p<.001 c': -.23 (.12), p=.049
Model 9: Anxiety symptoms[b]	537	-.24	[-.36, -.13]**	86.42	53	.003	.96	.89	.034	[.020, .047]	.060	a:5.24 (.74), p<.001 b: -.05 (.01), p<.001 c': -.21 (.10), p=.043

Model 10: PTSD symptoms[b]	540	-.29	[-.44, -.13]**	83.76	53	.003	.96	.90	.033	[.018, .046]	.059	a: .41 (.05), p<.001 b: -.05 (.01), p<.001 c’: -.21 (.12), p=.071

Note. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1 for all analyses; the path from the first-order factor Satisfaction/Efficiency to survey-measured satisfaction was fixed to 1 for all analyses. Coefficients for all sleep health indicators and all threat vigilance indicators (i.e., latent factors = Models 3-6) or observed variables (i.e., Models 1-2, 7-10) are regressed on age, sex, and race, respectively; covariate estimates are not displayed. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. path a = effect of ACE → mediator; path b = effect of mediator → latent sleep health; path c’ = ACE → latent sleep health, holding the mediator constant (i.e., direct effect). Path c (total effect) is not shown.

[a]N refers to number of participants for the mediator. [b]Latent variable covariance matrix (PSI) model was non-positive definite; estimates or fit statistics are presented but are not reliable.

**p*<.05, ****p*<.001

4.4 Exploratory Analyses

4.4.1 Exploratory Aim 1: Examine Whether the Relationship between Cumulative Childhood Adversity and Poor Sleep Health is Stronger in Those Who Also Report Witnessing Community Violence or Living in an Unsafe Neighborhood

Exploratory models tested whether (a) witnessing violence outside of the home or (b) unsafe neighborhood/poor neighborhood cohesion moderated the associations between childhood adversity and latent adult sleep health in separate structural equation models. As shown in Table 24 (Models 1 and 2), both models fit the data well but the interaction terms were not significant. Of relevance, in main effects only models, the main effect of childhood adversity on poor latent sleep health was still significant when controlling for witnessing violence (Model 1) and unsafe/low cohesion neighborhood (Model 2); on the other hand, the main effect of unsafe neighborhood, but not witnessing violence, on latent sleep health was significant when controlling for childhood adversity.

Table 24. Moderation results for ACE x [moderator] predicting worse latent adult sleep health

	N[a]	Unstandardized Path Coefficients		Model Fit Statistics						
		B(SE)	*p*	χ^2	*df*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR
Model 1		--	--	102.01**	64	.93	.86	.033	[.020, .045]	.054
ACE	540	-.48 (.11)	<.001							
Witnessed violence (yes/no)	540	-.15 (.15)	.314							
ACE x Witnessed violence	540	-.33 (.23)	.150							
Model 2		--	--	98.50**	64	.94	.87	.032	[.018, .043]	.054
ACE	540	-.43 (.11)	<.001							
Unsafe/low cohesion neighborhood (yes/no)[b]	540	-.45 (.16)	.005							
ACE x Neighborhood[b]	540	.09 (.06)	.871							
Model 3		--	--	99.01*	64	.94	.87	.032	[.019, .044]	.055
ACE	540	-.55 (.12)	<.001							
Childhood SES	540	.10 (.14)	.454							
ACE x Childhood SES	540	.40 (.14)	.034							
Model 4		--	--	92.64*	64	.95	.89	.029	[.014, .041]	.054
ACE	540	-.50 (.11)	<.001							
BMI	540	.02 (.40)	.969							
ACE x BMI	540	-.19 (.67)	.774							
Model 5[c]		--	--	94.85*	64	.95	.90	.030	[.016, .042]	.057
ACE	540	-.21 (.10)	.035							
Depressive symptoms	540	-.42 (.07)	<.001							
ACE x Depressive symptoms	540	-.06 (.07)	.369							
Model 6[c]		--	--	94.81*	64	.95	.90	.030	[.016, .042]	.058
ACE	540	-.20 (.09)	.023							
Anxiety symptoms	537	-.05 (.01)	<.001							
ACE x Anxiety symptoms	540	-.01 (.01)	.502							
Model 7[c]		--	--	99.74*	64	.94	.88	.032	[.019, .044]	.059
ACE	540	-.18 (.10)	.081							
PTSD symptoms	540	-.68 (.14)	<.001							
ACE x PTSD symptoms	540	-.28 (.14)	.053							

Note. All continuous variables, including those included in interaction terms, were mean-centered. Results for main effects of ACE and each moderator (e.g., witnessed violence) are presented for analyses that included only the main effects and not the interaction term; results for the interaction term also included both main effects. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1 for all analyses; the path from the first-order factor Satisfaction/Efficiency to survey-measured satisfaction was fixed to 1 for all analyses. Coefficients for all sleep health indicators were regressed on age, sex, and race; estimates are not displayed. Fit statistics are presented for models that included main effects and the interaction. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual.
[a]N refers to number of participants for the moderator. [b]Neighborhood refers to reporting unsafe neighborhood OR low neighborhood cohesion. [c]Latent variable covariance matrix (PSI) model was non-positive definite; estimates or fit statistics are presented but are not reliable.
**p*<.05, ***p*<.01

4.4.2 Exploratory Aim 2: Examine the Contribution of Childhood SES to Poor Sleep Health in the Context of Childhood Adversity

Childhood SES was treated several ways in analytic models: (a) as a covariate, (b) as an additive effect with total adversity on poor sleep health; and (c) as a potential moderator of the relationship between childhood adversity and poor sleep health. Regarding (a), the effect of childhood adversity on worse adult sleep health persisted after adjustment for age, race, sex, *and* childhood SES; see Table 22, Model 2.

Regarding (b), when adding the total score of childhood adversity to the total score of low childhood SES, model fit was still good, $\chi^2(df)$ = 73.81 (42), *p* = .002, CFI = .94, TLI = .85, RMSEA [90% CI] = .037 [.023, .051], SRMR = .057, and results suggested that the additive effect of childhood adversity + low SES was related to poorer latent sleep health [B(SE) = -.45 (.10), *β* = -.24 , *p* <.001], but standardized results were slightly weaker than the relationship between adversity and poor latent sleep health when childhood SES was included as a covariate [*β* = -.30, *p* <.001] or not included in the model at all [*β* = -.29 , *p* <.001].

Finally, regarding (c), the model testing the interactive effect of childhood adversity and low childhood SES on poor latent sleep health fit the data well and the interaction term between adversity X childhood SES was significant (*p* =.034); see Table 24, Model 3. However, this interaction was not probed, given extremely limited variability in SES, i.e., less than 5% of the sample reported low childhood SES (see Table 10). Consequently, there were not meaningful cell sizes to justify probing the effect. Of relevance, in main effects models, the main effect of childhood adversity on poor latent sleep health was significant when controlling for low childhood

SES, but the reverse was not true, i.e., the main effect of low childhood SES was not significant when controlling for childhood adversity; see Table 24.

4.4.3 Exploratory Aim 3: Examine the Contribution of Relevant Confounding Variables (i.e., BMI, Depressive Symptoms, Anxiety Symptoms, and PTSD Symptoms) to Poor Sleep Health in the Context of Childhood Adversity

Exploratory analyses were conducted testing the aforementioned variables as (a) covariates, (b) mediators, and (c) moderators of the relationship between childhood adversity and poor latent adult sleep health. Regarding (a), as previously described, the effect of childhood adversity on worse adult sleep health persisted after adjustment for age, race, sex, *and* separate adjustment for BMI, depressive symptoms, anxiety symptom, and PTSD symptoms; see Table 22 (Models 3-6), all ps<.05.

Regarding (b) mediation analyses, while fit was acceptable or good for all models, significant indirect effects emerged for psychosocial variables (Models 8-10) but not BMI (Model 7); Table 23. However, models testing mediation by depressive symptoms, anxiety symptoms, and PTSD symptoms were non-positive definite. This was likely due to each psychosocial mediator demonstrating larger correlations with indicators from the latent first-order Satisfaction/Efficiency factor than the correlations among the sleep indicators that composed the Satisfaction/Efficiency factor, which indicates model misspecification. Thus, results for psychosocial mediators are presented only in Table 23 but are not reliable. Table 23 also shows results regarding individual path effects (a, b, c'). Childhood adversity was not related to BMI (path a), but BMI was related to poor latent sleep health (path b). The relationship between childhood adversity and poor latent sleep health held after controlling for BMI (path c').

Finally, in analyses testing (c) moderation by BMI and psychosocial variables, fit was acceptable/good for all models but no interaction terms were significant (Table 24, Models 4-7). Similar to mediation results, models that included psychosocial variables were non-positive definite; results are presented in Table 24 but are not reliable. Regarding BMI (Model 4), main effects models indicated that the main effect of childhood adversity on poor latent sleep health was significant when controlling for BMI (Model 5), but BMI was not related to latent sleep health when controlling for childhood adversity.

4.5 Supplemental Analyses

4.5.1 Using Daily Diary Measures of Duration/Napping in Latent Sleep Health Factor

The structural equation model with direct effects from childhood adversity to poor latent adult sleep health (adjusting for age, race, and sex), was re-analyzed substituting actigraphy-measured sleep duration and napping with parallel diary measures. This new model fit the data well and results were consistent with Hypothesis 1 (Table 22). The interested reader can find results, including model fit statistics and unstandardized estimates and factor loadings, in Appendix M.

4.5.2 RUSATED Total Sleep Health Score for Survey/Actigraphy/Diary Data

As shown in Table 25, the average sleep health total score was greater for diary, compared to actigraphy, when the RUSATED sleep health cut-offs were applied to actigraphy and diary data and summed to create a total score.

Table 25. RUSATED cut-offs applied to actigraphy- and diary-assessed sleep dimensions

	N	*M (SD)*	Range	B (SE)	β	*p*
Actigraphy						
Sleep health total score (0-12)	112	5.46 (1.64)	0-10	-.23 (.24)	-.09	.331
Individual sleep dimensions (0-2)						
Regularity	112	1.41 (.61)	0-2	-.01 (.09)	-.01	.919
Satisfaction	112	n/a	n/a	n/a	n/a	n/a
Alertness	112	1.56 (.61)	0-2	-.24 (.09)	-.26	**.006**
Timing	112	.45 (.66)	0-2	.10 (.10)	.10	.305
Efficiency	112	.23 (.46)	0-2	-.04	-.06	.527
Duration	112	.61 (.62)	0-2	-.03 (.09)	-.03	.726
Daily Diary						
Sleep health total score (0-12)	113	7.11 (1.96)	0-12	-.42 (.28)	-.14	.137
Individual sleep dimensions (0-2)						
Regularity	113	1.42 (.61)	0-2	-.07 (.09)	-.07	.463
Satisfaction	113	1.15 (.77)	0-2	-.02 (.11)	-.02	.876
Alertness	113	1.44 (.68)	0-2	-21 (.10)	-.20	**.035**
Timing	113	.41 (.65)	0-2	.08 (.09)	.08	.420
Efficiency	113	1.64 (.63)	0-2	-.07 (.09)	-.08	.429
Duration	113	.97 (.69)	0-2	-.19 (.10)	-.18	**.062**

Note. Values for B(SE), β, and *p* reflect results from univariate regressions between log-transformed ACE total [ln(ACEtotal+1)] and actigraphy- or diary-assessed sleep health total scores and individual sleep dimensions when RUSATED cut-offs were applied to actigraphy/diary data. For all results, higher scores indicate better sleep health. Possible range for sleep health total score = 0-12. For actigraphy and diary individual sleep dimensions, data were coded such that 0-2 reflect frequency of meeting sleep health criteria: 0 = 0-1 days, 1 = 2-4 days, 2 = 5-7 days. Note that satisfaction cannot be measured by actigraphy, thus, daily diary satisfaction score was used in the actigraphy sleep health total score to obtain a possible range of 0-12. ACE = adverse childhood experiences; B(SE) = unstandardized coefficient (standard error); β = standardized coefficient; *p* = p value. n/a = satisfaction cannot be measured using actigraphy.

Figure 15 shows the frequency of meeting RUSATED cut-offs on 5-7 days for actigraphy and diary sleep dimensions. Overall, fewer than 10% and 20% of participants met cut-offs on 5-7 days for timing or duration, respectively. Approximately 50% of participants met cut-offs on 5-7 days for actigraphy- and diary-derived regularity. The percentage of participants who met cut-offs for alertness and efficiency varied notably by actigraphy vs. diary measures.

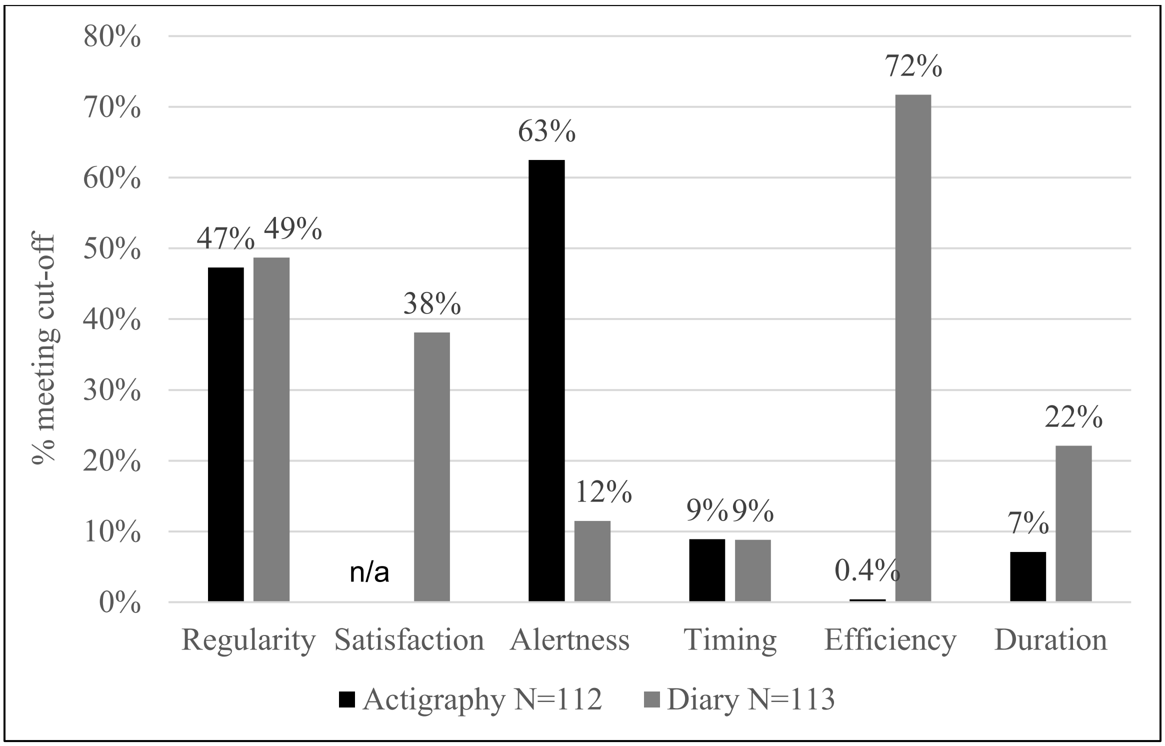

Figure 15. Frequency of participants who "usually/always" met RUSATED cut-offs for actigraphy- and diary-assessed sleep dimensions

Note. For each sleep dimension, weeklong averages for actigraphy and daily diary sleep dimensions were coded 0, 1, or 2, according to whether they met the cut-offs from the RUSATED survey (Buysse, 2014) on 0-1 days, 2-4 days, or 5-7 days, respectively, in order to approximate response categories from the RUSATED survey (0=rarely/never, 1=sometimes, 2=usually/always). For each sleep dimension, "% meeting cut-off" reflects the percentage of individuals who met the RUSATED cut-off (Buysse, 2014) on 5-7 days. This figure does not show the percentage of participants who met criteria on 0-1 or 2-4 days. Satisfaction is noted as "n/a" for actigraphy because it is possible to measure this sleep dimension using wrist actigraphy.

Table 26 compares the range of total sleep health scores for survey, actigraphy, and diary measures. Overall, results suggest that sleep health is poorer, and the range of total scores is more limited, for actigraphy-derived RUSATED total score, compared to survey or diary total scores.

Table 26. Frequency of total sleep health scores for survey, actigraphy, and diary-assessed sleep dimensions

N (%) unless noted	Survey Sleep Health Total Score (N=540)	Survey Sleep Health Total Score (N=114)	Actigraphy Sleep Health Total Score (N=112)	Diary Sleep Health Total Score (N=113)
M (SD)	7.07 (2.50)	7.20 (2.64)	5.46 (1.64)	7.11 (1.96)
0	5 (0.9)	5 (0.9)	--	--
1	1 (0.2)	1 (0.2)	--	--
2	10 (1.9)	10 (1.9)	3 (2.6)	2 (1.8)
3	26 (4.8)	26 (4.8)	10 (8.8)	2 (1.8)
4	42 (7.8)	42 (7.8)	21 (18.4)	4 (3.5)
5	62 (11.5)	62 (11.5)	22 (19.3)	16 (14.0)
6	89 (16.5)	89 (16.5)	25 (21.9)	18 (15.8)
7	65 (12.0)	65 (12.0)	20 (17.5)	23 (20.2)
8	67 (12.4)	67 (12.4)	8 (7.0)	21 (18.4)
9	75 (13.9)	75 (13.9)	2 (1.8)	17 (14.9)
10	56 (10.4)	56 (10.4)	1 (0.9)	5 (4.4)
11	22 (4.1)	22 (4.1)	--	3 (2.6)
12	20 (3.7)	20 (3.7)	--	2 (1.8)

Note. Values reflect the N (%) of individuals across the range of total scores for the RUSATED survey and when the RUSATED cut-offs were applied to the continuous weeklong actigraphy and diary data. Higher scores = better sleep health. Possible range for total scores = 0-12, which reflects the sum of six sleep dimensions (i.e., regularity, satisfaction, alertness, timing, efficiency, duration) with each dimension scored on a 0-2 scale. For survey-measured sleep health scores, 0-2 response options reflected frequency of meeting sleep health criteria: 0=rarely/never, 1=sometimes, 2=usually/always. For weeklong repeated measures of actigraphy and diary RUSATED sleep dimensions, data were coded such that 0-2 reflected frequency of meeting sleep health criteria: 0 = 0-1 days, 1 = 2-4 days, 2 = 5-7 days. Note that satisfaction cannot be measured by actigraphy and daily diary satisfaction score was used in the actigraphy sleep health total score to obtain a possible range of 0-12.

Hypotheses 1-2 and Exploratory Hypotheses 1-3 were conducted using the RUSATED sleep health total scores using four different outcomes in place of the latent sleep health factor: the survey-derived RUSATED total score in the full sample (N=540) and in the survey sub-sample (N=114), as well as the actigraphy-derived and diary-derived RUSATED total scores after applying cut-offs. Note that the interested reader can find results for the N=114 subsample RUSATED survey in noted tables/appendices, but these results are not discussed in the text.

4.5.2.1 Hypothesis 1: Cumulative childhood adversity will be associated with worse sleep health

Regarding (a), after adjustment for age, race, and sex in linear regressions, childhood adversity was significantly related to poorer survey-derived RUSATED total score in the N=540 full sample; a trend emerged for the N=114 survey total score and the diary-derived total score (Table 27, Model 1). The association in the N=540 sample persisted after further adjustment for childhood SES, BMI, alcohol use, marijuana use, depressive symptoms, anxiety symptoms, and PTSD symptoms in separate analyses and when all covariates were included in the same models (Models 2-12). Childhood adversity was not related to actigraphy-derived RUSATED total score.

Table 27. Associations between ACE and survey, actigraphy, and diary-derived RUSATED sleep health total scores

Adjusted for age, sex, race + [*covariate*]	**Survey N=540**	**Survey N=114**	**Actigraphy N=112**	**Diary N=113**
ACE → sleep health total score				
Model 1: *age, sex, race*	**-.81 (.18)****	-.66 (.38)†	-.29 (.24)	-.48 (.29)†
Model 2: + *low childhood SES*	**-.83 (.19)****	-.74 (.41)†	-.38 (.26)	**-.64 (.30)***
Model 3: + *BMI*	**-.81 (.18)****	-.67 (.38)†	-.30 (.25)	-.48 (.29)
Model 4: + *depressive symptoms*	**-.41 (.18)***	-.39 (.37)	-.15 (.24)	-.31 (.29)
Model 5: + *anxiety symptoms*	**-.46 (.18)***	-.42 (.39)	-.15 (.25)	-.29 (.30)
Model 6: + *PTSD symptoms*	**-.40 (.19)***	-.30 (.39)	-.07 (.25)	-.23 (.30)
Model 7: + *alcohol*	**-.88 (.18)****	-.70 (.39)†	-.32 (.25)	-.48 (.30)
Model 8: + *marijuana*	**-.78 (.18)****	-.63 (.38)	-.29 (.25)	-.48 (.29)
Model 9: + *childhood SES, BMI, depressive symptoms, alcohol, marijuana*	**-.44 (.19)***	-.48 (.40)	-.26 (.26)	-.46 (.31)
Model 10: + *childhood SES, BMI, anxiety symptoms, alcohol, marijuana*	**-.48 (.19)***	-.48 (.43)	-.25 (.28)	-.43 (.32)
Model 11: + *childhood SES, BMI, PTSD symptoms, alcohol, marijuana*	**-.43 (.20)***	-.35 (.42)	-.17 (.27)	-.37 (.25)
Model 12: *all covariates*	**-.39 (.19)***	-.44 (.42)	-.24 (.27)	-.40 (.32)
ACE + low SES → sleep health total score				
Model 1: age, sex, race	**-.75 (.16)****	-.52 (.36)	-.19 (.23)	-.28 (.27)

Note. Values reflect unstandardized coefficient (standard error). Age, BMI, ACE total [ln(ACEtotal+1)], and ACE + low SES total [ln((ACE + low SES)+1)] were natural log transformed prior to analysis. Low childhood SES, marijuana use, and total depressive and PTSD symptoms were square-root transformed prior to analysis. ACE = adverse childhood experiences total score; ACE + low SES = addition of total ACEs and number of low childhood SES items.
For survey, actigraphy, and diary-derived RUSATED sleep health total scores: higher=better sleep health.
†*p < .1, *p < .05, **p < .001.*

4.5.2.2 Hypothesis 2: Survey, daily diary, physiological, and behavioral measures of vigilance for threat will partially explain the relationship between cumulative childhood adversity and sleep health

Structural equation modeling was used to test indirect effects from childhood adversity to the survey-derived RUSATED total survey score in the N=540 full sample (Table 28) and the actigraphy-derived (Table 29) and diary-derived (Table 30) RUSATED total scores. Indirect effects were estimated using bootstrapping procedures with 5,000 resamples. Interested readers can find results for the N=114 subsample in Appendix N. Overall, no significant indirect effects emerged for any putative vigilance for threat mediator. Across all models, results for path a (childhood adversity → vigilance) mirror those results already described in Table 27. Results for path b (vigilance mediator → RUSATED sleep health total score) indicated that only dot probe bias score and latent CAUSE ratings were related to actigraphy- and diary-derived RUSATED total scores.

Table 28. Unstandardized indirect effects from bootstrapped analysis (5,000 resamples) of ACE → [mediator] → survey-derived RUSATED sleep health total score (N=540)

		Unstandardized Indirect Effects		Model Fit Statistics								Individual Path Effects
Mediator	N[a]	Estimate	[95% CI]	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	B (SE), *p*
Threat Vigilance												
Model 1: SVQ survey[b]	540	.01	[-.08, .04]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: .17 (.07), p=.011 b: .03 (.03), p=.305 c': -.10 (.05), p=.048
Model 2: Dot probe bias[b]	102	.00	[-.03, .03]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.13 (.12), p=.290 b: .004 (.09), p=.963 c': -.09 (.05), p=.074
Model 3: SVQ + Diary threat	113	-.02	[-.09, .04]	19.26	8	.014	.88	.54	.051	[.022, .081]	.042	a: .09 (.06), p=.132 b: -.24 (.91), p=.793 c': -.07 (.06), p=.239
Model 4: CAUSE ratings[c]	114	.001	[-.03, .03]	10.72	12	.553	1.00	1.03	.000	[.000, .040]	.031	a: .01 (.05), p=.858 b: .06 (.28), p=.823 c': -.10 (.05), p=.065
Model 5: Dot probe reactivity	114	.02	[-.14, .18]	8.10	4	.088	.84	.12	.044	[.000, .087]	.035	a: .12 (.11), p=.284 b: .16 (.68), p=.812 c': -.11 (.10), p=.234
Model 6: Speech reactivity	114	-.02	[-.10, .07]	5.34	10	.868	1.00	1.72	.000	[.000, .024]	.031	a: -.12 (.15), p=.443 b: .15 (.27), p=.580 c': -.08 (.07), p=.257
Health/Psychosocial												
Model 7: BMI[b]	540	-.002	[-.01, .01]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.02 (.01), p=.161 b: .14 (.18), p=.436 c': -.09 (.05), p=.066
Model 8: Depressive symptoms[b]	540	-.03	[-.07, .01]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 2.94 (.34), p<.001 b: -.01 (.01), p=.116 c': -.06 (.05), p=.240
Model 9: Anxiety symptoms[b]	540	-.02	[-.05, .01]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 1.36 (.19), p<.001 b: -.01 (.01), p=.251

												c’: -.08 (.05), p=.137
Model 10: PTSD symptoms[b]	540	-.02	[-.06, .01]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 5.26 (.74), p<.001 b:-.01 (.003), p=.116 c’: -.07 (.05), p=.179

Note. Coefficients for sleep health total score and all threat vigilance indicators (i.e., latent factors = Models 3-6) or observed variables (i.e., Models 1-2, 7-10) are regressed on age, sex, and race, respectively; covariate estimates are not displayed. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. path a = effect of ACE → mediator; path b = effect of mediator → latent sleep health; path c’ = ACE → latent sleep health, holding the mediator constant (i.e., direct effect). Path c (total effect) is not shown.

[a]N refers to number of participants for the mediator. [b]Model is fully saturated. [c]Latent variable covariance matrix (PSI) model was non-positive definite; estimates or fit statistics are presented but are not reliable.

Table 29. Unstandardized indirect effects from bootstrapped analysis (5,000 resamples) of ACE → [mediator] → actigraphy-derived RUSATED sleep health total score (N=112)

		Unstandardized Indirect Effects		Model Fit Statistics								Individual Path Effects
Mediator	N[a]	Estimate	[95% CI]	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	B (SE), *p*
Threat Vigilance												
Model 1: SVQ survey[b]	114	.01	[-.06, .07]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: .18 (.11), p=.096 b: .03 (.16), p=.858 c': -.19 (.18),p=.288
Model 2: Dot probe bias[b]	114	.14	[-.41, .13]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a:-.13 (.13), p=.299 b:1.09 (.08), p<.001 c': -.05 (.12), p=.697
Model 3: SVQ + Diary threat[a]	113	-.01	[-.11, .09]	5.59	8	.693	1.00	1.14	.000	[.000, .085]	.021	a: .06 (.05), p=.240 b:-.16 (1.07), p=.884 c': -.18 (.18), p=.321
Model 4: CAUSE ratings	114	-.06	[-.27, .16]	35.01	12	.001	.87	.56	.130	[.081, .181]	.049	a: .04 (.07), p=.598 b:-1.66 (.52), p=.001 c': -.13 (.18), p=.464
Model 5: Dot probe reactivity	114	-.05	[-.14, .22]	4.12	4	.390	.99	.95	.016	[.000, .143]	.026	a: .10 (.09), p=.281 b: -.46 (.90), p=.607 c': -.14 (.21), p=.505
Model 6: Speech reactivity[c]	114	--	--	--	--	--	--	--	--	--	--	--
Health/Psychosocial												
Model 7: BMI[b]	114	.000	[-.03, .04]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.01 (.02), p=.714 b: -.04 (.87), p=.964 c': -.19 (.18), p=.287
Model 8: Depressive symptoms[b]	114	.02	[-.08, .16]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a:1.90 (.60), p=.002 b: .02 (.03), p=.502 c': -.13 (.10), p=.220
Model 9: Anxiety symptoms[b]	114	.05	[-.03, .21]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a:1.27 (.37), p=.001 b: .07 (.04), p=.088 c': -.16 (.10), p=.132

Model 10: PTSD symptoms[b]	114	.04	[-.07, .15]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 4.5 (1.62), p=.005 b: .01 (.01), p=.437 c': -.23 (.19), p=.217

Note. Coefficients for sleep health total score and all threat vigilance indicators (i.e., latent factors = Models 3-6) or observed variables (i.e., Models 1-2, 7-10) are regressed on age, sex, and race, respectively; covariate estimates are not displayed. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. path a = effect of ACE → mediator; path b = effect of mediator → latent sleep health; path c' = ACE → latent sleep health, holding the mediator constant (i.e., direct effect). Path c (total effect) is not shown.

[a]N refers to number of participants for the mediator. [b]Model is fully saturated. [c]Latent variable covariance matrix (PSI) model was non-positive definite; estimates or fit statistics are presented but are not reliable. [d]Model did not converge.

Table 30. Unstandardized indirect effects from bootstrapped analysis (5,000 resamples) of ACE → [mediator] → diary-derived RUSATED sleep health total score (N=113)

		Unstandardized Indirect Effects		Model Fit Statistics								Individual Path Effects
Mediator	N[a]	Estimate	[95% CI]	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	B (SE), *p*
Threat Vigilance												
Model 1: SVQ survey[b]	540	.01	[-.05, .07]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: .18 (.11), p=.096 b: .05 (.14), p=.694 c': .12 (.14),p=.410
Model 2: Dot probe bias[b]	102	.06	[-.06, .17]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.13 (.13), p=.299 b: -.44 (.11), p<.001 c': .07 (.13),p=.572
Model 3: SVQ + Diary threat	113	-.06	[-.15, .03]	6.05	8	.642	1.00	1.09	.000	[.000, .091]	.024	a: .06 (.05), p=.258 b:-1.07 (1.0), p=.295 c': .19 (.14),p=.180
Model 4: CAUSE ratings	114	.06	[-.13, .25]	20.28	12	.062	.795	.85	.078	[.000, .135]	.036	a: .03 (.06), p=.556 b: 1.80 (.83), p=.029 c': .07 (.12),p=.570
Model 5: Dot probe reactivity	114	.05	[-.29, .38]	5.39	4	.249	.95	.70	.055	[.000, .160]	.027	a: .12 (.12), p=.312 b: .38 (.91), p=.674 c': .08 (.22),p=.703
Model 6: Speech reactivity[c]	114	--	--	--	--	--	--	--	--	--	--	--
Health/Psychosocial												
Model 7: BMI[b]	540	-.01	[-.05, .04]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.01 (.02), p=.714 b: 1.00 (.70), p=.150 c': .14 (.13), p=.316
Model 8: Depressive symptoms[b]	540	-.08	[-.20, .04]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a:1.90 (.60), p=.002 b: -.04 (.03), p=.141 c': .21 (.15), p=.173
Model 9: Anxiety symptoms[b]	540	-.07	[-.18, .05]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a:1.27 (.37), p=.001 b: -.05 (.04), p=.222 c': .19 (.15), p=.198

Model 10: PTSD symptoms[b]	540	-.11	[-.22, .00]*	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: .05 (.02), p=.005 b:-2.48 (.93), p=.008 c': .24 (.14), p=.085

Note. Coefficients for sleep health total score and all threat vigilance indicators (i.e., latent factors = Models 3-6) or observed variables (i.e., Models 1-2, 7-10) are regressed on age, sex, and race, respectively; covariate estimates are not displayed. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. path a = effect of ACE → mediator; path b = effect of mediator → latent sleep health; path c' = ACE → latent sleep health, holding the mediator constant (i.e., direct effect). Path c (total effect) is not shown.

[a]N refers to number of participants for the mediator. [b]Model is fully saturated. [c]Model did not converge.

*$p < .05$

4.5.2.3 Exploratory aim 1: Examine whether the relationship between cumulative childhood adversity and poor sleep health is stronger in those who also report witnessing community violence or living in an unsafe neighborhood

Exploratory models tested whether (a) witnessing violence outside of the home or (b) unsafe neighborhood/poor neighborhood cohesion moderated the associations between childhood adversity and latent adult sleep health in separate structural equation models. As shown in Table 31 (Models 1 and 2), the interaction term for both models was not significant. Of relevance, in main effects only models, the main effect of childhood adversity on poor latent sleep health was still significant when controlling for witnessing violence (Model 1) or unsafe neighborhood (Model 2), while the main effect of unsafe neighborhood, but not witnessing violence, was significant when controlling for adversity.

Table 31. Moderation results for ACE x [moderator] predicting worse survey, actigraphy, and diary-derived RUSATED sleep health total scores

	Survey N=540	Survey N=114	Actigraphy N=112	Diary N=113
Step 1				
Constant	7.08 (.17)**	7.43 (.37)**	5.64 (.23)*	6.88 (.28)**
Age	2.48 (2.01)	3.92 (3.37)	3.86 (2.11) †	4.14 (2.53)
Sex (1=Male)	.30 (.22)	.45 (.50)	-.18 (.32)	.37 (.38)
Race (1=non-white)	-.54 (.24)*	-1.08 (.50)*	-.32 (.31)	.18 (.38)
Steps 2 and 3 – separate models				
Model 1				
ACE	-.80 (.18)**	-.63 (.38)	-.26 (.25)	-.44 (.29)
Witnessed violence	-.13 (.28)	-.58 (.63)	-.41 (.40)	-.79 (.47) †
ACE x Witnessed violence	-.78 (.07)†	-1.22 (.88)	-.26 (.58)	-.84 (.66)
Model 2				
ACE	-.69 (.18)**	-.53 (.40)	-.17 (.25)	-.35 (.30)
Unsafe/low cohesion neighborbood[a]	-.60 (.25)*	-.62 (.54)	-.54 (.34)	-.65 (.41)
ACE x Neighborhood[a]	-.32 (.38)	.75 (.82)	.26 (.52)	.19 (.61)
Model 3				
ACE	-.83 (.19)**	-.74 (.41)†	-.39 (.26)	-.64 (.30)*
Low childhood SES	.07 (.23)	-.31 (.47)	.30 (.31)	.56 (35)
ACE x Low childhood SES	.69 (.32)**	.60 (.66)	.28 (.44)	.06 (.49)
Model 4				
ACE	-.80 (.18)**	-.66 (.38)†	-.29 (.25)	-.48 (.29)
BMI	.38 (.73)	-.92 (1.94)	-.47 (1.26)	.88 (1.46)
ACE x BMI	-.24 (1.19)	1.18 (2.99)	-.20 (1.97)	.22 (2.25)
Model 5				
ACE	-.41 (.18)*	-.39 (.37)	-.15 (.24)	-.31 (.29)
Depressive symptoms	-.59 (.08)**	-.68 (.19)*	-.37 (.12)*	-.44 (.15)*
ACE x Depressive symptoms	-.05 (.12)	.04 (.28)	-.35 (.18)†	-.21 (.22)
Model 6				
ACE	-.46 (.18)*	-.42 (.39)	-.15 (.25)	-.29 (.30)
Anxiety symptoms	-.07 (.01)**	-.05 (.03)*	-.03 (.02) †	-.04 (.02)*
ACE x Anxiety symptoms	-.01 (.02)	.001 (.004)	-.03 (.02)	-.02 (.03)
Model 7				
ACE	-.40 (.19)*	-.30 (.39)	-.07 (.25)	-.23 (.30)
PTSD symptoms	-1.00 (.18)**	-1.33 (.45)*	-.82 (.29)*	-.94 (.34)*
ACE x PTSD symptoms	-.40 (.25)	-.15 (.64)	-.52 (.40)	-.39 (.48)

Note. Values reflect unstandardized coefficient (standard error). Age, BMI, and ACE total [ln(ACEtotal+1)] were natural log transformed prior to analysis. Low childhood SES, marijuana use, and depressive and PTSD symptoms were square-root transformed prior to analysis. All continuous variables (i.e., age, ACE, SES, BMI, depressive symptoms, anxiety symptoms, PTSD symptoms) were mean-centered by N=540 or N=114, respectively. All analyses were conducted using separate hierarchical linear regression models adjusting for age, sex, and race (Step 1), followed by lnACE and the moderator of interest (Step 2), and the interaction term (Step 3). Higher sleep health total scores = better sleep health. ACE = adverse childhood experiences.

[a]Neighborhood refers to reporting unsafe neighborhood OR low neighborhood cohesion.

†*p* < .1, **p* < .05, ***p* < .001.

4.5.2.4 Exploratory aim 2: Examine the contribution of childhood SES to poor sleep health in the context of childhood adversity

Childhood SES was treated several ways in analytic models: (a) as a covariate, (b) as an additive effect with total adversity on poor sleep health; and (c) as a potential moderator of the relationship between childhood adversity and sleep health. Regarding (a), childhood adversity was related to worse survey-derived RUSATED total score in the N=540 sample and to worse diary-derived RUSATED total score, after adjustment for age, race, sex, *and* childhood SES; Table 27 (Model 2).

Regarding (b), when adding the total score of childhood adversity to the total score of low childhood SES, results suggested that the additive effect of childhood adversity + low SES was related to poorer survey-derived RUSATED total score in the N=540 sample [B(SE) = -.75 (.16), p<.001; data not shown]. Finally, regarding (c), the interaction term of adversity X SES was significant for the survey-derived RUSATED score in the N=540 sample (Table 31, Model 3). However, in line with the latent sleep health analyses, this interaction was not probed due to limited variability in SES. Of note, in main effects only models, the main effect of childhood adversity on poor sleep health was significant when controlling for low childhood SES, but the main effect of childhood SES was not significant after controlling for childhood adversity.

4.5.2.5 Exploratory aim 3: Examine the contribution of relevant confounding variables (i.e., BMI, depressive symptoms, anxiety symptoms, and PTSD symptoms) to poor sleep health in the context of childhood adversity

Exploratory analyses were conducted testing the aforementioned variables as (a) covariates, (b) mediators, and (c) moderators of the relationship between childhood adversity and poor latent adult sleep health. Regarding (a), childhood adversity was associated with worse survey-derived RUSATED total score in the N=540 sample after adjustment for age, race, sex, *and* separate adjustment for BMI, depressive symptoms, anxiety symptom, and PTSD symptoms; see Table 27 (Models 3-6), all ps<.05.

Regarding (b) mediation analyses, BMI, depressive symptoms, or anxiety symptoms did not emerge as significant mediators of the relationship between childhood adversity and survey-derived RUSATED total score in the N=540 sample (Table 28, Models 7-9), actigraphy-derived RUSATED total score (Table 29, Models 7-9), or diary-derived RUSATED total score (Table 30, Models 7-9). PTSD symptoms did emerge as a significant mediator of the relationship between childhood adversity and diary-derived RUSATED total score (Table 30, Model 10). Childhood adversity was related to more PTSD symptoms (path a) and PTSD symptoms were related to poorer diary-derived sleep health total score (path b), adjusting for age, sex, and race.

Finally, in analyses testing (c) moderation by BMI and psychosocial variables, results suggested that no variables emerged as significant moderators of the association between childhood adversity and survey-derived RUSATED total score in the N=540 or N=114 samples or actigraphy- or diary-derived RUSATED total scores (Table 31, Models 4-7). However, given that the interaction term for adversity X depressive symptoms just missed conventional levels of significance for the actigraphy-derived RUSATED total score (p=.051; Table 31, Model 6), simple slopes were analyzed at values representing the top tertile, median, and bottom tertile of depressive symptoms, via the method of Aiken and West (1991). Results for simple slope analyses were not significant (ps > .228); data not shown.

4.6 Results Summary

Table 32 provides a summary of results for all primary and exploratory analyses, presented by type of sleep health outcome.

Table 32. Summary of all study findings presented by sleep health outcome

Young adults reporting more childhood adversity demonstrated:	Latent higher-order sleep health factor (N=540)	Survey sleep health total score (N=540)	Survey sleep health total score (N=114)	Actigraphy sleep health total score (N=112)	Diary sleep health total score (N=113)
1. Worse sleep health *(adjusting for age, sex, race)*	✓	✓	✓ ***trend***	x	✓ ***trend***
2. Worse sleep health *(adjusting for age, sex, race, low childhood SES)*	✓	✓	✓ ***trend***	x	✓
3. Additive effect of ACE + low childhood SES	✓	✓	x	x	x
4. Mediation by:					
SVQ total score	x	x	x	x	x
Dot probe threat bias score	x	x	x	x	x
SVQ + Daily diary threat	x	x	x	x	x
CAUSE ratings	x	NPD model	x	x	x
Dot probe reactivity	x	x	x	x	x
Speech reactivity	x	x	x	NPD model	NPD model
BMI	x	x	x	x	x
Depressive symptoms	NPD model	x	x	x	x
Anxiety symptoms	NPD model	x	x	x	x
PTSD symptoms	NPD model	x	x	x	✓
5. Moderation by:					
Witnessing violence	x	✓ ***trend***	x	x	x
Unsafe neighborhood	x	x	x	x	x
BMI	x	x	x	x	x
Low childhood SES	x	✓	x	x	x
Depressive symptoms	NPD model	x	x	✓ ***trend***	x
Anxiety symptoms	NPD model	x	x	x	x
PTSD symptoms	NPD model	x	x	x	x

Note. Reactivity = residualized values of SBP, DBP, and PR (i.e., task levels of SBP, DBP, and PR regressed on baseline levels of SBP, DBP, and PR, respectively). ACE = adverse childhood experiences; BMI = body mass index; DBP = diastolic blood pressure; NPD = non-positive definite model (i.e., results were not reliable); SBP = systolic blood pressure; PR = pulse rate; SVQ = Social Vigilance Questionnaire; x = non-significant results; ✓ = significant results; ✓ ***trend*** = p < .10.

5.0 DISCUSSION

This study examined the relationship between childhood adversity and poor adult sleep health, as well as mediators and moderators of this relationship, in a sample of 540 healthy undergraduates. To our knowledge, this study is the first to use the RUSATED sleep health survey in combination with weeklong actigraphy- and daily diary-measured sleep outcomes. After adjustment for sociodemographic, health, and psychosocial variables, childhood adversity was associated with poorer latent sleep health and poorer survey-derived RUSATED sleep health total score. Hypotheses regarding mediation and moderation were largely unsupported, with two exceptions: PTSD partially mediated the relationship between childhood adversity and diary-derived sleep health total score, and low childhood SES moderated the relationship between adversity and survey-derived sleep health total score, but this interaction was not probed due to less than 5% of participants reporting low childhood SES.

5.1 Prevalence of Adverse Childhood Experiences

Results from this study indicated that 52% of participants in the full sample experienced one or more forms of childhood adversity before age 18, with a mean of 1.2 exposures. In comparison, the most recent 2011-2014 CDC BRFSS study found that 61.6% of a nationally representative sample of 9,597 adults aged 18-24 reported at least one form of adversity and a mean of 1.87 exposures (Merrick, Ford, Ports, & Guinn, 2018). Rates of exposure to one, two, or three forms of adversity were quite similar between these studies, with the discrepancy widening at 4+ ACEs. For both studies, exposure to parental/caregiver mental illness or substance abuse were two of the most frequent exposures (Merrick et al., 2018), although rates of each type of ACE were lower in the present study, which likely reflects restriction of range and sampling bias in this smaller college sample. Unfortunately, given the range of questionnaires that are used to measure childhood adversity (i.e., ACE questionnaire; Childhood Trauma Questionnaire [CTQ], Bernstein et al. (1994); ad-hoc study-specific measures; etc.), it can be difficult to compare prevalence across samples. However, the prevalence of ACEs found in this study are broadly similar to other college samples that used the ACE Questionnaire or selected items from the questionnaire (e.g., Karatekin, 2018; Karatekin & Ahluwalia, 2016; Windle et al., 2018).

5.2 Increased Childhood Adversity Is Related to Worse Adult Sleep Health

Childhood adversity was associated with poorer adult sleep health, both when sleep health was examined as a second-order latent factor using information from survey, actigraphy, and diary sources, as well as with the survey-derived RUSATED sleep health total score in the N=540 full sample. Childhood adversity was also related to diary-derived sleep health total score in the N=113 subsample, albeit at trend-level, but not to actigraphy-derived sleep health. Significant results persisted after adjustment for age, sex, race, childhood SES, BMI, alcohol use, marijuana use, as well as depressive, anxiety, and PTSD symptoms. These results are similar to those reported by Brindle et al. (2018), the only other study to investigate the relationship between childhood adversity and sleep health, albeit in mid-life adults with a history of depression. However, they found associations between childhood adversity and a total sleep health score using both diary-and actigraphy-assessed cut-offs, while the present study did not find associations when RUSATED cut-offs were applied to actigraphy data.

Univariate regressions demonstrated associations between childhood adversity and worse RUSATED survey satisfaction, efficiency, and duration, as well as increased napping using weeklong averages for both actigraphy and diary measures *and* when RUSATED cut-offs were applied to actigraphy and diary data; results held after adjustment for age, sex, and race (data not shown). These results are consistent with the majority of the extant literature, which focuses on single sleep dimensions. Prior evidence indicates relationships between childhood adversity (including single items of maltreatment and cumulative adversity scores) and worse sleep quality (Counts, Grubin, & John-Henderson, 2018; Koskenvuo et al., 2010; Ramsawh et al., 2011; Rojo-Wissar et al., 2019), insufficient sleep duration (Chapman et al., 2013; Sullivan, Rochani, Huang, Donley, & Zhang, 2019), and greater self-reported daytime sleepiness (Agargun et al., 2003; Chapman et al., 2011; Cho et al., 2012; Greenfield et al., 2011), in samples without diagnosed sleep disorders. Some studies find no evidence of a direct relationship with sleep quality (Abajobir, Kisely, Williams, Strathearn, & Najman, 2017; John-Henderson, Williams, Brindle, & Ginty, 2018), which is consistent with our null results for daily diary-assessed quality (i.e., using a continuous weeklong average and when the RUSATED cut-off was applied to daily diary data). Given that much of the available literature on childhood adversity and sleep has been conducted in clinical samples with diagnosed sleep or psychiatric disorders, the present results are a step toward understanding how childhood adversity is related to sleep in healthy adults.

Results are generally supported by data from prospective longitudinal studies that included follow-up periods between 3-10 years and found associations between various measures of childhood adversity and sleep quality (Abajobir et al., 2017), insomnia (Gregory et al., 2006), and sleep disturbances (e.g., trouble falling/staying asleep, short or poor quality sleep; Noll et al., 2006). Two studies used substantiated measures of abuse: Noll et al. (2006) found associations with childhood sexual abuse (but did not test other types of maltreatment), while Abajobir et al. (2017) found that physical abuse was related to worse sleep quality in males only; they reported null associations for other types of maltreatment, age at substantiation, and frequency of substantiations. Finally, one recent study examined cross-sectional relationships between total ACEs and short sleep duration and found that the relationship attenuated over time but persisted for each tested decade of age, from the 20s through the 60s (Sullivan et al., 2019). Although they cannot establish a longitudinal association between adversity and poor sleep, results withstood adjustment for numerous sociodemographic, health, and psychological covariates.

Overall, the extant literature on childhood adversity and sleep is based on self-report measures of individual sleep dimensions. In contrast, the present study used a sleep health survey that assessed both nighttime and daytime dimensions of sleep, as well as weeklong actigraphy and daily diary measures. To my knowledge, no other studies in the childhood adversity literature have compared outcomes across retrospective survey, prospective daily diary, and actigraphy measures of sleep in a healthy, non-clinical sample. Our findings suggest that childhood adversity is more related to self-report measures of sleep compared to actigraphy. This reflects work by Reuben et al. (2016), who reported that retrospectively-assessed adversity may lead to inflated results with self-reported health outcomes, and that retrospective measures may be less related to objectively-measured outcomes than prospective measures of adversity.

5.2.1 Theoretical Considerations

Taking a step back, the present results are relevant to consider in the context of the "3P model" of insomnia (Spielman, Caruso, & Glovinsky, 1987), which describes *predisposing*, *precipitating*, and *perpetuating* risk factors. Although childhood adversity was related to poor sleep in the present study, one must acknowledge the possibility that significant associations were due to sleep problems that preceded exposure to adversity. Results from this study do not speak to predisposing risk factors for poor sleep (i.e., biological or psychosocial characteristics that increase vulnerability to sleep difficulties; see Perlis, Shaw, Cano, & Espie, 2010), and while they *can* speak to perpetuating factors (i.e., behaviors that the individual does to compensate for or cope with poor sleep or sleepiness; Perlis et al., 2010), this was not a study aim. However, the present results add value to the literature by identifying *precipitating factors*, or "acute occurrences that trigger sleep disturbances" (Perlis et al., 2010). Although the present study cannot shed light on the timing of the onset of sleep disturbances relative to the first experience of childhood adversity, and it is likely that poor sleep did not just occur in adulthood, our results suggest that exposure to childhood adversity may in fact trigger poorer sleep health that persists into adulthood. This is supported by results from prospective longitudinal studies (e.g., Gregory et al., 2006; Noll et al., 2006) that are able to establish temporal precedence of adversity with poor sleep outcomes, although they, too, cannot fully dispute the possibility that poor sleep was present prior to the adverse exposures.

5.3 Examining the Sleep Health Construct and RUSATED Survey

Beyond the context of childhood adversity, sleep health is a relatively a novel construct that takes into account multiple dimensions of nighttime and daytime sleep across the 24-hour day (i.e., regularity, satisfaction, alertness, timing, efficiency, duration), highlighting the fact that these dimensions are conceptually related and do not occur in isolation (Buysse, 2014). Recently, the National Sleep Foundation emphasized the need to study sleep health in the general population and to track trends over time; they also published their own 28-item measure of sleep health (Knutson, Phelan, et al., 2017). To date, there are few studies that have investigated sleep health and those that exist have used the construct in different ways. The majority of studies either use the RUSATED survey (Becker, Martins, de Neves Jesus, Chiodelli, & Rieber, 2018; Dalmases et al., 2018) or investigate the sleep health construct using existing datasets that have parallel survey, actigraphy, or daily diary sleep health dimensions and use published cut-offs to determine if individuals, typically mid-life or older adults, meet "good" or "poor" sleep for each dimension (Brindle et al., 2018; Brindle, Yu, Buysse, & Hall, in press; L. Dong, Martinez, Buysse, & Harvey, 2019; Furihata et al., 2017). Thus, the present study is the first to have collected sleep health data from the RUSATED survey *and* weeklong actigraphy and daily diary, affording the unique ability to compare across these three types of measures in the same sample.

In order to take advantage of both the 540 individuals who provided RUSATED survey data and the subsample of 114 individuals who completed the weeklong actigraphy/daily diary protocol, the present study created a second-order latent factor of sleep health with data across these three measures. However, to obtain good model fit, several decisions based on theory and statistical necessity were made: removing the first-order timing factor, combining satisfaction and efficiency into one first-order factor, and removing diary measures of duration and napping but retaining actigraphy versions of these measures. To my knowledge, two other groups have created a latent factor using sleep health indicators. Becker and colleagues (2018) attempted to create a latent factor using the 6-item RUSATED scale in a sample of 540 adults aged 18-90 years; in order to obtain good model fit they removed the efficiency item, which demonstrated a low factor loading. Cribbet and colleagues (2016) used daily diary data averaged across 7+ days of measurement and found that all six sleep health dimensions loaded onto a single factor in a middle-aged sample (N=1,639). In the present study, sleep dimensions measured by weeklong daily diary (or actigraphy) in the N=114 subsample did not fit the observed data (*cf.* Cribbet et al., 2016), while a latent factor composed of RUSATED survey indicators, including efficiency, demonstrated acceptable model fit in the N=540 sample (*cf.* Becker et al., 2018). Ultimately, while the present study used a second-order latent sleep health measure, no two studies that use the RUSATED survey or that invoke the sleep health construct have been similar.

5.3.1 Differences In Survey, Actigraphy, and Diary Sleep Using RUSATED Cut-offs

Results from supplemental analyses demonstrated striking differences in the proportion of individuals who "usually/always" met RUSATED cut-offs for each sleep dimension (henceforth called "good" sleep) across survey, actigraphy, and diary measures. However, in order to apply the RUSATED criteria to the weeklong actigraphy/diary data, it was necessary to translate the survey response categories of "rarely/never", "sometimes", and "usually/always" to a specific number of days; this study chose to use 0-1 days, 2-4 days, and 5-7 days, respectively, but those choices were not based in empirical literature. Thus, different results could be obtained if different numbers of days were used for each category.

Several of the RUSATED sleep dimensions deserve closer examination. First, the percentage of individuals who met "good" criteria across all three measures was most consistent for sleep regularity. At face value, the question *"Do you wake up at about the same time (within one hour) every day?"* is straightforward and requires little to no calculation or interpretation, as opposed to the questions for duration and efficiency. Second, rates of "good" alertness varied widely; actigraphy-measured alertness was based on the most stringent criteria, as actigraph naps were only scored if at least one nap was reported that day in the diary. Thus, actigraphy napping may have been underestimated, and in turn, produced inflated estimates of "good" alertness. Third, rates of "good" timing were likely overestimated by survey; rates were almost identical for actigraphy and diary measures, which is likely due to the investigator consistently applying the same cut-off to the data (i.e., yes/no sleep midpoint fell any time between 2:00-4:00 am). However, by survey, it is possible that individuals made different interpretations of the item *"Is the middle of your nighttime sleep between 2:00 a.m. and 4:00 a.m.?"* For example, one could interpret that question as asking whether one is asleep at any time between 2:00-4:00am, while others may have calculated their exact sleep midpoint, leading to different responses. This item appears the least face valid compared to the other sleep dimensions, and it is not surprising that the first-order timing factor had to be removed from the second-order latent sleep health factor to obtain good model fit. Efficiency also demonstrated huge discrepancies across measures. Less than one percent of individuals met "good" criteria via actigraphy, while over 70% of individuals met "good" criteria by daily diary, and the survey measure appeared to reflect an average value between the two (38%). Finally, individuals tended to overestimate their sleep duration on the survey, with over 40% of participants meeting "good" criteria (i.e., 7-9 hours) compared to 22% and 7% via diary and actigraphy, respectively.

It is not surprising that the same cut-offs applied to retrospective survey, prospective daily diary, and actigraphy measures produced notable differences, as this has been found in the literature. A recent study in adults found a tendency to over-report sleep duration via prospective daily diary, as compared to actigraphy, and a tendency to over-report via retrospective questionnaire, compared to both daily diary and actigraphy (Matthews, Patel, et al., 2018). Brindle et al. (in press) attempted to empirically derive cut-off values for the six sleep health dimensions using actigraphy and daily diaries in the MIDUS sample and found that their cut-off values, specifically for sleep duration, were shorter than previous studies that used self-report questionnaires. They opined that "optimal values to distinguish 'good' from 'poor' across each sleep health dimension remain to be determined" and that "different cut-off values will arise as a function of methodology" (Brindle et al., in press). Based on findings from the present study alone, determining different cut-offs by method is a valuable research agenda.

5.3.2 Importance of Studying Sleep Health

Emerging data in adolescents and adults suggests poorer sleep health is related to more self-reported health issues and worse self-rated health (Dalmases et al., 2018), cardiometabolic outcomes (Brindle et al., in press), cross-sectional and longitudinal 6-year risk for depressive symptoms (Furihata et al., 2017), and increased odds for obesity and current mood or anxiety disorders (L. Dong et al., 2019). Dalmases et al. (2018) found that a sleep health score performed better than a single retrospective item of sleep duration in models predicting self-rated health status (via comparison of receiver operating characteristic curves). As the present study and others have demonstrated, there is something important about the construct of "sleep health" that goes beyond measuring single dimensions of sleep. Ultimately, both the RUSATED survey and the construct of sleep health warrant further study and validation.

5.4 Vigilance for Threat Did Not Emerge As a Mediator

Against expectation, vigilance for threat did not emerge as a significant mediator of the relationship between childhood adversity and poor sleep health. Given that this specific model had not been tested in the literature, it is not possible to compare results to previous studies. Childhood adversity was not related to the majority of measures of vigilance for threat, and vigilance variables were unrelated to most sleep outcomes. One explanation for the lack of hypothesized associations with vigilance for threat is that the vast majority (96.5%) of students reported living on campus vs. at home during the study. For some students, living away from home actually may have made some students feel *more* secure and *less* vigilant, depending on the nature of their exposure to adversity in the family/home environment. Several broad explanations for the lack of findings are relevant, including statistical issues, task-specific issues for each laboratory measure of threat, and issues of generalizability.

The present study hypothesized that all measured vigilance for threat variables (i.e., self-report survey, daily diary, behavioral, physiological) would form a cohesive latent factor, which was not supported. While this was theoretically defensible, fit was poor for the majority of models and observed correlations among the variables were generally nonexistent and weak at best. Most surprisingly, the SVQ survey was unrelated to all vigilance variables, with the exception of daily diary measures of threat; however, diary items were based off of the SVQ. Consequently, it was also not possible to create within-method (e.g., behavioral, physiological) latent mediators that incorporated the SVQ, the only vigilance variable that was measured in the full sample. Thus, most observed and latent mediators involved the N=114 subsample, and we were underpowered to find indirect effects, based on the 300-400 recommended in the literature (Fritz & MacKinnon, 2007). From a theoretical standpoint, the four types of vigilance measures are quite different, which may explain the lack of correlations among them: the SVQ survey is best conceptualized as a *trait* measure of vigilance as compared to the *state*-like daily diary items (i.e., "an attribute of a person" vs. "an attribute of a person-in-a-situation", respectively; Steyer, Mayer, Geiser, & Cole, 2015), and these measures are further distinct from measures of behavior or physiology. Accordingly, the threat/vigilance literature may struggle with similar issues to the impulsivity/disinhibition literature, who have also found low correlations among self-report, behavioral, and physiological measures that theoretically are measuring the "same thing" (e.g., Creswell, Wright, Flory, Skrzynski, & Manuck, 2018; Sharma, Markon, & Clark, 2014).

Beyond the lack of correlations, the SVQ survey did not perform as expected. Overall, participants reported low levels of vigilance, with total scores reflecting levels between "almost never" and "rarely", although SVQ was positively correlated with symptoms of depression, anxiety, and PTSD (data not shown). This novel survey is currently being tested as a predictor of longitudinal risk for atherosclerosis in a large community-based sample of adults (Ruiz et al., 2017), but has not been utilized in other studies on childhood adversity or sleep. Given a paucity of available measures on social vigilance, the SVQ was the best-available option at the inception of this study. It may be the case that these items do not tap into trait-level vigilance as experienced by young adults with a trauma history, or perhaps vigilance behaviors are best measured at the state-level, i.e., within-person changes in response to naturally occurring social interactions (which would allow for variability within individuals and across time, as opposed to the present study, which simply averaged daily diary ratings across the weeklong study period).

Regarding task-specific issues, this study did not find a relationship between childhood adversity and the dot probe bias score. Importantly, task accuracy was high (>96%), suggesting that participants were engaged, however, some may not have found the stimuli threatening or meaningful given that the stimuli reflected only young white males and females. The present null results are inconsistent with prior studies that have found either bias toward or away from threat cues in samples with and without a history of adversity; we found neither. It is important to note that the majority of past studies involve children and/or samples with documented psychiatric disorders; thus, sampling differences may help explain why the present study found no relationship with childhood adversity. Further, it may be the case that the dichotomy of bias *only* toward vs. away from threat is too narrow a view, as one study in a sample of young adult females with high trait anxiety found multiple "expressions" of attention bias that were related to the type of threatening stimuli presented, including angry faces, attacking animals, and violent scenes (Zvielli et al., 2014). Thus, future work in trauma-exposed adults may consider using a similar task that includes multiple types of threatening stimuli and provides the opportunity to compare responses across types of stimuli and not simply categorize as bias toward vs. away.

This study found that individuals who reported childhood adversity did not interpret the ambiguous video scenarios as more threatening. While no studies have tested the CAUSE videos in relation to childhood adversity, previous evidence suggests that adolescents (Chen et al., 2004; Chen & Matthews, 2001) and adults (unpublished data reported in Miller et al., 2011) from low- vs. high-SES backgrounds tended to rate the ambiguous scenarios as more threatening, even after adjusting for current SES in adults. Indeed, the CAUSE results may be specific to SES adversity and not to other forms of childhood adversity, although this cannot be tested in the present study given the lack of variability in childhood SES. Further, while the present study utilized post-video rating questionnaires that were provided by the CAUSE task creators, several early studies using the CAUSE protocol involved asking participants open-ended questions about their interpretations of the vignettes, which were later coded by trained research assistants, which may have allowed for a more nuanced approach to measuring threat interpretations. Finally, while the present study found no physiological reactivity during the task, prior CAUSE studies found that greater threat interpretations were related to elevated DBP and HR reactivity in the lab (Chen et al., 2004), elevated ambulatory SBP when talking to friends in their natural environments, and elevated HR at night (Chen et al., 2007).

Participants did demonstrate CV reactivity (i.e., significant increase from baseline for SBP, DBP, and PR) for the dot probe, speech prep, and speech tasks, but CV reactivity was not related to childhood adversity. The literature on childhood adversity and reactivity to laboratory stressors is mixed, with some studies finding heightened reactivity (e.g., Heim et al., 2000; Kendall-Tackett, 2000) and others blunted reactivity (e.g., Bunea, Szentagotai-Tatar, & Miu, 2017; Ginty, Masters, Nelson, Kaye, & Conklin, 2017; Heleniak, McLaughlin, Ormel, & Riese, 2016; Lovallo, 2013); results often vary by type of adversity and biological system (i.e., hypothalamic-pituitary-adrenal cortex vs. sympathetic nervous system) being assessed, among other factors. In the present study, latent factors of CV reactivity were created within-task (e.g., speech SBP, DBP, PR) as well as across tasks (e.g., SBP reactivity, DBP reactivity), but no latent factors emerged as significant mediators. However, correlations among SBP, DBP, and PR within some tasks were relatively low (e.g., *r*s = .20-.28 for the dot probe), and it was evident that participants responded most strongly to the speech task. Thus, it may be worthwhile for future analyses to separately examine SBP, DBP, and PR responses to each task that showed reactivity, particularly the speech task.

Ultimately, while the present study utilized tasks that were expected to tap into vigilance for threat, it appears they may not have done so, perhaps because participants did not find the laboratory-based tasks realistic or meaningful. One possible exception was the speech task, which was rated as the most demanding and stressful task and also elicited the largest BP and PR responses. This may reflect the fact that participants were told they were being audio-recorded and they knew the experimenter was in the control room listening closely. Considering results from the CAUSE study, which found effects of threat interpretations on ambulatory physiology in adolescents' daily lives, it may be the case that individuals with a history of childhood adversity also demonstrate increased reactivity to daily interpersonal interactions, which was recently demonstrated in a college sample (Raposa & Hammen, 2018). Future studies may ask participants to wear ambulatory monitors to obtain physiological reactivity and also to describe their cognitive, behavioral, and emotional responses to daily events and social interactions that they appraise as threatening using an ecological momentary assessment approach.

5.5 Lack of Significant Results from Exploratory Mediators and Moderators

The present study tested several additional mediators and moderators, including exposure to Expanded ACEs, childhood SES, BMI, and symptoms of depression, anxiety, and PTSD, and results were generally not significant.

5.5.1 Expanded ACEs

Expanded ACEs were prevalent in this sample, even among students who reported no exposure to adversity in the family/home environment, such that 22% and 40% of participants reported witnessing violence in the community or living in a neighborhood that was unsafe or had low cohesion. This suggests that studies that only assess family/home adversity may overlook other exposures that are relevant to sleep and health. The current study found a main effect of unsafe/low cohesion neighborhood on poor sleep, consistent with previous findings that greater perceived neighborhood crime and safety concerns were related to poorer sleep (Desantis et al., 2013; Hale et al., 2013; Hill et al., 2009; Johnson et al., 2017). However, there was no relationship between exposure to violence outside of the home environment and poor sleep health (*cf.* Johnson et al., 2017). Previous research has also found an interaction between childhood trauma and census-level neighborhood crime, such that the impact of past trauma on current depressive symptoms was strongest in adults who lived in neighborhoods with high crime (Lowe et al., 2016). In contrast, the present study found that childhood adversity and living in an unsafe/low cohesion neighborhood were independently, but not interactively, related to poor sleep health; however, we used a two-item subjective measure of neighborhood safety/cohesion as opposed to objective census-level data. Future work is needed to test this cross-level (i.e., individual X community) interaction on sleep outcomes using more detailed measures of neighborhood factors or perhaps documented levels of crime on college campuses.

5.5.2 Childhood SES

In an attempt to address a longstanding problem in the childhood adversity literature, namely, when and how to include childhood SES in analytic models (see Appleton, Holdsworth, Ryan, & Tracy, 2017), the present study examined low childhood SES multiple ways. However, less than 5% of this college sample reported low childhood SES, which was largely based on home/car ownership, difficulty making ends meet, and parental education. This childhood SES measure was drawn from a community-based longitudinal study of mid-life women (Matthews et al., 2016) and it was clearly not sensitive enough to pick up on SES differences in this young sample, who, despite exposure to childhood adversity, largely came from families with some economic resilience as evidenced by the students' ability to attend college. This low base rate likely explains why childhood SES was unrelated to poor sleep in the current study, a finding that has been documented in the literature (Matthews, Jennings, & Lee, 2018; Tomfohr, Ancoli-Israel, & Dimsdale, 2010a). The effect of childhood adversity on poor sleep health did persist *beyond* adjustment for childhood SES, while results from additive models (i.e., sum of ACEs and low SES items) indicated the effect on poor sleep health was somewhat weaker, but still significant, compared to models where childhood SES was a covariate.

Although results indicated that low childhood SES moderated the relationship between childhood adversity and poor survey-derived sleep health total score, given the limited range of childhood SES, it was not possible to probe simple slopes. Past research in adults has found interactions between characteristics of the home/family (e.g., childhood adversity, maternal warmth) and low SES (e.g., adult neighborhood SES, low childhood SES) on physical health outcomes, including inflammatory outcomes (Chen, Miller, Kobor, & Cole, 2011) and allostatic load (Slopen, Non, Williams, Roberts, & Albert, 2014). Recently, results from a college sample indicated that lower subjective childhood SES measured using the MacArthur Scales of Subjective Social Status (Adler, Epel, Castellazzo, & Ickovics, 2000) and "risky" childhood family environments (i.e., high on conflict/neglect, low on warmth; S. E. Taylor, Lerner, Sage, Lehman, and Seeman (2004)) independently and interactively predicted worse sleep quality; specifically, a more risky family environment was related to poorer sleep quality for students at low *and* high childhood SES, with students from low childhood SES families who also reported risky family environments reporting the worst sleep quality (Counts et al., 2018).

The literature on low childhood SES has largely developed separately from the childhood adversity literature, yet it is critical that studies on childhood adversity and sleep also measure childhood SES. Although childhood adversity and low childhood SES are correlated, they are not overlapping constructs, and based on the present results, future research would benefit from including SES as a covariate *and* a potential effect modifier, but not adding SES items to cumulative adversity scores (which appears to wash away the nuance this variable can add to the understanding of childhood adversity on sleep and health).

5.5.3 BMI

Self-reported BMI did not emerge as a mediator or moderator of the relationship between childhood adversity and sleep health. Although meta-analytic evidence suggests a relationship between childhood adversity and increased BMI (Danese & Tan, 2014), to my knowledge, there are no other studies that have tested BMI as a modifier or mediator of the adversity-sleep relationship in young adults. Average BMI for this young adult sample was in the "normal weight" range and there was limited variability, likely due to recruiting a healthy sample free of diagnosed medical, psychiatric, and sleep conditions. Thus, while young adults are typically quite healthy, relative to mid-life or older adults, the present sample is perhaps even more healthy than what would be expected of this age group, and it is possible that BMI would emerge as a mediator/moderator in older samples with greater variability in BMI. Indeed, in a community sample of mid-life women, BMI and childhood sexual abuse had an interactive effect on mental health outcomes, such that obese women with a history of childhood sexual abuse reported significantly more depression, anxiety, and PTSD symptoms (Ramirez & Milan, 2016).

5.5.4 Psychosocial Symptoms

Based on the present results, it is unclear if symptoms of depression, anxiety, or PTSD mediate or moderate the relationship between childhood adversity and poor *latent* sleep health, given that all models were non-positive definite; thus, results are not reliable and should not be interpreted. Closer examination of these models indicated moderate correlations between each psychosocial symptom and the satisfaction and efficiency indicators for the first-order "Satisfaction/Efficiency" factor. Indeed, the correlations between these sleep indications and psychosocial variables were larger than most correlations among the "Satisfaction/Efficiency" indicators, suggesting that the underlying structure of the sleep health factor, and the mediation models more broadly, was misspecified. While it is possible that these psychosocial variables do mediate relationships between childhood adversity and sleep health, resolving this issue would likely require specifying a different latent sleep health factor.

In contrast, supplemental analyses that tested psychosocial mediators and moderators of the relationship between childhood adversity and survey-, actigraphy-, and diary-derived RUSATED total sleep health scores found that PTSD symptoms emerged as a significant partial mediator for diary-derived total sleep health score. Given that sleep disturbances are considered a hallmark of PTSD symptoms (e.g., Germain, 2013), it is not surprising that worse PTSD symptoms were related to worse self-reported sleep health. Importantly, the PTSD symptom measure used in the present study was selected because it did *not* include items on sleep disturbances, and instead focused on avoidance behaviors and disturbances in concentration and emotions, thus, we were not directly picking up on poor sleep in both the mediator and the outcome. It is also interesting that PTSD symptoms, but not depressive and anxiety symptoms, emerged as a mediator, as the symptoms include heightened arousal and hypervigilance, which is actually in line with the hypothesis that childhood adversity and poor sleep would be mediated by vigilance for threat. Of relevance, the present study also tested an alternate model in which diary total sleep health score mediated the relationship between childhood adversity and PTSD symptoms and found that this model was not significant (data not shown).

The lack of significant mediation results, specifically for the RUSATED total sleep health scores, is in contrast to two prior studies in college samples. John-Henderson et al. (2018) found that “psychological distress” (a combination of depression and anxiety symptoms) mediated the relationship between CTQ-measured emotional neglect and sleep quality in 185 undergraduates after adjustment for age and gender. They also tested an alternate model to determine whether sleep quality mediated the relationship between maltreatment and psychological distress, but this was not supported. Interestingly, they did not find direct relationships between any maltreatment variable (i.e., physical/emotional neglect or physical/emotional abuse) and sleep quality. Rojo-Wissar et al. (2019) reported that depressive symptoms and anxiety symptoms fully mediated the relationship between total ACEs and worse sleep quality in 399 undergraduates; they also found that the reverse was true, such that sleep quality partially mediated the relationship between ACEs and both depression and anxiety outcomes. While the present study assessed a multi-dimensional outcome of sleep, these studies both used the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) as their sleep outcome. Given the documented relationships between depression/anxiety and sleep quality (Triantafillou, Saeb, Lattie, Mohr, & Kording, 2019), it is possible that their mediation results emerged due to common reporting biases, or that other untested mediators are more relevant to consider for multi-dimensional sleep outcomes.

5.6 If Not the Hypothesized Mediators and Moderators, Then What?

Given that the majority of hypothesized mediators or moderators were not supported, questions remain about other possibilities. For example, an investigation of 327 college students found that neuroticism significantly mediated the association between CTQ-assessed childhood adversity and adult PSQI sleep quality (Ramsawh et al., 2011), which the authors suggested could be a target in future sleep interventions. Healthy sleep practices, or "sleep hygiene" also may mediate relationships between childhood adversity and poor sleep health (Peltz & Rogge, 2016). This includes reducing "screen time" (e.g., computers, phones) before bed and refraining from using alcohol, marijuana, or over-the-counter sleep aids to help with sleep, among other behaviors. It is possible that healthy sleep practices are less common in individuals with a history of childhood adversity compared to their non-exposed peers. While this has not been formally tested in the literature, evidence suggests that routines, including regular bedtimes, are more difficult to establish and execute in families dealing with economic and social adversities, but have been related to better health outcomes in children raised in more chaotic/unpredictable households (Fiese, Rhodes, & Beardslee, 2013). Thus, adults from more chaotic family backgrounds may have had limited modeling of healthy sleep practices and engage in behaviors that are problematic for long-term sleep health.

Several additional moderators are also important to consider. Females and minority participants in this study reported greater exposure to childhood adversity, consistent with nationally representative surveys (Merrick et al., 2018), and testing moderation by sex and race is necessary to determine if there are vulnerable subgroups. Additionally, social support (Runsten et al., 2014) and resilience (Wingo et al., 2010) moderate the relationship between adversity and inflammation and depression in adults, respectively, but this has not been tested with sleep.

5.7 Future Studies

The current study extends our understanding of the relationship between childhood adversity and poor sleep health in young adults, while raising additional questions for future study using data collected for this study but not analyzed for this dissertation project. First, investigating whether particular types (e.g., physical abuse) or categories (e.g., abuse, neglect, household challenges) of adversities or interactions among adversities are most strongly related to poor sleep health, or whether age at first exposure provides evidence of developmental timing effects on poor adult sleep. Additional measures of adversity (e.g., bullying, family climate), neighborhood factors, resilience, current stressful events, and social support can be explored as moderators. It may be fruitful to determine if there are common "poor sleep health profiles" or subsets of poor sleep dimensions that tend to co-occur (see L. Dong et al., 2019). The role of personality remains to be assessed, specifically whether personality factors are differentially related to self-report vs.

behavioral sleep outcomes (e.g., Reuben et al., 2016), or whether personality serves as a mediator of the adversity-sleep relationship (Ramsawh et al., 2011).

Outside the scope of the present study, future studies should continue to investigate interventions for individuals who report adversity and/or poor sleep. Emerging evidence in college samples suggests the potential utility of sleep health promotion programs with individualized sleep feedback (Levenson et al., 2016); cognitive-behavioral therapy for insomnia (D. J. Taylor et al., 2014); mindfulness-based stress reduction programs (Kerrigan et al., 2017); or mindfulness through "movement-based courses" such as Pilates (Caldwell, Harrison, Adams, Quin, & Greeson, 2010). Although these programs were not specifically studied in trauma-exposed populations, they have demonstrated promising initial results on sleep, stress, and mood and may be modified to be consistent with a trauma-informed approach.

5.8 Limitations

This study had a number of limitations, first being the use of retrospective self-report for childhood adversity and expanded ACEs, as opposed to using prospective and/or collateral reports from parents, teachers, or child protection or government agencies. Although the majority of the literature is based upon retrospective study designs, there are potential reporting biases due to poor memory, biased post-hoc interpretation of past events, or the influence of concurrent negative mood or psychosocial adversity, as discussed in comprehensive reviews by Maughan and Rutter (1997) and Hardt and Rutter (2004). One of the most frequently noted sources of concern is that data may be biased by mood or mental health at the time of recall. Accordingly, *negative* mood may lead to overestimates of the association between adversity and outcomes, particularly mental health outcomes (Gilbert et al., 2009), while other evidence suggests *positive mood* (or better mental health) may lead to *under-reporting* of adverse experiences (Hardt & Rutter, 2004). Second, issues related to memory may influence retrospective reports, including evidence that adults have difficulty reliably recalling events that took place early in life, possibly from birth to age 2 or 3 (Hardt & Rutter, 2004) or even up to age 7 (Maughan & Rutter, 1997), termed "infantile amnesia." Furthermore, exposure to adversity in childhood has direct impacts on brain structures related to memory (i.e., Danese & McEwen, 2012; Hardt & Rutter, 2004), which may also compromise recall. However, it is possible that the young age of this sample, compared to studies conducted in middle-aged or older adults, may minimize some recall bias due to memory. At face value, one may hypothesize that prospective data are "closer to the truth", but there is also a possibility of under-reporting due to fear of legal or social consequences. Ideally, studies may involve a combination of retrospective and prospective measures, but this is not always logistically or financially feasible. Considering the aforementioned issues regarding self-report data, it is a further limitation of this study that participants self-reported *both* childhood adversity and current sleep health (via survey and diary measures), thus, results may reflect common reporter biases; this is notable given that all significant results involved self-reported sleep outcomes.

This study required a baseline level of technological literacy and access to a smartphone or computer with internet to complete daily diaries, which is expected in college samples, but could be a barrier to participation if this study was conducted in community-based or lower SES samples or in older adults. BMI was calculated using self-reported height and weight; although experimenters obtained anthropometric measures at the Phase II laboratory visit, self-report from the online survey was used for all analyses to maintain consistency across the full sample.

Regarding statistical limitations, the internal consistency of the RUSATED survey was poor. Additionally, although SEM with maximum likelihood estimation can tolerate some missing data, given that only a subsample (N=114) of the larger full sample N=540 completed the laboratory study and ambulatory sleep protocol, it is likely that having 80% missingness on actigraphy- and daily diary-assessed sleep and laboratory-assessed vigilance for threat variables contributed to poor model fit and performance for the second-order latent factor of sleep health and attempts to create latent factors of vigilance variables. Along the same lines, mediation models involving behavioral, physiological, and diary-measured vigilance for threat were underpowered, as the N=114 subsample that completed the laboratory study was far less than the recommended sample size of 300-400 participants needed (Fritz & MacKinnon, 2007).

Due to the cross-sectional study design, claims cannot be made about causal inference. Also, all three variables in our mediation analyses (predictor, mediator, outcome) were measured concurrently and we cannot establish temporal precedence. Thus, it is possible that childhood adversity is related to poor mental health (i.e., depressive, anxiety, PTSD symptoms) via poor sleep health, but longitudinal data would be needed to establish temporal ordering. As previously noted, there is the potential that some participants may have had pre-existing issues with sleep that pre-date the exposure to adversity, a possibility that cannot be explored in this study. However, this study did assess four items related to poor childhood sleep between the ages of 6-16 years (i.e., nightmares; slept less than most kids; slept more than most kids [day or night]; trouble sleeping) and found that the relationship between childhood adversity and adult sleep held following adjustment for childhood sleep (data not shown). Ultimately, these results reflect only a “snapshot” of sleep, and it may be the case that the period of sleep measurement was subject to unknown influence by external stressors during the academic semester, including exams, projects, or extra-curricular or employment responsibilities.

There are also several issues regarding generalizability of results. First, eligibility criteria required that students were healthy in terms of mental health, cardiovascular health, sleep, and limited drug/alcohol use. Participants who did not meet eligibility criteria more frequently reported increased exposure to childhood adversity and regular use of ineligible medications and/or marijuana. It is possible that effects on sleep would be stronger if inclusion criteria were less restrictive. Second, this was a college sample, a population that has relatively more control over their sleep schedules compared to other similar age groups, such as adolescents or young working adults, who typically have more constraints due to set start times for school or work. Third, the sample was predominantly white and high SES. Finally, since childhood adversity is related to lower lifetime academic achievement, it is probable that individuals who have been exposed to adversity but ultimately enter college are different from similar-aged peers with trauma histories who are not able to enter/remain in college. Yet in this sample, exposure to more childhood adversity was related to worse symptoms of depression, anxiety, and PTSD, as well as lower resilience (data not shown), thus, advancing to college does not imply that this sample is aberrant compared to other trauma-exposed samples.

5.9 Strengths

Despite those limitations, this study also had numerous strengths. The sample size for the survey data (N=540) was large and reflected the broader demographics of the Introduction to Psychology subject pool. There was a wide distribution of exposure to adversity, with about half of the sample reporting exposure to 1-9 types. In addition to assessing childhood adversities using an established questionnaire with excellent internal consistency, this study also assessed adversities experienced outside the home and childhood SES using a multi-item measure. Thus, we were able to obtain a broader picture of adverse experiences than is available in other studies, especially those on childhood adversity and sleep.

The use of retrospective survey *and* weeklong actigraphy and daily diary provided repeated measures of behavioral and prospective self-reported data on sleep; the combination of these measures in a healthy sample improves upon past studies that have relied on retrospective self-report measures or that have used actigraphy but only in clinical or psychiatric samples. The daily diary measures provide a nuanced daily assessment of sleep, mood, threat, and health behaviors, which may be used in future analyses testing day-to-day changes in these measures. Furthermore, compliance was excellent for wearing the actigraph and completing the online daily diaries, with over 90% of the sample providing seven useable days, which far exceeds the four-day minimum that most studies require. This study also assessed the impact of relevant sociodemographic, health, and psychological covariates; tested multiple mediators and moderators; and used multi-method assessment of the primary mediator, vigilance for threat. Finally, the study used sophisticated analytic strategies, specifically confirmatory factor analysis and structural equation modeling with bootstrapping for mediation models.

5.10 Implications

This study contributes to our understanding of how childhood adversity is related to sleep health in young adults. There are several implications of these findings. Despite the sample being higher-SES over half reported exposure to childhood adversity, which suggests that trauma histories warrant attention on college campuses. Consistent with past studies in college students (Karatekin, 2018) and adults 18+ in the general population (e.g., Koenen et al., 2007; Merrick et al., 2017; Norman et al., 2012), participants in the present study with trauma histories reported higher symptoms of depression, anxiety, and PTSD compared to their non-exposed peers; of the group that reported exposure to childhood adversity, 48% and 40% reported scores above the cut-offs for depression and PTSD, respectively, compared to 22.4% and 16.2% for the group who reported no past exposure. Accordingly, while college students tend to experience high levels of problematic mental health symptoms at baseline (American College Health Association, 2012), those who have also been exposed to childhood adversity may be even more vulnerable to poor mental health and associated negative sequalae on health and academic functioning. These students may benefit from extra support around the transition to college and balancing the stress of academic and social responsibilities with health and well-being.

Less than 50% of individuals in this study met "good" sleep health cut-offs for survey-measured sleep health dimensions, and this was even lower when cut-offs were applied to actigraphy and diary measures. This suggests there is much work to be done, both by clinicians to address sleep deficits *and* by sleep health researchers to determine method-specific cut-offs for future study. According to national survey data, 26.4% of students believed their sleep difficulties were "difficult to handle" (American College Health Association, 2012), which highlights the need to provide students with psycho-education about healthy sleep practices or interventions targeting sleep health. The RUSATED scale could be administered quickly and easily over time on college campuses or in community healthcare or hospital settings, allowing for efficient longitudinal tracking and perhaps a cost-effective way to identify individuals who may benefit from completing more intensive sleep assessments. Fortunately, college campuses have departments that may be equipped to screen for childhood adversity, including academic advising centers and student health or counseling centers.

These results have broader implications on health and well-being. Both childhood adversity (Metzler, Merrick, Klevens, Ports, & Ford, 2017) and poor sleep (Hershner & Chervin, 2014) have been related to worse academic performance and lower educational attainment. Thus, the combination of adversity and poor sleep may have additive or multiplicative effects on students' academic performance and later success in the workforce. Considering the general adult population, the economic and social costs of childhood adversity are staggering, including unemployment and living below the federal poverty level (Metzler et al., 2017), high health care utilization (Koball et al., 2019), and premature mortality (Brown et al., 2009), not to mention the growing societal costs of poor sleep (Hafner, Stepanek, Taylor, Troxel, & van Stolk, 2017). Meta-analytic data suggests that childhood adversity (Jakubowski et al., 2018) and poor sleep (Meng et al., 2013; Xi, He, Zhang, Xue, & Zhou, 2014) are related to worse cardiometabolic health, while intriguing new data suggests childhood adversity may affect sleep duration up to 50 years later (Sullivan et al., 2019). Taken together, there are clear public health and policy arguments for continued investigation into social determinants of disease and sleep health in the general population.

6.0 SUMMARY

Retrospectively-assessed childhood adversity was related to poorer latent sleep health and survey-reported sleep health after adjustment for sociodemographic, health, and psychological variables in healthy college students. Results suggested that vigilance for threat, BMI, childhood SES, community-level indicators of adversity, depressive symptoms, and anxiety symptoms did not emerge as significant mediators or moderators of this relationship, although PTSD symptoms did partially mediate the relationship with diary-reported sleep health. This study used a multi-method approach to study sleep health, including retrospective self-reports *and* weeklong behavioral (actigraphy) and prospective (daily diary) measures of sleep, across multiple daytime and nighttime sleep dimensions in a healthy young sample. These findings are an important contribution to a literature that is largely based upon single retrospectively-assessed sleep dimensions and clinical samples. Although several analytic challenges arose from using the RUSATED survey, it is important to continue studying the sleep health construct, in order to obtain a fuller picture beyond single isolated sleep dimensions to determine how these sleep dimensions impact on health and well-being. The sleep health construct may provide a more nuanced way to understand individual sleep patterns and to provide more focused intervention efforts that may mitigate downstream risk of adverse social and cardiometabolic outcomes.

APPENDIX A DOT PROBE PROTOCOL

A visual probe-detection, or "dot-probe" task (Posner, Snyder, & Davidson, 1980) was used as an implicit measure of participants' attentional bias toward or away from threatening social stimuli (Mogg & Bradley, 1999) (Mogg & Bradley, 1999). The protocol for the proposed study is based on a procedure used by other studies in the child maltreatment and attention bias literature (e.g., Pine et al. 2005).

Participants were seated at a laptop computer in a darkened room. Stimuli were presented electronically using the E-prime 3.0 software (Psychology Software Tools, Pittsburgh, PA). Threat bias was assessed using face stimuli from 12 actors (50% male) taken from the NimStim face stimulus set (Tottenham et al., 2009), each expressing fearful, neutral, and happy expressions. An equal number of male and female models displaying the three expressions was used. Trials were designated as congruent if the probe appeared in the same location as the emotion face (i.e., Angry/Happy) and incongruent if appearing in the location of the neutral face. Trial congruency, sex of the face, and probe location were counterbalanced across trials. The pictures and dot probe were presented equally often at the right or left position.

Participants first completed a practice trial consisting of 20 picture pairs. Each trial began with the presentation of a 485ms central fixation cross followed by the 485ms presentation of a face pair in horizontal orientation. Immediately after the face pair disappeared, an arrow probe appeared for 1,085ms on either the left or the right side of the screen in the location of one of the faces. Using the computer keypad, participants were asked to indicate, as quickly and accurately as possible, whether the arrow was pointing up or down. The inter-trial interval ranged from 190-590ms. For the main task, 3 blocks of 72 picture pairs (24 Angry/Neutral pairs, 24 Happy/Neutral pairs, and 24 Neutral/Neutral pairs) were presented. Each block was approximately 4 minutes in duration.

While contrast of interest is between the angry/threatening facial expressions and the neutral expressions, the task also included happy expressions in order to demonstrate in future work that attentional biases are specific to angry faces, and not to emotional faces in general, consistent with past studies (e.g., Pine et al., 2005).

APPENDIX B CAUSE VIDEOS PROTOCOL

In the Cognitive Appraisal and Understanding of Social Events (CAUSE) videos protocol, participants will be shown two videotaped social scenarios (3-min each) on a television screen (Chen & Matthews; 2003). Each social scenario depicts an ambiguous situation in which the main character could make hostile, neutral, or benign attributions for others' behavior. Participants will be asked to complete a brief six-item questionnaire (Chen et al., 2007) immediately following each video. The questionnaire is designed to measure vigilance for threat in evaluating the scenarios.

Video #1: A high school student, Billy, is sitting in class while his teacher hands back graded tests. The teacher alerts the class to his suspicion that some students have cheated, and dwells at length on his disappointment in students who have cheated and his pride in students who have earned their test scores. The teacher hands back a high test score to Billy and asks to speak to him at the end of class, leaving Billy to wonder why the teacher wants to speak to him (e.g., to accuse Billy of cheating, to ask if Billy saw anything during the test, to congratulate Billy on his test score).

Video #2: A teen is shopping with her friend. A sales associate follows the teen closely and asks if she can help the teen several times while the teen is browsing and trying on clothing in the dressing room. At the end of the scenario, the sales associate asks a security guard the direction in which the teen has gone. Based on the entire scenario, participants can make several attributions for the sales associate's behavior (e.g., thinking the teen has stolen something, wanting to make a sale, wanting to help the teen or return a bag the teen has left by the dressing room).

Participants will be instructed to image that they were the youth in each of the social scenarios, and to imagine how the teacher and sales associate would respond to them. After viewing each social scenario, participants will rate the likelihood of a benign, neutral and hostile motivation for the other person's ambiguous behavior on a 5-point Likert scale. After viewing the "Billy" scenario, participants will rate the likelihood that the teacher would complement them for doing well on a test, ask if they saw anything suspicious during the test, or accuse them of cheating. Participants will also be asked to rate how scared and calm they would feel in the situation, as well as how stressful they found the situation, each on a 1 to 5 scale. After viewing the "Shopping" scenario, participants will rate the likelihood that the saleswoman was trying to help them, trying to make a sale, or trying to find them because she suspected them of stealing an article of clothing, as well as their emotional responses to the situation (i.e., how scared, calm, stressful).

B.1 Cause Videos Questions: "Billy"

BILLY GETS HIS GRADE

Instructions: Close your eyes and imagine that this situation has just happened to you. Picture the teacher talking to you. Picture his face and expression. Think about how you would feel, what you would think, and what you would do. Take a few seconds to feel yourself reacting to this situation.

Respond to the following questions, pretending as if the situation has just happened to you:

1. How likely is it that the teacher will complement you for doing well on the test?

1	2	3	4	5
not at all likely				very likely

2. How likely is it that the teacher will ask you if you saw anything suspicious during the test?

1	2	3	4	5
not at all likely				very likely

3. How likely is it that the teacher will accuse you of cheating on the test?

1	2	3	4	5
not at all likely				very likely

4. How CALM would you feel in this situation?

1	2	3	4	5
not at all calm				very calm

5. How SCARED would you feel in this situation?

1	2	3	4	5
not at all scared				very scared

6. How STRESSFUL would you find this situation?

1	2	3	4	5
not at all stressful				very stressful

B.2 Cause Videos Questions: "Shopping"

SHOPPING

<u>Instructions</u>: Close your eyes and imagine that this situation has just happened to you. Picture the saleswoman talking to you. Picture her face and expression. Think about how you would feel, what you would think, and what you would do. Take a few seconds to feel yourself reacting to this situation.

Respond to the following questions, <u>pretending as if the situation has just happened to you</u>:

1. How likely is it that the saleswoman was trying to help you?

1	2	3	4	5
not at all likely				very likely

2. How likely is it that the saleswoman was trying to make a sale?

1	2	3	4	5
not at all likely				very likely

3. How likely is it that the saleswoman was trying to find you because she suspected you of stealing an article of clothing?

1	2	3	4	5
not at all likely				very likely

4. How CALM would you feel in this situation?

1	2	3	4	5
not at all calm				very calm

5. How SCARED would you feel in this situation?

1	2	3	4	5
not at all scared				very scared

6. How STRESSFUL would you find this situation?

1	2	3	4	5
not at all stressful				very stressful

APPENDIX C SPEECH TASK: PREP

<u>Speech task: Prep</u>

We are now at the last task – it has two parts.

The last task is a speaking task. ***<u>Everyone gets worried from time to time</u>****, so I would like you to think of a time in the* ***<u>last 6 months</u>*** *when you became* ***<u>extremely worried</u>*** *and this worry* ***<u>made it difficult for you to sleep at night</u>****.*

This might be something that you can still get worried about, that may still interfere with your sleep at night, or keeps coming back to make you worried again. Think about what made you worried and how worried you felt. I want you to really try and get back into the situation in your mind and re-experience it.

In a few minutes, I am going to ask you to prepare and give a brief 4-minute speech about this worry. Your speech should cover the following: describe an incident in the last 6 months that made you very worried, describe how this worry impacted your sleep, and describe how you dealt with the event. Here is a CARD that will remind you of the points I would like you to cover in your speech.

Do you have any questions? Do you have a situation in mind? If not, I can offer some help.

If they say they haven't gotten worried about anything in the last 6 months, say, "Nobody did or said anything, or gave you news that made you worried?" "No situation made you worried because it was unexpected, stressful or hectic?"

If they still can't think of something, offer examples:

- *any conflict with friends, family, roommates?*
- *did you have a big exam, paper, or project coming up? An interview?*
- *were you waiting on results of a test, paper, project, or application (e.g., job, grad school, etc.)?*
- *were you worried about your health or finances, or someone else's?*
- *did you just feel like you had a lot on your plate?*
- *did you have any big changes coming up, like moving, traveling, or starting a new job?*
- *did you have any social events or situations that made you nervous, worried, or afraid?*

(Once they have a topic in mind) → *To recap, you will have 3 minutes to prepare your speech and 4 minutes to deliver the speech while speaking into an audio recorder.*

(After any participant questions have been answered) → *Your preparation time begins now.*

SET CLOCK FOR 3 MINUTES.
RECORD BP AT START OF SPEECH PREP AND WITH 1 MINUTE REMAINING
Lights are <u>ON</u> in participant room

If participant stops speaking during the speech, **wait 10 SECONDS**, then prompt them to continue speaking with the following questions:

"Describe in detail what exactly you were feeling."	*"How was your sleep impacted?"*
"What were your thoughts then?"	*"Did you talk to anyone about the worries?"*
"What did you do when the event occurred?"	*"How long did you continue to be worried after the event?*
"What was it about the event that made you worried?"	*"Are you still worried?*

Time is up- thank you. We have one more questionnaire for you.

APPENDIX D SPEECH CARD

- ❖ Describe an incident in the last 6 months that made you <u>very</u> worried.

- ❖ Describe how this impacted your sleep.

- ❖ Remember specific people/things involved.

- ❖ Describe how you dealt with the event.

- ❖ Describe how strong your feelings felt and how you handled your feelings.

- ❖ Tell us how the event ended.

- ❖ Tell us how it may still be upsetting or worrysome, even now.

APPENDIX E POST-TASK QUESTIONNAIRE

Post-Task Questionnaire

How **demanding** was the task you just did?

Not at all demanding 1 2 3 4 5 Very demanding

How **stressful** was the task?

Not at all stressful 1 2 3 4 5 Very stressful

Ok, let's see what you thought of your speech. We will have you use a scale to rate your feelings on your speech. Please circle the response that best represents your feeling for each statement.

1. Captured the event in my speech?	Not at all	A little bit	Moderately	Quite a bit	Extremely
2. Felt almost as strongly during my speech as during the situation?	Not at all	A little bit	Moderately	Quite a bit	Extremely
3. Started feeling bodily reactions— sweating, pounding heart—during my speech?	Not at all	A little bit	Moderately	Quite a bit	Extremely

4. Felt nervous, anxious, or tense during my speech?

Not at all	A little bit	Moderately	Quite a bit	Extremely

APPENDIX F MORNING SLEEP DIARY

Please complete these questions immediately upon waking.

Day of the week: ________________ **Date: ________________**

1. Last night I got into bed at: ___ : ___ PM / AM (i.e., reading, watching TV)

2. I actually tried to go to sleep at: ___ : ___ PM / AM

3. I think it took me about ______ minutes to fall asleep

4. Did you take any over-the-counter or prescription medication(s) to help you fall asleep?
NO YES
Name: ______________ Amt. of dose: ________________ Time: ________________
Name: ______________ Amt. of dose: ________________ Time: ________________

5. Last night after I finally fell asleep, I remember waking up this many times during the night:

0	**1**	**2**	**3**	**4**	**5+**

6. Altogether, these nighttime awakenings lasted about ______ minutes.

7. This morning I finally woke at… ____:____ AM / PM

8. I actually got out of bed to start my day at: ____:____ AM / PM

9. The quality of my sleep last night was:

1 = Very Poor	2 = Poor	3 = Average	4 = Good	5 = Very

APPENDIX G EVENING SLEEP DIARY

Please complete these questions immediately before going to bed.

Day of the week: ________________ **Date:** ________________

1. Was today a fairly typical day for you? NO YES
2. Today, I was ill (e.g., cold, fever, nausea) NO YES
3. Today I had/did the following:

	Morning *wake–12pm noon*	**Afternoon** *12pm noon–6pm*	**Evening** *6 pm–bedtime*
# of caffeinated drinks			
# of alcoholic drinks			
# of cigarettes or other tobacco products			
How long did you **NAP** (*sleep on purpose*)?	________ mins	________ mins	________ mins

4. Today, I took the following medications: ____________________ Amount of dose: __________
(e.g., *herbal, prescription, over-the-counter*)____________________ Amount of dose: __________

5. The most vigorous physical activity that I did today was: None Light Medium Heavy
Altogether, this activity lasted approximately __________minutes.

6. Answer the following questions about your social interactions today. Use the scale below:
1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely/very much

a.	Did someone make you feel accepted, included, or cared about?	
b.	Did someone make you feel rejected or ignored?	
c.	Did you experience conflict or disagreement with someone?	
d.	Did you feel like someone was helpful or supportive toward you?	
e.	Did you pay extra attention to people who might say something negative about you?	
f.	Did you feel like someone had negative intentions toward you?	
g.	Did you pay extra attention to voice tones, facial expressions, or body language that seemed to be negative or disapproving toward you?	

7. Did you interact with these types of people today? (check all that apply)

☐ University Personnel (e.g., instructor, advisor, RA)	☐ Friend(s)	☐ Parent(s)	☐ Other Relative(s)	☐ Other

8. Use the following scale to rate your general mood throughout the day, since waking up this morning:
happy/cheerful *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*
energetic/lively *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*
calm/at ease *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*
angry/resentful *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*
depressed/sad *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*
tense/nervous *1 = not at all 2 = a little 3 = moderately 4 = quite a bit 5 = extremely*

9. Did you take the actiwatch off at any time today? NO YES
If Yes, please record any times you took off the actiwatch:
1. OFF: ______ AM / PM; **ON:** ______ AM / PM.
2. OFF: ______ AM / PM; **ON:** ______ AM / PM.

APPENDIX H CFA RESULTS

In Models 1-2, all six items from the RUSATED scale served as indicators for a single survey sleep health factor in the overall sample of 540 participants (Model 1) and in the subsample of 114 participants (Model 2). In Model 3, the five actigraphy-measured parameters of sleep health and the diary-measured indicator of sleep quality (given that this cannot be measured via actigraphy) served as indicators for a single actigraphy sleep health factor. In Model 4, the six actigraphy-measured parameters of sleep health served as indicators for a single diary sleep health factor. In Model 5, six first-order factors of Regularity, Satisfaction, Alertness, Timing, Efficiency, and Duration served as indicators for a single second-order factor (Figure 3). Each first-order factor included indicators of survey, actigraphy, and diary-measured sleep health (with the exception of the Satisfaction factor, which included only survey and diary). All sleep health indicators were correlated within-method (i.e., within survey, actigraphy, and diary methods).

The summary of fit statistics for Models 1-5 can be found in Table 4. Surprisingly, none of the within-method factors demonstrated good fit. While the survey-measured sleep health factor demonstrated adequate model fit in the subsample (Model 2), this factor fit poorly in the full sample (Model 1); however, modification indices suggested correlating regularity and timing, and these changes led to adequate fit (Model 1a). The actigraphy + satisfaction factor (Model 4) demonstrated poor fit, while the diary factor (Model 5) did not converge.

The second-order factor (Model 5) demonstrated poor fit and indicated a non-positive definite latent variable covariance matrix, which suggests that the factor structure was not properly specified. Several problematic issues emerged. First, results demonstrated that survey, actigraphy, and diary indicators of sleep timing did not load onto a unitary Timing factor; indeed, in bivariate correlations, diary timing was unrelated to survey- or actigraphy-measured timing variables (see Table 18) and was actually more strongly related with other parameters of sleep health (e.g., survey and actigraphy duration). Second, actigraphy- and diary-measured daytime napping (r=.93, p<.01) and nocturnal duration (r=.82, p<.01) were strongly correlated, which posed problems for overall model fit given that these indicators appeared somewhat redundant. I decided to remove the diary measures of duration and napping, given that the survey indicators already provided a self-reported measure of both sleep parameters, while actigraphy was unique in that it provided a behavioral measure of sleep. Third, both actigraphy- and diary-measured sleep efficiency were correlated as strongly with survey quality as they were with survey efficiency, indicating that perhaps there were not separate factors of Efficiency and Satisfaction, but rather, that survey, actigraphy, and diary indicators might be best represented by one factor of Satisfaction/Efficiency. Given that sleep efficiency incorporates information about sleep latency and wake after sleep onset, which may be considered markers of poor or restless sleep, I chose to create a "Satisfaction/Efficiency" factor; which fit the data well ($\chi^2(df)$ = 7.81 (5), p = .167, CFI = .97, TLI = .94, RMSEA [90% CI] = .032 [.000, .074], SRMR = .041) and demonstrated standardized estimates ranging from .38-.74.

APPENDIX I FIT INDICES FOR CFA OF PLAUSIBLE THREAT VIGILANCE FACTOR MODELS

Table 33. Fit indices for CFA of plausible threat vigilance factor models

Model	N	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	Model Fit Decision
Models with SVQ Survey										
SVQ + All Measures										
1a. All variables: Survey, Behavioral, Physiological (Overall CV reactivity), Diary	540	901.42	230	.000	.24	.17	.074	.069, .079	.152	Poor
SVQ + Behavioral Measures										
2a. SVQ + CAUSE + Dot probe	540	50.39	20	.000	.87	.82	.053	.035, .072	.069	Poor
3a. SVQ + CAUSE	540	48.77	14	.000	.86	.79	.068	.048, .089	.076	Poor
4a. SVQ + Dot probe	540	-	-	-	-	-	-	-	-	Not identified
SVQ + Physiological Measures										
5a. SVQ + SBP reactivity	540	16.14	5	.007	.82	.64	.064	.031, .101	.068	Poor
6a. SVQ + DBP reactivity	540	-	-	-	-	-	-	-	-	No convergence
7a. SVQ + PR reactivity	540	30.00	5	.000	.76	.53	.096	.065, .131	.093	Poor
8a. SVQ + Dot probe (SBP, DBP, PR)	540	1.17	2	.557	1.00	1.18	.000	.000, .073	.027	Good fit, but SVQ does not load
9a. SVQ + CAUSE (SBP, DBP, PR)	540	2.98	2	.225	.970	.91	.030	.000, .096	.040	NPD
10a. SVQ + Prep (SBP, DBP, PR)	540	.39	2	.822	1.00	1.23	.000	.000, .051	.016	NPD
11a. SVQ + Speech (SBP, DBP, PR)	540	2.03	2	.363	1.00	1.00	.005	.000, .086	.030	Good fit, but SVQ does not load
12a. SVQ + Basal physiology (SBP, DBP, PR)	540	.85	2	.654	1.00	1.13	.000	.000, .066	.022	Good fit, but SVQ does not load
SVQ + Daily Diary Measures										
13a. SVQ + Average diary measures	540	.65	2	.722	1.00	1.02	.000	.000, .061	.015	Good

Models without SVQ Survey										
All Measures										
1b. All variables: Behavioral, Physiological (Overall CV reactivity), Diary	114	-	-	-	-	-	-	-	-	No convergence
Behavioral Measures										
2b. CAUSE + Dot probe	114	45.17	14	.000	.87	.81	.140	.095, .186	.071	Poor
3b. CAUSE	114	43.57	9	.000	.86	.77	.184	.131, .240	.080	Poor
3b. CAUSE (without Neutral + mod indices)	114	7.68	4	.104	.99	.96	.090	.000, .185	.036	Acceptable/Good
4b. Dot probe	114	-	-	-	-	-	-	-	-	1 indicator, not possible
Physiological Measures										
5b. Average SBP reactivity	114	14.51	2	.001	.80	.41	.234	.131, .354	.075	Poor
6b. Average DBP reactivity	114	8.48	2	.014	.84	.52	.169	.064, .293	.060	Poor
7b. Average PR reactivity	114	25.22	2	.000	.78	.33	.321	.216, .438	.094	Poor
8b. Dot probe (SBP, DBP, PR)	114	0	0	0	1.00	1.00	.000	.000, .000	0	Just-identified, good loadings
9b. CAUSE (SBP, DBP, PR)	114	0	0	0	1.00	1.00	.000	.000, .000	0	Just-identified, good loadings
10b. Prep (SBP, DBP, PR)	114	0	0	0	1.00	1.00	.000	.000, .000	0	NPD, just-identified
11b. Speech (SBP, DBP, PR)	114	0	0	0	1.00	1.00	.000	.000, .000	0	Just-identified, good loadings
12b. Basal physiology (SBP, DBP, PR)	114	0	0	0	1.00	1.00	.000	.000, .000	0	NPD, just-identified
Daily Diary Measures										
13b. Average diary measures	114	0	0	0	1.00	1.00	.000	.000, .000	0	Good

Note. CFA = confirmatory factor analysis; CFI = comparative fit index; $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; *p* = p-value; Mod. indices = modification indices; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. Acceptable model fit was defined as: RMSEA < .08, CFI > .90, TLI > .90 (Bentler, 1990; Hu & Bentler, 1999). Good model fit was defined as: tests with *p* > .05, CFI > .95, TLI > .95, RMSEA < .05, SRMR < .08 (Hu & Bentler, 1999).

I.1 Decision Process for Retaining Possible Threat Vigilance Factor Models

Initially, 13 CFAs were conducted, each including the SVQ survey, and several latent factors involving daily diary or physiology variables (8a, 11a, 12a, 13a), but not behavioral variables, demonstrated good fit. However, results suggested that the SVQ loaded weakly onto factors that included physiology variables, while the SVQ + Daily Diary threat model (13a) demonstrated good fit and standardized loadings and the model was retained for analysis. Given evidence from CFA results and bivariate correlations (Table 20) that the SVQ was not correlated with any threat variables, the set of 13 CFAs was conducted again, excluding SVQ as an indicator in all models. Five latent models indicated good fit and were retained for potential analysis for Hypothesis 2: see Table 6 for fit statistics and the range of standardized factor loadings for each retained model.

APPENDIX J FREQUENCY OF INDIVIDUAL ACE ITEMS

Table 34. Frequency of individual ACE items

Type of Exposure, N (%)	**Phase I ACEs**		**Phase II ACEs**	
	1 (n=137)	**2+ (n=144)**	**1 (n=26)**	**2+ (n=45)**
Emotional abuse				
1. Swear, insult, put you down	10 (7.3%)	47 (32.6%)	3 (11.5%)	15 (33.3%)
2. Act in a way that made you afraid that you might be physically hurt	0 (0.0%)	28 (19.4%)	0 (0.0%)	7 (15.6%)
Physical abuse				
3. Push, grab, slap, or throw something at you	0 (0.0%)	21 (14.6%)	0 (0.0%)	7 (15.6%)
4. Hit you so hard that you had marks or were injured	0 (0.0%)	6 (4.2%)	0 (0.0%)	1 (2.2%)
Sexual abuse				
5. Touch or fondle you in a sexual way	11 (8.0%)	26 (18.1%)	1 (3.8%)	13 (28.9%)
6. Have you touch their body in a sexual way	9 (6.6%)	17 (11.8%)	1 (3.8%)	9 (20.0%)
7. Attempt oral, anal, or vaginal intercourse with you	8 (5.8%)	14 (9.7%)	0 (0.0%)	7 (15.6%)
8. Actually have oral, anal, or vaginal intercourse with you	8 (5.8%)	10 (6.9%)	0 (0.0%)	5 (11.1%)
Emotional neglect				
9. No one in your family loved you or thought you were special or important	1 (0.7%)	20 (13.9%)	0 (0.0%)	6 (13.3%)
10. Your family didn't look out for each other, feel close to each other, or support each other	0 (0.0%)	45 (31.3%)	0 (0.0%)	18 (40.0%)
Physical neglect				
11. You didn't have enough to eat, had to wear dirty clothes, and/or had no one to protect you	0 (0.0%)	5 (3.5%)	0 (0.0%)	2 (4.4%)
12. Your parents were too drunk/high to take care of you	0 (0.0%)	11 (7.6%)	0 (0.0%)	4 (8.9%)
13. There was no one to take you to the doctor if you needed it	0 (0.0%)	4 (2.8%)	0 (0.0%)	2 (4.4%)
Intimate Partner Violence				
14.Your (step)mother was ever slapped, hit, kicked, punched, or beat up	13 (9.5%)	30 (20.8%)	3 (11.5%)	9 (20.0%)
15. Your (step)mother was ever threatened with, or hurt by, a knife or gun	6 (4.4%)	4 (2.8%)	3 (11.5%)	0 (0.0%)
Household challenges				
16. Problem drinker or alcoholic	12 (8.8%)	68 (47.2%)	1 (3.8%)	21 (46.7%)
17. Used illegal street drugs or abused prescription medications	5 (3.6%)	40 (27.8%)	1 (3.8%)	11 (24.4%)

18. Depressed or mentally ill	54 (39.4%)	93 (64.6%)	10 (38.5%)	29 (64.4%)
19. Attempted suicide	11 (8.0%)	22 (15.3%)	4 (15.4%)	10 (22.2%)
20. Served time or was sentenced to serve time in a prison, jail, or other correctional facility	0 (0.0%)	23 (16.0%)	0 (0.0%)	4 (8.9%)
Parents separated or divorced				
21. Parents separated or divorced	25 (18.2%)	66 (45.8%)	4 (15.4%)	19 (42.2%)

APPENDIX K PREVALENCE OF SURVEY-MEASURED SLEEP HEALTH DIMENSIONS FOR PHASE I (N=540)

Table 35. Prevalence of survey-measured sleep health dimensions for Phase I (N=540)

N (%)	Full Sample (N=540)	0 ACE (n=259)	1 ACE (n = 137)	2+ ACE (n = 144)	$\chi^2(4)$	*p*
Regularity					4.58	.333
Rarely/Never	60 (11.1%)	23 (8.9%)	15 (10.9%)	22 (15.3%)		
Sometimes	276 (51.1%)	132 (51.0%)	74 (54.0%)	70 (48.6%)		
Usually/Always	204 (37.8%)	104 (40.2%)	48 (35.0%)	52 (36.1%)		
Satisfaction					32.16	<.001
Rarely/Never	103 (19.1%)	38 (14.7%)	18 (13.1%)	47 (32.6%)[b]		
Sometimes	299 (55.4%)	138 (53.3%)	84 (61.3%)	77 (53.5%)		
Usually/Always	138 (25.6%)	83 (32.0%)	35 (25.5%)	20 (13.9%)		
Alertness					4.78	.311
Rarely/Never	94 (17.4%)	38 (14.7%)	23 (16.8%)	33 (22.9%)		
Sometimes	218 (40.4%)	108 (41.7%)	58 (42.3%)	52 (36.1%)		
Usually/Always	228 (42.2%)	113 (43.6%)	56 (40.9%)	59 (41.0%)		
Timing					5.91	.206
Rarely/Never	136 (25.2%)	61 (23.6%)	31 (22.6%)	44 (30.6%)		
Sometimes	220 (40.7%)	102 (39.4%)	65 (47.4%)	53 (36.8%)		
Usually/Always	184 (34.1%)	96 (37.1%)	41 (29.9%)	47 (32.6%)		
Efficiency					13.12	.011
Rarely/Never	136 (25.2%)	55 (21.2%)	35 (25.5%)	46 (31.9%)		
Sometimes	198 (36.7%)	88 (34.0%)	51 (37.2%)	59 (41.0%)		
Usually/Always	206 (38.1%)	116 (44.8%)	51 (37.2%)	39 (27.1%)		
Duration					11.05	.026
Rarely/Never	73 (13.5%)	28 (10.8%)	16 (11.7%)	29 (20.1%)		
Sometimes	246 (45.6%)	112 (43.2%)	66 (48.2%)	68 (47.2%)		
Usually/Always	221 (40.9%)	119 (45.9%)	55 (40.1%)	47 (32.6%)		

Note. p-values reflect comparison across ACE groups (0, 1, 2+) by chi-square.

APPENDIX L PREVALENCE OF SURVEY-MEASURED SLEEP HEALTH DIMENSIONS FOR PHASE II (N=114)

Table 36. Prevalence of survey-measured sleep health dimensions for Phase II (N=114)

N (%)	Full Sample (N=114)	0 ACE (n=43)	1 ACE (n=26)	2+ ACE (n=45)	$\chi^2(4)$	*p*
Regularity					.74	.947
Rarely/Never	12 (10.5%)	4 (9.3%)	3 (11.5%)	5 (11.1%)		
Sometimes	60 (52.6%)	23 (53.5%)	15 (57.7%)	22 (48.9%)		
Usually/Always	42 (36.8%)	16 (37.2%)	8 (30.8%)	18 (40.0%)		
Satisfaction					10.73	.030
Rarely/Never	21 (18.4%)	4 (9.3%)	3 (11.5%)	14 (31.1%)		
Sometimes	47 (53.5%)	23 (53.5%)	14 (53.8%)	24 (53.3%)		
Usually/Always	42 (28.1%)	16 (37.2%)	9 (34.6%)	7 (15.6%)		
Alertness					4.50	.343
Rarely/Never	25 (21.9%)	6 (14.0%)	5 (19.2%)	14 (31.3%)		
Sometimes	47 (41.2%)	19 (44.2%)	10 (38.5%)	18 (40.0%)		
Usually/Always	42 (36.8%)	18 (41.9%)	11 (42.3%)	13 (28.9%)		
Timing					.40	.982
Rarely/Never	22 (19.3%)	8 (18.6%)	5 (19.2%)	9 (20.0%)		
Sometimes	43 (37.7%)	15 (34.9%)	10 (38.5%)	18 (40.0%)		
Usually/Always	49 (43.0%)	20 (46.5%)	11 (42.3%)	18 (40.0%)		
Efficiency					7.56	.109
Rarely/Never	24 (21.1%)	8 (18.6%)	6 (23.1%)	10 (22.2%)		
Sometimes	41 (36.0%)	11 (25.6%)	8 (30.8%)	22 (48.9%)		
Usually/Always	49 (43.0%)	24 (55.8%)	12 (46.2%)	13 (28.9%)		
Duration					2.49	.647
Rarely/Never	21 (18.4%)	7 (16.3%)	4 (15.4%)	10 (22.2%)		
Sometimes	45 (39.5%)	16 (37.2%)	9 (34.6%)	20 (44.4%)		
Usually/Always	48 (42.1%)	20 (46.5%)	13 (50.0%)	15 (33.3%)		

Note. p-values reflect comparison across ACE groups (0, 1, 2+) by chi-square

APPENDIX M HYPOTHESIS 1 MODEL RESULTS WITH DIARY-MEASURED DURATION AND NAPPING

Table 37. Hypothesis 1 model results with diary-measured duration and napping

	B (SE)	*β*	*P*
Path model			
ACE → Sleep Health	-1.31 (.34)	-.28	<.001
Second-order latent factor			
Sleep Health			
Regularity	.16 (.05)	.553	.002
Satisfaction/Efficiency	.47 (.09)	.947	<.001
Alertness	.21 (.07)	.536	.001
Duration	.31 (.07)	.552	<.001
First-order latent factors			
Regularity			
Survey	1.0	.471	--
Actigraphy	-3.07 (.77)	-.568	<.001
Diary	-4.39 (1.31)	-.814	.001
Satisfaction/Efficiency			
Survey satisfaction	1.0	.770	--
Diary satisfaction	.74 (.19)	.605	<.001
Survey efficiency	.79 (.16)	.516	<.001
Actigraphy efficiency	-.19 (.08)	-.333	.023
Diary efficiency	-.46 (.15)	-.433	.003
Alertness			
Survey	1.0	.564	--
Diary	-.36 (.17)	-.630	.038
Duration			
Survey	1.0	.858	--
Diary	.47 (.38)	.287	.22

Note. Results reflect replacing actigraphy-measured duration and napping with diary measures. Model fit indices were as follows, $\chi^2(df)$ = 73.48 (40), *p* = .001, CFI = .94, TLI = .82, RMSEA [90% CI] = .039 [.025, .053], SRMR = .056. The paths from the first-order factors of Regularity, Alertness, and Duration to their respective survey-measured indicators were fixed to 1 for all analyses; the path from the first-order factor Satisfaction/Efficiency to survey-measured satisfaction was fixed to 1 for all analyses. Coefficients for all sleep health indicators regressed on age, sex, and race, respectively, are not displayed as these variables were included as covariates. ACE = adverse childhood experiences (total score); $\chi 2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; standardized root mean square residual.

APPENDIX N INDIRECT EFFECTS FOR SURVEY-DERIVED RUSATED SLEEP HEALTH TOTAL SCORE (N=114)

Table 38. Unstandardized indirect effects from bootstrapped analysis (5,000 resamples) of ACE → [Mediator] → survey-derived RUSATED sleep health total score (N=114)

		Unstandardized Indirect Effects		Model Fit Statistics								Individual Path Effects
Mediator	N[a]	Estimate	[95% CI]	χ^2	*df*	*p*	CFI	TLI	RMSEA	RMSEA [90% CI]	SRMR	B (SE), *p*
Threat Vigilance												
Model 1: SVQ survey[b]	114	-.01	[-.05, .02]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: .18 (.11), p=.096 b: -.06 (.07), p=.384 c': .02 (.10), p=.879
Model 2: Dot probe bias[b]	102	.00	[-.03, .03]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.13 (.12), p=.299 b: .004 (.08), p=.963 c':.004 (.10), p=.965
Model 3: SVQ + Diary threat	113	-.02	[-.09, .04]	14.34	8	.073	.93	.72	.083	[.000, .152]	.042	a: .03 (.06), p=.653 b: -.96 (.89), p=.277 c': .03 (.10), p=.782
Model 4: CAUSE ratings[c]	114	.001	[-.03, .03]	10.72	12	.553	1.00	1.03	.000	[.000, .040]	.031	a: .01 (.05), p=.840 b: .06 (.25), p=.816 c':.003 (.10), p=.972
Model 5: Dot probe reactivity	114	.02	[-.18, .22]	8.10	4	.088	.81	-.05	.095	[.000, .189]	.034	a: .12 (.11), p=.268 b: .15 (.66), p=.820 c': -.01 (.14), p=.921
Model 6: Speech reactivity[c]	114	-.003	[-.07, .07]	.677	4	.954	1.00	2.79	.000	[.000, .000]	.011	a: -.14 (.16), p=.382 b: .02 (.18), p=.902 c': .01 (.11), p=.946
Health/Psychosocial												
Model 7: BMI[b]	114	.003	[-.02, .03]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: -.01 (.02), p=.714 b: -.49 (.45), p=.281

												c’:.001 (.10), p=.994
Model 8: Depressive symptoms[b]	114	-.05	[-.13, .02]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 1.90 (.60), p=.002 b: -.03 (.02), p=.099 c’: -.06 (.10), p=.569
Model 9: Anxiety symptoms[b]	114	-.02	[-.09, .05]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 1.27 (.37), p=.001 b: -.02 (.03), p=.524 c’: .03 (.10), p=.804
Model 10: PTSD symptoms[b]	114	-.01	[-.07, .06]	0.00	0	.000	1.00	1.00	.000	[.000, .000]	.000	a: 4.5 (1.6), p=.005 b:-.002 (.01), p=.799 c’: .01 (.11), p=.911

Note. Coefficients for sleep health total score and all threat vigilance indicators (i.e., latent factors = Models 3-6) or observed variables (i.e., Models 1-2, 7-10) are regressed on age, sex, and race, respectively; covariate estimates are not displayed. ACE = adverse childhood experiences (total score); $\chi2$ = chi-square fit statistic; *df* = degrees of freedom; CFI = comparative fit index; TLI = Tucker-Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval; SRMR = standardized root mean square residual. path a = effect of ACE → mediator; path b = effect of mediator → latent sleep health; path c’ = ACE sleep health, holding the mediator constant (i.e., direct effect). Path c (total effect) is not shown.

[a]N refers to number of participants for the mediator. [b]Model is fully saturated. [c] Latent variable covariance matrix (PSI) model was non-positive definite; estimates or fit statistics are presented but are not reliable.

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