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ASSOCIATIONS BETWEEN ADVERSE CHILDHOOD EXPERIENCES AND

NEGATIVE SLEEP HEALTH AMONG YOUNG ADULTS

by

Yanzhou Lu

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ABSTRACT

ASSOCIATIONS BETWEEN ADVERSE CHILDHOOD EXPERIENCES AND
NEGATIVE SLEEP HEALTH AMONG YOUNG ADULTS

by

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Poor sleep health has been marked as a major factor impacting young adults' social, academic, and physical performance in a negative direction. Existing research has shown that stress related mental illness or disorder are significant risk factors that contribute to negative sleep health in a bidirectional relationship. Such stress can be contributed by stressors of daily life, as well as adverse experiences and other experiences from earlier in the development. Purpose of the current study aimed to contribute to the existing understanding of the mechanisms that connect early trauma and disadvantage to sleep difficulties in emerging adulthood. Results indicated that adverse childhood experiences/events (ACEs) were significantly negatively associated with current sleep health among young adults, and that these relationships are partially associated with emotional distress symptoms or levels as well. Thus, early ACEs can significantly contribute to impaired sleep health among young adults in the present, and emotional distress symptom could be one of the mechanisms contributing to this relationship among young adults.

Keywords: Adverse Childhood Experiences, sleep health, emotional distress symptoms

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Introduction

Sleep serves as an important marker of both physical and psychological well-being

Current research suggests that in order to maintain physiological and psychological

well-beings, an average of 7 to 8 hours of sleep per night should be set as the goal (Pilcher et

al., 1997). In addition, the quality of sleep (e.g., aspects that can reflect how well an

individual's sleep is such as how long does it take to fall in asleep) is more significant than

the quantity (e.g., actual hours of sleep) (Pilcher et al., 1997). Sleep health has been proven to

be an important marker of an individual's well-being since insufficient sleep is associated

with a variety of negative health outcomes including to higher rates of mortality at earlier

ages (Steptoe et al., 2006). Unfortunately, evidence supports that most adults are not getting

the recommended amounts of sleep (Bonnet & Arand, 1995). Based on the existing research,

critically insufficient sleep occurs in over 30% of adults. According to a research on the sleep

length, the normal (healthy) range of sleep hours among young adults (ages 18-25) is from 8

to 9 hours per night. In contrast, sleep length around 7 hours is considered deficient, and

sleep of 6 hours a single night or less is described by these authors as "disastrous" (Bonnet &

Arand, 1995, p. 908).

In a study of evaluating sleep quality and quantity, Pilcher and colleagues (1997) found

that inadequate sleep quality was associated with elevated complaints of physical health, as

well as elevated feelings of depression, tense mood, impatience, physical tiredness, and

distraction. Additionally, people who suffer from impaired sleep have reported a reduction in

beneficial stimuli (good things that surround them or positive energy) and a decline in happiness with their lives. Also, people who experience impaired sleep have reported elevated levels of daytime sleepiness (Pilcher et al., 1997). Strine and colleagues (2005) found that sleep deprivation led to serious physical consequences such as body systems functioning abnormally such as reduced immunity (Irvin, 2002), physical fatigue (Akerstedt et al., 2002), and lung disease (Goodwin & Stein, 2004), aggravated psychiatric symptomatology, and exacerbation of existing chronic conditions (Strine et al., 2005). Strine and colleagues (2005) also pointed out that sleep problems are correlated with damage in every component of health-related quality of life, and sleep is significantly associated with adverse health behaviors. Existing studies regarding impaired sleep have argued that issues associated with sleep could unfavorably influence the functioning of body systems, aggravate psychiatric symptomatology, and could aggravate the progress of chronic illness (Strine et al., 2005). As a result, such impairments of body systems could generate a longer term of impaired sleep, and a vicious circle of impaired sleep and unhealth outcomes has formed. Strine and colleagues (2005) thus claimed the evaluation of sleep seems to be a crucial element of general medical care. Additionally, increased awareness of sleep and sleep problems among the population may lead to better understanding of the importance of sleep and the many benefits that people may experience when they work to improve their sleep experience.

A research consensus has emerged that sleep plays an important role for promoting health and is highly associated with people's daily functioning (Lentino et al., 2013). An important area of research concerns the association between poor sleep and impaired learning

and academic performance. Research suggests that the sleep health is associated with individual's physical performance and lifestyle in a similar direction. In other word, the poorer the sleep health an individual has, the unhealthier the individual's lifestyle and worse the performance is going to be (Lentino et al., 2013). Lentino and colleagues (2013), suggested that low quality of sleep is associated with chaotic or irregular neuroendocrine and metabolic systems, psychological disorder such as anxiety and depression, overweight, cardiovascular diseases, and numerous life stressors. Unfortunately, few researchers have studied the diverse outcomes of poor sleep comprehensively, in a single sample and longitudinally. Bidirectional influences appear to exist between sleep and elements of unhealthy lifestyle, including immoderate eating behaviors and sedentary lifestyles or inadequate physical activities. These behaviors were negatively associated with sleep, and poor sleep makes overeating and poor exercise even more likely. Ultimately, the immoderate eating behaviors and lack of exercise can lead to health issues such as obesity, and this phenomenon is happening among school-aged children (Morrissey et al., 2020). The study conducted by Morrissey and colleagues (2020) found a strong negative correlation between the sleep duration and obesity among school-aged children.

Consequences due to sleep deprivation

Bonnet and Arand and colleagues (1995) further suggested that data showed about 57% of automobile accidents were associated with physical and /or mental fatigue due to insufficient sleep. Sleep deprivation increases rates of forgetting in episodic memory (Ashton et al., 2020). After comparing the ability of recalling episodic memories between different length of overnight sleep, alertness during the day, and generally short in sleeping hours of

the overnight sleep. Ashton and colleagues (2020) found that unable to recall items was heightened over alertness during the day, and sleep deprivation, as compared to control group who had normal sleep. Particularly, sleep deprivation has resulted in loss of associative memory which did not occurred after the alertness during the day. The results advocated that sleep destitution has activated fragmentation of episodic memories and connections of those memories related to item recall.

Also, insufficient sleep or unhealthy sleep patterns can result in weakening the immune system, increasing risk of cardiovascular diseases, and cancer (Irwin, 2015). Physiologically, sleep affects not only the hypothalamus-pituitary-adrenal (HPA) axis, but also the sympathetic nervous system (SNS). These two crucial systems are responsible for balancing the immune responses. When an individual is asleep, that individual's level of cortisol, epinephrine, and norepinephrine in blood would decrease. Instantaneously, levels of chemicals in blood which contribute to cell growth, growth hormone as instance, were proved to increase (Besedovsky et al., 2012).

<u>Factors that could result in impaired sleep health</u>

One major factor that led people resulted in sleep deprivation is the excessive smart phone use before bed. Such use of smart phones is referred as the problematic mobile phone use (PMPU) and believed to be significantly impairing the sleep quality (White et al., 2011), and mental health (Tao et al., 2017). According to Tamura and colleagues (2007), another major factor which can cause people result in sleep deprivation is the excessive use of social media during the daytime, which can significantly result in increasing levels of stress due to paying too much attention on social relationships between people. Tamura and colleagues

(2007) suggested that the overuse of social media among adolescents (with an age range from 15-19 years old) has significantly increased the chance of been depressed by experiencing more mental effort exhaustion due to pay a lot of attentions on interpersonal relationships. Tamura and colleagues (2007) further suggested that by comparison of excessive use of social media, other internet related actives such as news searching, game playing, and video watching have contributed depression to adolescents less than the use of social media. There are other indications which pointed out stress and psychological trauma can negatively affect sleep quality (Sadeh et al., 1996). Sadeh and colleagues (1996) pointed out that one of the general forms of traumatic events experienced by most children is from their care providers or adults from their families in a way of child abuse and neglect. From a hypothetical point of view, Sadeh and colleagues (1996) suggested that two pathways which are apparently competing about potential stress-related consequences on sleep. The first one is the presence of the biobehavioral switch-on reaction which suggested that stress contributes to elevated level of anxiety, disturbance, alertness, bring arousal to the sympathetic adrenergic system and ultimately leads to adversities of both starting to sleep and keeping asleep, and stress can also contribute to stress-associated parasomnias, in this case, nightmares specially. The second one is that dealing with stress and/or decline to obtain earlier stage of well-being could result in switch-off reaction which suggested that an organized removal and drifting apart from extrinsic and intrinsic sources of stimulation by necessarily declining the level of activeness, enhancing, and deepening sleep. The two conflicting inclinations of explaining the relationship between stress and sleep mentioned above may probably accounted for a lot of the adverse results of the studies related to this

topic. However, Sadeh and colleagues (1996) suggested that defining child abuse is a relatively hard work in itself, and stressful events such as sexual, physical and mental abuse are largely determined by cultural norms. Overall, distress symptoms such as depression can result in sleep deprivation, as Kaneita and colleagues 2006 found that people who reported they are generally stressful and depressive feelings were significantly reporting a sleep duration less than 6 hours per night as well (Kaneita et al., 2006). On the other hand, sleep health can not only be consequence due to distress symptoms, but can also be mediated by distress symptoms (Lopresti et al., 2013). Lopresti and colleagues 2013 suggested that sleep and distress revealed a by-directional relationship of causality. In other word, distress symptoms such as depression can result in negative sleep health, and such negative sleep can result in generating more distress symptoms. Thus, Lopresti and colleagues 2013 suggested that negative sleep health can be reduced by mediating distress symptoms.

Alcohol use has also been determined as a negative contributor of impaired sleep (Peeke et al., 1980; Carole et al., 1981; Singleton & Wolfson, 2009; Thakkar et al., 2015). According to Carole and colleagues (1981), by consuming alcohol before bedtime, the chance of the number of sleep events such as sleep apnea has significantly increased among health adults. Additionally, excessive consumption of alcohol can significantly result in lower academical performance through impaired sleep (Singleton & Wolfson, 2009), and sleep disruption through damaging sleep homeostasis (Thakkar et al., 2015).

A general view of Adverse Childhood Experiences (ACEs)

Based on previous research, unhealth sleep is most likely resulted from stress and mental disorders caused by stress. Such stress and other mental illness that caused sleep

deprivation among adults are possibly resulted in Adverse Childhood Experiences (ACEs) (Chapman et al., 2004). ACEs are defined as childhood neglect and abuse that include emotional, physical, or sexual abuse and neglect. Childhood's household dysfunction, such as fights between parents, is also considered as an ACE (Felitti et al., 1998). ACEs are now considered as a major risk factor for the health condition in later adult hood (Chang et al., 2019), and a significant predictor for an individual's future health (Musa et al., 2018).

According to Herzog & Schmahl. (2018), evidences from present researches regarding the field of neurobiology and epidemiology have indicated that Adverse Childhood Experiences (ACEs) are strongly associated with permanent brain functions impairment. Consequently, ACEs can impact an individual's psychological and physical health in the rest of an individual's life. Such ACEs can include sexual abuse, verbal abuse, and domestic violence.

It is clear that ACEs can lead to major health issues in later adulthood. According to Felitti and colleagues (1998), a notable association between health-risking factors that would result in death such as cancer and the experience of childhood abuse or familial violence among adults. Felitti and colleagues (1998) suggested that impaired self-reported health conditions were also exhibited a notable association to the experience of childhood abuse or familial violence. The results of the research indicated that the influence of ACEs on health conditions tend to be intense and incremental.

ACEs could result in psychological trauma, and could ultimately leads to anxiety or depression. Distress symptoms such as anxiety and depression has been proven that they are linearly associated with shorter duration of sleep in a study regarding short sleep duration and

distress among young adults conducted by Glozier and colleagues (2010). Glozier and colleagues (2010) suggested that a feasible mechanism for the association between mental distress and the duration of sleep is that the low level of sleep duration is one of the symptoms of the mental distress being evaluated. Interfered sleep is a significant symptom in psychological disorders such as depression, even though it is considered as well as a general discovery within populations without any psychological disorders. Low level of sleep duration could be an initial sign of a psychological disorder or a reminding symptom of a prior disorder.

Negative aspects of health issues caused by ACEs can be resulted in physical disorders such as the increasing risk of arthritis, lung disease, and hypertension (Goodwin & Stein, 2004). Goodwin & Stein (2004) suggested that their data indicate some level of selectivity in how strong the relationships between different childhood trauma or ACEs and the risk of any physical health issues during later adulthood. Also, their results suggested that the association between childhood trauma or ACEs and physical health issues in later adulthood is significant among the population of the adult in U.S., which is not only limited in their selected samples. ACEs of early ages can also contribute into the variety of depressive disorders among adults, in this case, the recognition of early childhood abuse is crucial to help preventing the risk of depressive symptoms (Chapman et al., 2004). Chapman and colleagues (2004) pointed out that ACEs possess a strong correlation with the chance of being suffered from lifetime psychological disorders such as depression that will be continuously into later adulthood. Since different ACEs items are associating with each other, it is crucial to expend the consideration of including childhood abuse and within family conflicts as a standard of

experiences that would impact the risk of psychological disorders like depression. Such disorders are evidently will impair healthy sleep in the later adulthood for a long period of time.

In a study that was investigating the relationship between ACEs and insomnia, Bader and colleagues (2007) pointed out that ACEs that such as emotional and physical abuse were believed to be a critical risk factor that can influence a person's health in later adulthood. As their results of the study has suggested that ACEs in childhood and adolescence are believed to be associated with sleep quality in later adulthood suffering from primary insomnia among their participants. Bader and colleagues (2007) have raised an important question which is what mechanisms can be explained to a possible relationship between ACEs and impaired sleep among adults. Bader and colleagues (2007) suggested that the hyperarousal is an often-observational outcome of traumatic exposure, which can identify the incidence of impaired sleep among patients who suffered from PTSD. Additionally, A history of child abuse and early childhood neglect is believed to often associated with long-term or psychological torments. Such torments can result in an adaptive course of the organism of the body system, and can ultimately lead to the continuous of stress-suppressed neurophysiological modes. In other word, this phenomenon can cause chronically increased catecholamines, increased HPA axis, and lead to an elevated stress reactivity.

<u>The association between ACEs and impaired sleep health</u>

ACEs such as child abuse that has mentioned earlier is a considerable source that causes insufficient sleep among adults. It is believable that ACEs are responsible for high level of distress, and ultimately results in a poor level of sleep health (Herzog & Schmahl, 2018).

Such stress and psychological trauma that due to ACEs are believed to be negatively affecting sleep quality indirectly. A longitudinal study which investigated the association between the childhood sexual abuse and the sleep problems in later ages among adolescents has concluded that the psychological safety of sleep has been compromised due to the experience of sexual abuse, and therefore the psychological insecure leads to PTSD, and this psychological burden has resulted in problematic sleep (Noll et al., 2005). Noll and colleagues (2005) claimed that they have found an evidential association between the sever, long-term PTSD or depression and sexual abuse in early childhood. PTSD and depression are contiguous connected between each other, and to some level defined by, sleep interferes like insomnia, waking up during the middle of the night and nightmares for examples. Therefore, Noll and colleagues (2005) suggested this study has further developed to establish a distinct association between sexual abuse during the early childhood and sleep health related issues separately from any comorbid PTSD and depression.

Other than the individual's abuse or maltreatment, one study about the associations between family conflict during childhood and ACEs has suggested that ACEs can be severe enough to be a predictor of insomnia in later adulthood, and the study also suggested that the family conflicts (fights between parents or siblings) can contribute to a person's insomnia after the age of 18 (Gregory et al., 2006). According to Gregory and colleagues (2006), a dose-response relationship has been discovered through the higher cases of evaluation at which a subject's family has reported a significant level of conflict or fight, causing the higher chance of that participant to experience insomnia in later age. Even though these results do not support indications for a direct association between the conflict within family

and insomnia in later age, yet they do form a preparatory work in proving the causality between these factors. The study of Gregory and colleagues (2006) has supported existing studies on proving that insomnia is often related with depression and other mental health issues. Also, results of this study have made up gaps of studies which related to associating other psycho-social components such as social stratum of their parents, their racial identities, and pressure from schoolwork with sleep health issues.

How do ACEs impair sleep

One possible mechanism of how ACEs negatively affect sleep are been investigated in a study, which suggests that the increased corticotrophin-releasing hormone (CRH) and the hyperactivity of hypothalamic-pituitary-adrenal axis have interfered the sleep health (Kajeepeta et al., 2015). Kajeeoeta and colleagues (2015) claimed that it is possible that ACEs have elevated the reactivity of CRH, which could result in impacting sleep quality. Another possible mechanism of how ACEs can impact sleep brought by Kajeepeta and colleagues (2015) is that the development of the impaired ability of control mood because of traumatic experiences during early ages, since early ages and adolescence are the time of fast brain development. Traumatic experiences during this fast brain developing period can disrupt the normal brain development and damage a person's capability to exploit skills that are essential for being more independent in later adulthood. This damage is frequently related to mental disorders, such as depression and PTSD, and for people who have suffered from those mental disorders, impaired sleep is a common symptom for them (Kajeepeta et al., 2015).

Evidence of ACEs impairing sleep in later adulthood was also found by Agargun

colleagues. (2002). In a study related to a relationship between dissociative experiences and violent behavior during sleep (VBS), Agargun and colleagues (2002) found that ACEs, for example, physical harm or sexual abuse during childhood could generate dissociative symptomatology as a consequence. Dissociative struggles can associate to daytime manifestations and as well as to manifestations that can occur during night-sleep. Destructive behaviors and dissociative hallucinations that are related to problematic sleep are considered to connect as sexualized behavior, and these behaviors are combined with self-protective behaviors at the same time. Also, Agargun and colleagues (2002) pointed out that some sleep-related disorders such as sleepwalking, sleep terror, and sleep-related eating are significantly associated to suicidal and as severe as self-mutilating behaviors. According to Agargun and colleagues (2002), the relationship between sleep associated violent behaviors, childhood physical and sexual abuse, and dissociative occurrences are significantly associative. Furthermore, parasomnias would lead to injuries during sleep and develop mental agony from recurrent losing control over one-self during sleep. Thus, Agargun and colleagues (2002) suggested that the dissociation which resulted in ACEs serves a great purpose not only in sleep associated behaviors, but also in individual's cognitive and behavior functions.

Limitation of the existing research and the purpose of the current study

Most of the studies regarding the association between ACEs and sleep health in later adulthood did not focus solely on a single developmental period (Bader et al., 2007; Chapman et al., 2004; Gregory et al., 2006), in this case, college students with an age range of 18-25 years old which is the intended audience of the current research. The ones that did focus on young adults, however, did not focusing solely on the impaired sleep that is due to

ACE (Hershner & Chervin, 2014; Singleton & Wolfson, 2009; Schwarz et al., 2019). In other word, the research about the association between ACEs and impaired sleep used young adults as the targeting audiences are relatively few.

Even though by preventing ACEs while people are in early ages can protect them from suffering from psychological disorders or mental illness, and thus to avoid impaired sleep in their present and future seems like a feasible solution. However, for those who are already turned into adulthood with impaired sleep caused by mental disorders and have ACEs, this is not a solution for them anymore. Currently, a recommend strategy for the population with ACEs and suffered from impaired sleep is to seek psychological or psychiatric treatment. The thought is to resolve or mitigate the mental disorders in the first place, and the problems with sleep could go alone the way with disorders. Thus, the main goal of the current study is to examine the association between ACEs and impaired sleep among young adults, and contribute a valid data analysis in the bases of the previous research.

Additionally, given that distress symptoms are highly associated with both negative sleep consequences, and ACEs, the current study has designed to compare distress levels with participants who have high ACEs and provide explanations on how the combination of ACEs and distress symptoms (e.g., anxiety and depression) level could result in a more severe sleep impairment, or predict the total sleep health by both ACEs and distress symptoms among young adults. Such innovation of using the additive effect analysis of ACEs and distress symptoms to explain sleep health among young adults with an age range of 18-25 years has not been researched entirely before.

Statement of the Problem

Research has documented associations between ACEs and later sleep problems, but research has not specifically examined this causality particularly among emerging adults, many of whom are college students or engaging in training in other areas where new knowledge and skills are being acquired. The clear connections between sleep problems and problems with learning and memory make this an important developmental period to examine. In addition, this project will look at a possible additive effect including distress symptoms as an additional factor that may help to explain more of the relationship of early ACEs and aspects of sleep over developmental time.

Hypothesis 1: Consistent with previous research, there will be a significant and positive association between both Child Maltreatment and Family Dysfunction scales on the ACEs' measures and items on the Sleep Health Index® (Sleep Duration, Sleep Quality, Sleep Disorder, and the overall SHI Total Score), and the Sleep Hygiene Questionnaire.

Hypothesis 2: Current emotional distress measures (PROMIS Anxiety and PROMIS Depression) with higher scores will significantly lead to lower scores on the sleep measure (SHI) and the combination of childhood trauma and current distress will be specifically associated with poorer sleep.

Method

Participants

821 emerging adults (M = 21.82, SD = 1.94) who were predominately college students with a range of educational background from 6-20 years (M = 14.23, SD = 2.06) have been recruited and contributed useful data to the current study. Participants were drawn from

samples collected in Psychology 660/760 "Experimental Child Psychology" over 3 semesters. Students who enrolled in this class were required to recruit 8 participants (4 male and 4 female), with an option to recruit additional participants for extra credit. In order to discourage students from fabricating data for the assignment, students are allowed to get full credit for the assignment by describing efforts that they made to recruit participants even if unsuccessful.

Adverse Childhood Experiences

The Centers for Disease Control & Prevention (CDC) Adverse Childhood Experiences (ACE) Scale was developed by Felitti and colleagues (1998). It consists of 10 items that cover both abuse and neglect (child maltreatment) experiences and items that cover experiences of family dysfunction such as domestic violence and parental incarceration with 5 items for each category. The items differ in the specific frequencies asked about for each item, and standardized scoring is used to convert each item into a presence/absence (or 1/0) score for each item, and a total score is acquired by adding up the scores across 10 items. Thus, higher scores on the ACEs measure reflect wider breadth of adverse experiences, not necessarily more frequent or severe experiences. The CDC ACEs scale has been shown to present with strong reliability and validity (McEwen, 2007; Anda et al., 2006; Repetti, 2002).

The version of the ACEs scale used in this study is called the Childhood Experiences Survey (CES) which is an extended version of the CDC measure that was developed by Mersky and colleagues (2017). Compared to the conventional 10-items ACEs developed by Felitti and colleagues (1998), this version has an additional 7 items including family financial issues, food insecurity, homelessness, absence of parents, death of family member(s),

bullying from others, and violent crime that provide a more complete picture of stressors that can be important in development (see Appendix 1.) (Mersky et al., 2017). This modified ACEs scale was been used in research investigating associations between ACEs and racial/ethnicity (Mersky, & Janczewski, 2018), and in youth with incarcerated parents (Turney, 2018). Also, this version of the ACEs scale has been shown to be a reliable predictor of health problems associated with adverse childhood experiences (Koita et al., 2018; Oh et al., 2018; Saini et al., 2019; McEwen, & Gregerson, 2019).

Sleep Health Index[®]

Sleep Quality, Sleep Duration, and level of Sleep Problems were assessed by using the Sleep Health Index[®] (SHI; Knutson et al., 2017) developed by the National Sleep Foundation (SleepFoundation.org). The SHI consists of 12 items in three major categories: 1) 6 items measuring sleep quality, 2) 3 items measuring sleep duration, and 3 items measuring disordered sleep (see Appendix 2.). Existing research has shown that the SHI is a valid and reliable measurement of sleep quality across these three areas and a total scale (DeSantis et al., 2019; Hale, & Buysse, 2020; Allen, 2018).

Sleep Hygiene—Sleep behavior scores across sleep status

In addition to SHI scores, information on sleep hygiene behaviors will also be measured through the Sleep Hygiene Questionnaire (Gellis & Lichstein, 2009). This measure assesses for behaviors and patterns known to detract from the quality of sleep (see Appendix 3.). The Sleep Hygiene Questionnaire has been shown to be a reliable and valid measure of sleep promoting/detracting behaviors that are correlated with physiological sleep measures (Lanaj et al., 2014), improvement of sleep quality (Hahn et al., 2011), and association of poor sleep

outcomes (Barnes, 2012).

PROMIS Emotional Distress—Anxiety and Depression— Short Forms

The adult versions of these measures developed by Pilkonis and colleagues (2011) from the PROMIS Health Organization (PHO) and PROMIS Cooperative Group will be used to assess current emotional distress. Items include questions about current negative emotional states (such as fearful, uneasy, worthless, helpless) rated on a Likert scale (from never to always) during the past 7 days (see Appendix 4.). This scale has been widely used for research and proven to be reliable and valid (Maples et al., 2014; Amtmann et al., 2014).

Data Analysis

Data analysis was conducted using the Spearman's rho from IBM SPSS Statistics Version 26, where ACE factor scores and sleep factor scores were compared for correlation and significance, as well as distress items were compared with both ACEs and sleep items. Additionally, a two-way between subjects ANOVA analysis was conducted to evaluate simultaneous effects of ACEs and distress symptoms on the sleep health measure. It is hypothesized that high distress measures (PROMIS Anxiety and PROMIS Depression) with higher scores will significantly lead to lower scores on the sleep measure (SHI) and the combination of childhood trauma and current distress will be specifically associated with poorer sleep. The current study has manipulated distress measures (low versus high) and measured participants' sleep health scores on the SHI, where higher values indicated better sleep health.

Results

Direct associations between ACEs and Sleep Health

Results of the data analyses (Table 1) indicated that Child Maltreatment items from the ACE measure were significantly and negatively associated with Sleep Duration, Sleep Quality, symptoms of Sleep Disorder and as well as the Total Sleep Health (for all scales of the SHI®, higher scores indicate better sleep or fewer sleep problems). A higher level of Family Dysfunction from the ACE measure was also significantly and negatively associated with poorer rated Sleep Duration, Sleep Quality, Sleep Disorder and as well as the Total Sleep Health. Additionally, after comparing SHI scores with the 7 New ACE Items, results indicated that a higher level of 7 New ACE Items were significantly associated with poorer rated Sleep Duration, Sleep Quality, the Total Sleep Health, but not significantly associated with symptoms of Sleep Disorder. Finally, the higher level of 17 ACE Items Total was significantly associated with poorer rated Sleep Duration, Sleep Quality, Sleep Disorder and the Total Sleep Health. Taken together, these results indicate robust associations between adverse childhood experiences and sleep health.

Table 1. Relationships (Spearman rho) Between Adverse Childhood Events and Sleep Health Index® Scores (N=821)

	Sleep Duration	Sleep Quality	Sleep Disorder	Total
ACE Child Maltreatment	-.110 **	-.208 **	-.153 **	-.228 **
ACE Family Dysfunction	-.099 **	-.254 **	-.121 **	-.240 **
Total ACE	-.129 **	-.286 **	-.168 **	-.290 **
7 New ACE Items	-.105 **	-.246 **	-.059	-.230**
17 ACE Items Total	-.130 **	-.301 **	-.143 **	-.296 **

** p < .01

Table 2 presents correlational results of the association between ACE scores and the six factors of the Sleep Hygiene Questionnaire. ACEs' scores were significantly and positively correlated with poorer Sleep Scheduling, use of Sleep-Disrupting Products, Arousing Activities Near Bed, Bed Activities other than Sleep, Environmental Conditions, and the Total Sleep Hygiene Score.

Additionally, results of Spearman rho analyses have indicated that the 7 New ACE Items were associated with sleep hygiene factors of Arousing Activities Near Bed, Bed Activities other than Sleep, Environmental Conditions, and the Total Sleep Hygiene Score. Also, the Total 17 item ACE Score was associated with the SHQ factors of use of Sleep-Disrupting Products, Arousing Activities Near Bed, Bed Activities other than Sleep, Environmental Conditions, and the Total Sleep Hygiene Score. Taken together, these results suggest consistent associations between adverse childhood events and current behaviors which are known to interfere with good quality sleep.

Table 2. Relationships (Spearman rho) Between Adverse Childhood Events and Sleep Hygiene Scores (N=821).

	Child Maltreatment	Family Dysfunction	ACE Total	7 New ACE Items	17 ACE Items Total
Sleep scheduling	.058	.032	.075*	-.003	.055
Sleep-disrupting products	.106**	.103**	.122**	.055	.107**
Arousing activities near bed	.217**	.158**	.220**	.165**	.223*
Bed activities other than sleep	.057	.090**	.079*	.059	.080*
Environmental conditions	.153**	.139**	.173**	.153**	.175**

Total sleep hygiene	.199**		.177**		.219**	.140**	.208**

* p<.05, ** p<.005

Emotional Distress and Sleep Health

Results of Spearman rho correlations indicated that both sleep health and ACEs are significantly associated with emotional distress symptoms (e.g., anxiety and depression) (see Table 3). To be specific, sleep health measured by SHI and Sleep Hygiene have shown to be associated with Distress Symptoms in a negative direction. Also, Distress Symptoms have shown to be associated with ACEs (both the conventional and new ACEs items) in a positive direction.

Table 3. Relationships (Spearman rho) Between Emotional Distress symptoms and Sleep Health Index® Scores, Adverse Childhood Events, and Sleep Hygiene Scores (N=821).

	Anxiety	Depression	Total Distress
Sleep Duration	-.109**	-.131**	-.126**
Sleep Quality	-.469**	-.464**	-.500**
Sleep Disorder	-.183**	-.189**	-.194**
Sleep Total	-.390**	-.414**	-.428**
ACE Child Maltreatment	.197**	.261**	.243**
ACE Family Dysfunction	.218**	.203**	.222**
Total ACE	.246**	.266**	.270**
7 New ACE Items	.193**	.228**	.225**
17 ACE Items Total	.251**	.284**	.283**
Sleep Scheduling	.123**	.105**	.118**
Sleep-Disrupting Products	.135**	.124**	.142**
Arousing Activities near Bed	.387**	.371**	.405**
Bed Activities other than Sleep	.305**	.286**	.315**
Environmental	.219**	.221*	.235**

| Conditions				
Total Sleep Hygiene	Sleep	.386**	.367**	.402**

** p<.005 * p<,05

Additive effect between ACEs, distress and sleep

Additionally, a two-way between subjects ANOVA analysis was used to investigate the hypothesis that the accumulation of distress symptoms and ACEs is affecting sleep health in a greater extend. Results of the two-way ANOVA analysis suggested that there were significant main effects of items of ACEs, $F(3, 777) = 9.79$, $p < .001$, and levels of distress, $F(3, 777) = 34.26$, $p < .001$. Although the statistical test of interaction was not significant $F(9, 777) = 1.359$, $p = .203$, as Figure 1. makes clear, the current result did reveal a combinatory effect where the poorest sleep is seen for individuals who have experienced both higher levels of ACEs and have higher current distress.

Figure 1. Effects of ACEs, Distress Symptoms, on Sleep Health.
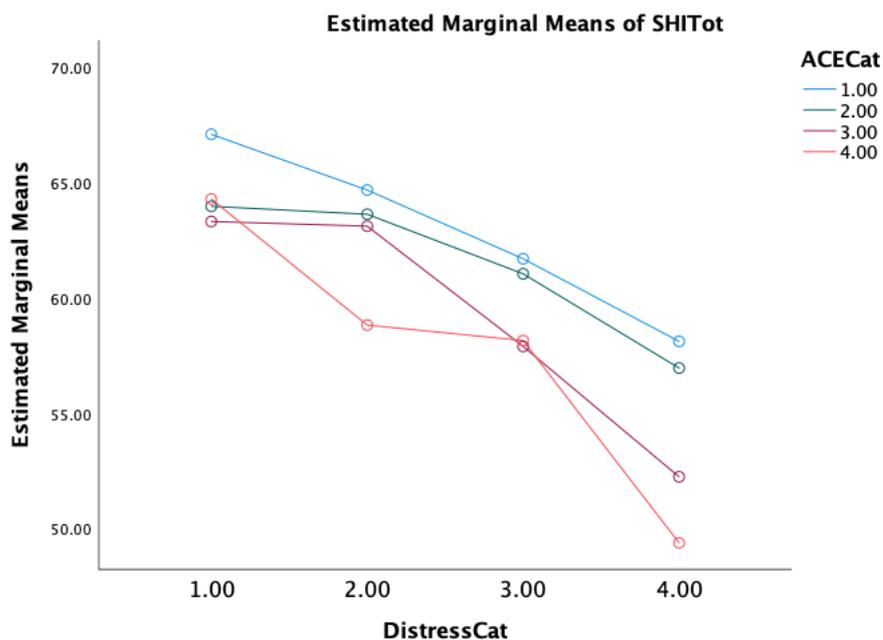
Follow-up tests were used to examine between-group differences. First of all, results of

Scheffe's post hoc test revealed that the sleep health measured by SHI scores was statistically

significantly lower after reporting the 3-4 ACEs items (M = 58.79, SD = 11.01, p < .001), and

more than 4 ACEs items (M = 55.70, SD = 11.53, p < .001) items compared to the no ACEs

items (M = 63.98, SD = 8.78). There was no statistically significant difference between the

no ACEs and 1-2 ACEs items (M = 61.32, SD = 8.9, p = .078), and no statistically significant

difference between the 1-2 ACEs and 3-4 ACEs (p = .081). Secondly, results of Scheffe's

post hoc test revealed that the sleep health measured by SHI scores was statistically

significantly lower after reporting the distress levels of median level of distress (M = 59.29,

SD = 9.03, p < .001), and severe level of distress (M = 52. 64, SD = 12. 02, p < .001)

compare to no distress level (M= 64.90, SD = 8.24). No statistically significant difference

between the no distress level and mild distress level (M = 62.70, SD = 9.10, p = .078), and no

significant difference between mild distress and median levels of distress.

Discussion

Association between ACEs and SHI

Based on the results of comparing ACEs' items and SHI scores, there is a significant

negative correlation between the present sleep health and ACEs (e.g., positive correlation

between ACEs and problematic sleep consequences) that happened in childhood among

young adults with an age range of 18-25 years old. This suggests that adults who with a

broader variety of ACEs are significantly more likely to experience sleep problems. Similar

relationship between current sleep hygiene behaviors and ACE experiences has been

observed: adults who reported a broader range of adverse experiences in childhood report

more behaviors known to interfere with positive sleep such as arousing activities near bed. These results contribute to the clear picture that broad ACE experiences are associated with poorer health outcomes across the lifespan, and are especially important since sleep has been marked as a significant component to maintain both physical and mental health.

What results from Spearman's rho have indicated is that each category under the SHI measure has shown to be significantly associated with each category under the ACEs measure. In other words, both the child maltreatment category and the family dysfunction category from ACEs measures are contributing to each broad sleep categories (e.g., sleep quality, sleep disorder, and sleep duration) from the SHI. Compare to results from existing research, the current result has confirmed and contributed the identical trend which suggest that past ACEs can impair sleep health among young adults. To be specific, what results have found is that items from Family Dysfunction of ACEs have a larger effect size with impaired total sleep health than items from Child Maltreatment subscale (although both make a statistically significant contribution to the prediction of sleep health).

Thus, the first hypothesis which suggests that a significant and negative association between items (e.g., items of the Child Maltreatment, Family Dysfunction, and the total score of ACEs) from the ACEs scale and all items from the Sleep Health Index® (e.g., items of the Sleep Duration, Sleep Quality, Sleep Disorder, and the total score of SHI) has been supported by results.

Association between ACE and Sleep Hygiene

As an additional evidence of indicating ACEs were impacting present sleep other than the comparison between ACEs and SHI scores, results from current study's investigation

between ACEs and sleep hygiene items have also shown a series of significant results on poor sleep behaviors associated with early ACEs. Although not all of the specific sleep hygiene items have shown to be significant due to ACEs, but the total ACEs score (ACE Total from Table 6) is clearly predictive of the overall sleep hygiene score (Sleep Hygiene Total from Table 6). This result has indicated that young adults with past ACEs are significantly more likely to develop behaviors associated with poor sleep, such as performing aroused actives near bed, and attempting to sleep in environments not conducive to good sleep.

Thus, the result between the sleep hygiene and ACEs has indicated that sleep hygiene items can be another mediator to mediate the relationship between ACEs and the overall sleep health other than emotional distress symptoms. In other word, the mechanism of how ACEs impact the total sleep health can be explained by ACEs have caused negative sleep behaviors, and resulted in negative sleep consequences. (See more discussion on the future direction section)

Additive effect between ACEs, distress symptoms, and sleep

Beyond documenting the relationship between ACEs and later sleep health, it is important that the current study to explore possible mechanisms of how these results are created and maintained. Given that mechanisms of how early ACEs can impair later sleep health and the fact that distress symptoms are serving as a risk factor of affecting sleep, the current study has hypothesized that participants who reported higher levels of distress on current emotional distress measures would significantly lead to a lower score on the sleep measure (SHI) and the combination of childhood trauma and current distress will be specifically associated with poorer sleep. However, after running an interaction effect

analysis through a two-way ANOVA, results suggested that there is no interaction between effects of the ACEs and distress levels on the total score of sleep health on the SHI measure. Which suggested that neither do participants' distress levels nor ACEs serving as moderators over their relationships with sleep health. Although, results of main effects from the ANOVA analysis did reveal that participants who reported more ACEs items and higher levels of distress levels were significantly reporting lower scores on the SHI measure. In other word, both factors (e.g., ACEs and distress) are sharing a similar effect on participants' sleep health, and such distress levels could be contributed to by past ACEs through either physiological (Herzog & Schmahl, 2018) or psychological (Cabrera et al., 2007) pathways. There is also considerable evidence that internalizing symptoms are associated with sleep problems.

Even though the ANOVA analysis has revealed an insignificant interaction effect between ACEs and distress levels, but both significant main effects have partly confirmed the second hypothesis of the current study. Based on significant main effects on both ACEs and distress levels over current sleep health among participants, Current results have suggested that there is a causal relationship between ACEs, distress, and sleep. This important finding opens a door to possible interventions. Emerging adults who have been exposed to early trauma may experience improvement when their anxiety and depression are alleviated via one of various efficacious interventions.

Implications

Overall, current results are consistent with other research based on samples of other ages, namely that there are robust associations between adverse childhood experiences and quality of sleep later in life. It was striking that ACEs were associated with all three

characteristics assessed by the Sleep Health Index®, specifically sleep duration, sleep quality, and symptoms of sleep disorder. Secondly, results from the additive analysis of combining ACEs and distress symptoms to predict impaired sleep have suggested a mechanism by which these effects might be transmitted into current experiences. Thus, current results have brought new insight into the complex relationships between ACEs, emotional distress, and various aspects of sleep health. These results set the stage for evaluating whether we can improve sleep in this vulnerable population via interventions to address distress levels and/or sleep directly (e.g., Cognitive Behavioral Therapy for Insomnia (CBT-I)). Such interventions could lead to various other benefits for emerging adults, including better health, reduced internalizing distress, and improved learning, memory, and academic performance.

Limitations

Limitations of this study are needed to be pointed out. Since this study is based on the data analysis of an online survey, the nature of the survey itself presented specific limitations. First of all, given that the survey was conducted through the internet, and the answers were self-reported by participants, the credibility of some answers could be concerned. Secondly, the survey was quite lengthy, which it took an average from 35 to 45 minutes for a participant to complete it. A long and heavy worded survey might lead to fatigue and frustration among participants, and less careful attention to their responses, led to concerns on the validity of the data. Thirdly, the validity of answers that participants have provided should be payed attention to, in other word, the retrospective bias. Notably, the nature of ACEs is a huge barrier to the data validation because ACEs are happened in the past, which means the creditability of the data about ACEs is solely relying on participants comfortableness on

reporting.

The attitude of participants when they were going through the survey should also been payed attention to. Since significant participants have been pointed out with different levels of mental health problem form minor to severe, their mental health states could affect on how they were answering questions. For instance, a participant with depression might willing to admit with his/her mental health problem, but not the past ACEs which are sources of his/her mental problem. In other word, it is quite difficult for participants when they have to recall unbearable memories when they were participating this study, and this could significantly interfere the validity of the data.

Most importantly, the setting of variables (ACEs and distress) in the two-way ANOVA has generated some notable limitations as well. First of all, the current study categorized participants via numbers instead of the severity of ACEs items. In other word, the effects of ACEs items are different from one to another, and could bring different impacts toward sleep depending on the nature of specific ACEs items, and this is mostly likely the reason that the interaction effect between ACEs and distress levels is insignifint. For example, ACEs items used in the current study included from finical problem to physical and sexual abuse that participants may experience. Secondly, the emotional distress such as depression can not only be generated by ACEs, but also can be generated by impaired sleep health (Tsuno et al., 2005). Which causes a greater complexity to identify a participant's emotional distress is caused by whether the past ACEs or the present impaired sleep health. There is an alternative possibility that emotional distress serves a byproduct that is caused by impaired sleep. Thus, given the simplicity of the current model, a more sophisticated and psychiatric related

approach would aid such identification of the additive effect between ACEs, emotional distress and impaired sleep.

<u>Possible modifications and research directions in the future</u>

First of all, the form of data collection of a similar study in future could consider the form of face-to-face interview with participants. Although this type of form of collecting data is inefficient and requires more effort from researchers, but considering the atmosphere of an interview could make participants less uncomfortable and willing to discuss their early ACEs since talking to other people could ease the psychological burden.

Secondly, as the limitation has mentioned, given that the current interaction analysis revealed a non-significant result on the hypothesized additive effect between ACEs, distress symptoms, and sleep, a more sophisticated model of researching such relationship is important, because the complicative natures of each factors make them difficult to connect and generate a certain directional causality (e.g., differences on the severity between each ACEs items). To be specific, in future studies regarding the similar topic, ACEs items could be categorized by their severities over participants' health instead of categorizing participants by numbers of ACEs items they have reported.

Thirdly, given that ACEs could impair sleep through emotional distress level, and impaired sleep could generate distress as well, the relationship between emotional distress and impaired sleep could ultimately fall into a looping cycle (e.g., distress has caused sleep problems, and such problems result in more distress). Thus, a more sophisticated model could explain the causality in a better sense, such as a mediation or a moderation model of analysis. As the discussion over the relationship between ACEs and sleep hygiene items has

mentioned, instead of applying the sleep hygiene measure to conclude the overall sleep heath, sleep hygiene items or sleep behaviors can be a mediator or a moderator to explain the causality between ACEs and the total sleep. Thus, future research could expand the current study by considering sleep hygiene items as a mediating or moderating pathway to outline the casual relationship between past ACEs and present sleep to a greater extension.

Since the current study has confirmed the statement which suggests that ACEs are negatively impacting sleep health, as well as distress symptoms are causing negative consequences toward sleep health among young adults, more interventions about how adults with ACEs and suffer from impaired sleep can recover from it or engage improvement toward healthy sleep can be discovered in the future. Interventions such as psychological intervenes on emotional distress with the aim of improving sleep problems among young adults are feasible.

An additional topic can be researched on in the future is the growing environment of children. According to the current results of the study, results from the correlation of the Family Dysfunction and the total sleep health have suggested that a normal and functional household environment is more significantly than the maltreatments a child has received themselves. Thus, future studies regarding pediatric health could focusing more on children's families and household environment, especially the mental health of parents, which is contributing more damages to children than any other ACEs items according to current results.

Conclusion

Sleep health among young adults appears to be another risk factor of the overall health

which can be negatively affected by the breadth of ACEs. Moreover, emotional distress symptoms such as depression have significantly impacted the total sleep health as well. Which suggested that emotional distress could be an explanation on how and why do ACEs impact sleep. Problematic sleep and poor sleep hygiene have the potential to further magnify other physical and behavioral health outcomes known to be affected by adversity such as poor academic and activity performance. ACEs resulted impaired sleep should be an important area for intervention in this high-risk population since sleep health is the fundamental indication toward good health state and it is theoretically treatable through therapeutic approaches.

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Appendix 1

ACEs questionnaire.
All of the following questions refer to the time period before you were 18 years of age. Now looking back before you were 18 years of age...

	Never	Rarely	Sometimes	Often	Very often
As a child, how often did you experience serious financial problems?					
How often were you hungry because your family could not afford food?					
How often were you homeless when you were growing up? (Note: This means having to stay somewhere like a transitional housing program, a shelter, a hotel/motel paid by voucher, someone else's home, a car or other vehicle, an abandoned building, anywhere outside, or anywhere else not meant for people to live.					
How often did a parent or adult in your home ever swear at you, insult you, or put you down?					
How often were you bullied or severely teased by other children or adolescents? (Note: This refers to bullying or teasing by children or adolescents of any age. They could have been older than you, younger then you, or the same age. It does not include experiences with adults or with siblings).					
Before age 18, how often was there an adult in your household who tried hard to make sure your basic needs were met? By "basic needs" we mean food, shelter, clothing, and medical care. (Note: This could be any					

adult in the household, not just a parent)					
How often was there an adult in your household who made you feel safe and protected?					
Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking.					
How often did your parents or adults in your home ever slap, hit, beat, kick, or physically hurt each other?					
How often did an adult, or anyone at least 5 years older than you, touch you sexually, try to make you touch them sexually, or force you to have sex?					
Did you live with anyone who was depressed, mentally ill, or suicidal?					
Did you live with anyone who was a problem drinker or alcoholic?					
Did you live with anyone who used illegal street drugs or who abused prescription medications?					
Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?					
Were you parents separated or divorced?					
Was either of you parents absent from your life for a long period of time? Do not include absence due to death of parent.					
Before age 18, did you experience the death of a parent, caregiver, or sibling?					
Before age 18, were you ever					

the victim of a violent crime? This refers to any violent act that was perpetrated by someone other than a parent or household family member.				

Appendix 2

Sleep Health Index®.

Survey questions	Answer types
In general, how would you rate your sleep quality? Would you say it's excellent, very good, good, only fair, or poor?	Choose 1 out of 5 categories from "Poor" to "Excellent."
Thinking about just the past 7 days, what time did you most often go to bed on workdays? Please answer about weekdays if you did not work last week.	Choose 1 answer from "Before 8:00 pm" to "After 3:00 am."
What about on non-work days or weekends – what time did you most often go to bed on those days?	
What time did you most often wake up for the day on work days or weekdays?	Choose 1 answer from "Before 5:00 am" to "After 1:00 pm."
What about on non-work days or weekends – what time did you most often wake up for the day on those days?	
During the past 7 days, how many days did you wake up feeling well-rested, if any?	Choose 1 answer from "0" to "7."
How many nights did you have trouble falling asleep?	
And how many nights did you have trouble staying asleep?	
Still thinking about the past 7 days, how many days did poor or insufficient sleep significantly impact your daily activities, like your work performance, socializing, exercising, or other typical activities?	
How many days did you fall asleep without intending to, such as dozing off in front of the TV or in any other situation?	
How many nights did you take over-the-counter or prescription medication to	

help you sleep?	
Have you ever been told by a doctor that you have a sleep disorder, such as insomnia or sleep apnea, or not?	Answer either "Yes" or "No."
Have you ever discussed any sleep problems you were having with a doctor or medical professional, or has this not come up?	
How many hours of sleep do you need per day to be well-rested and feel your best?	Choose 1 answer from "3 hours or less" to "12 hours or before."

Appendix 3.

Sleep Hygiene questionnaires

Questions	Answers choices including 8 levels from 0 to 7.
1. Napped during the day.	
2. Woke up at approximately the same time.	
3. Went to bed at approximately the same time.	
4. Drank caffeinated beverages such as coffee or tea or soft drinks between 5 to 10 hours before bedtime.	
5. Drank caffeinated beverages such as coffee or tea or soft drinks within 5 hours of bedtime.	
6. Drank alcohol within three hours of bedtime.	
7. Smoked a cigarette or chewed tobacco within 2 hours of bedtime or in the middle of the night.	
8. Engaged in exciting or emotionally upsetting activities near bedtime.	
9. Performed activities demanding high levels of concentration near bedtime.	
10. Exercised within 4 hours of bedtime.	
11. Worried, planned, or thought about important matters at bedtime.	
12. Read in bed	
13. Watched television in bed	
14. Lounged around in bed	
15. Worried, planned, or thought about	

important matters in bed.	
16. Slept on an uncomfortable mattress.	
17. Slept in a room with an uncomfortable nighttime temperature.	
18. Slept in a noisy environment.	
19. Slept in a room that was too bright.	

Appendix 4.

PROMIS Emotional Distress—Anxiety and Depression— Short Form

	Excellent	Very Good	Good	Fair	Poor
In general, would you say your health is:					
In general, would you say your quality of life is:					
In general, how would you rate your physical health?					
In general, how would you rate your mental health, including your mood and your ability to think?					
In general, how would you rate your satisfaction with your social activities and relationships?					
In general, please rate how well you					

carry out your usual social activities and roles (this includes activities at home, at work, and in your community, and responsibilities as a parent, child, spouse, employee, friend, etc.).					