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Are Adverse Childhood Experiences Associated with Health Behaviors Among College Students: Emotion Regulation as a Potential Moderator

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Abstract

In this study, we sought to examine the relations among adverse childhood experiences (ACEs), physical activity (PA), sleep quality, and emotion regulation in college students. ACEs have been proven to have a dose-response relation with adverse health outcomes in adulthood, including heart disease, cancer, lung disease, liver disease, poor mental health, and risky health behaviors (Felitti et al., 1998; Merrick et al., 2016; Zhang et al., 2020). ACEs have also been previously associated with poor sleep quality and emotion dysregulation (Kajeepeta, Gelaye, Jackson, & Williams, 2015; Kim & Cicchetti, 2010). Given these findings, we sought to examine how ACE exposure contributes to physical activity and sleep quality in undergraduate students. We also sought to examine emotion regulation as a possible moderator. Utilizing cross-sectional data from a survey of 395 undergraduate students, we found significant correlations between ACEs and sleep problems, difficulties in emotion regulation (DER) and sleep problems, and ACEs and DER. ACEs and DER were significant predictors of sleep problems, but there was no evidence of moderation. None of the relations to PA that were examined were significant. These findings contribute to the body of literature surrounding ACEs, how they contribute to health outcomes, and how to combat the adverse health outcomes. Further studies must be conducted to confirm the relations found here and examine the effectiveness of interventions using knowledge of DER and sleep problems to improve health outcomes in adults with a history of ACE exposure.

Introduction

Adverse childhood experiences (ACEs) have been identified by previous studies as having a detrimental effect on health outcomes in adults. Studies have found a dose-response relation between ACEs and heart disease, cancer, lung disease, liver disease, poor mental health, and risky health behaviors (Felitti et al., 1998; Merrick et al., 2016; Zhang et al., 2020). The mechanisms by which ACEs affect these health outcomes are biological, psychological, and behavioral in nature. Emotion regulation has also been found to be affected by ACEs, and emotion regulation can also affect health behaviors (Kim & Cicchetti, 2010). College students have been studied in recent years as a distinct population, a young population experiencing many changes. This time period is when many ideas and behaviors are solidified for adulthood, making this time ideal for interventions (Arnett, 2000). College students have also been found to not meet physical activity and sleep guidelines in general (Taylor & Bramoweth, 2010). Therefore, the current study seeks to examine the link between ACEs and the health-related behaviors of physical activity and sleep among college students. In addition, emotion regulation will be examined as a potential moderator of this link.

ACEs

The concept of adverse childhood experiences (ACEs) and how they affect health in adults first came about with a study conducted by Felitti and colleagues in 1998. In this study, Felitti et al. (1998) defined ACEs as experiences, including physical, emotional, and sexual abuse, and exposure to household dysfunction, substance abuse, and family member mental illness, that cause moderate to severe stress in children before the age of 18. The study examined 13,494 Kaiser Health plan members who visited the Health Appraisal Clinic during different periods of time between 1995 and 1997. Through multiple surveys, this study associated ACEs with different health outcomes. Of those surveyed, 52% of respondents reported exposure to at least one ACE (Felitti et al., 1998). The researchers also found a strong dose-response relation between ACEs and "disease conditions including ischemic heart disease, cancer, chronic lung disease, skeletal fractures, and liver disease, as well as poor self-rated health" (Felitti et al., 1998, p. 251). In other studies, these findings have been replicated and extended. In a recent study, Giano et al. (2020) found that 57.8% of individuals from 2009 to 2017 reported exposure to at least one ACE. This suggests that ACE exposure is only increasing, despite what we now know about their adverse health effects.

The effects of ACE exposure on mental health have also been widely studied. ACE exposure also exhibits a dose-response relation with poorer mental health (Merrick et al., 2016). Exposure to at least one ACE is strongly correlated with anxiety and depression (Karatekin, 2017). One study found that two thirds of suicide attempts can be traced back to having exposure to at least one ACE (Karatekin, 2017). ACEs are additionally correlated with increased health risk behaviors (Windle et al., 2018; Zhang et al., 2020). These behaviors include smoking, binge drinking, suicidal behavior, risky sexual behavior, and illicit drug use (Zhang et al., 2020). The effect that ACEs have on adult health outcomes can be explained through biological, behavioral, and psychological models.

Biological Model

One of the models for how ACEs affect health outcomes in adults is the biological model. The basics of this model explain how ACE exposure changes bodily processes and composition to lead to the negative health outcomes that have been associated with ACEs. First, it is crucial to understand the body's stress response system. One of the body's main stress response pathways is through the hypothalamic-pituitary-adrenal (HPA) axis (Stephens & Wand, 2012). In normal response to a perceived stressor, the hypothalamus is triggered to release corticotropin-releasing factor (CRF) and arginine vasopressin (AVP) which travels down blood vessels to reach the anterior pituitary gland (Stephens & Wand, 2012). Both of these hormones work to stimulate the secretion of adrenocorticotropic hormone (ACTH) in the anterior pituitary. ACTH in the bloodstream then stimulates the production and release of glucocorticoids, with the main one being cortisol, by the adrenal gland that sits on the kidneys (Stephens & Wand, 2012). This system is regulated by a negative feedback loop to maintain homeostatic balance. When the body is exposed to too much cortisol over longer periods of time, it feels the wear and tear and is more likely to develop certain neurological and metabolic disorders (Nemeroff, 2016; Stephens & Wand, 2012). Trauma during crucial developmental periods leads to dysregulation of the body's stress response. Increased levels of cortisol also depress immune response (Nemeroff, 2016). Induced by ACE exposure, this prolonged stress response accounts for one of the mechanisms that could explain how ACEs lead to such adverse health outcomes.

Behavioral Model

Another model for how ACEs affect health outcomes is through changes in behavior. The link between higher health risk behaviors and ACEs has been established, including smoking, binge drinking, suicidal behavior, risky sexual behavior, and illicit drug use (Zhang et al., 2020). Research suggests that the engagement in health risk behaviors is used as a means to cope or alleviate the psychological symptoms and turmoil felt in individuals with a history of exposure to ACEs (Pomerlou & Pomerlou, 1987). Many of these health-risk behaviors alleviate the psychological symptoms associated with ACEs; for instance, smoking increases mood or alcohol decreases anxiety (Pomerlou & Pomerlou, 1987). Many of these coping behaviors are strongly associated with adverse health outcomes, which is why these behaviors have been identified as a possible mechanism through which ACEs affect health outcomes.

However, there has been research to show that ACEs still affect health outcomes even without the presence of these health-risk coping behaviors. In one study, the link between ACE scores and the risk of coronary artery disease remained significant even after controlling for smoking habits (Dong et al., 2004). Another study found a significant link between ACEs and risk of liver disease, even after controlling for alcohol abuse and risky sexual behaviors (Dong et al., 2003). Chartier, Walker and Nalmark (2009) found that health-risk behaviors, specifically obesity, smoking and alcohol abuse, were partial mediators between childhood abuse and health outcomes; they had a clear effect on the strength of the relation, but they were not the only link. While the behavioral model still posits a valid mechanism for the effects of ACEs on health outcomes, this is not the only mechanism at work.

Psychological Model

Increases in ACE exposure make a person more likely to develop mental health problems. These mental health problems include anxiety, depression, substance abuse, post-traumatic stress disorder (PTSD) and affective dysregulation (Karatekin, 2017). ACE scores show a dose-response relation with poorer mental health outcomes in adulthood (Merrick et al., 2016). One study found mental health problems to be a strong mediator between ACEs and physical health outcomes (Chartier et al., 2009). Mental health problems can lead to physical health issues through many different mechanisms which include “decreased adherence to treatment recommendations, suppressed immune system functioning, and increased autonomic nervous system or hypothalamic pituitary adrenal axis activity” (Chartier et al., 2009, p. 851). Dong and colleagues (2004) found that participants reporting depressed affect were 2.1 times more likely to have ischemic heart disease. Another study found that worse PTSD symptoms were associated with an increased risk of gastrointestinal disorders, cardiovascular disease, respiratory issues, and chronic pain disorders (Sareen et al., 2007). Psychological symptoms present one of the clear mechanisms that may explain or impact the relation between ACEs and health outcomes. Emotion regulation is one important psychological factor that may impact this relation.

Emotion Regulation as a Potential Moderator of the Association between ACESs and Health-Related Behaviors

Emotion regulation is extremely important in maintaining one's psychological well-being. Emotion regulation is defined as "the ability to modulate one's emotional arousal such that an optimal level of engagement with the environment is fostered" (Kim & Cicchetti, 2010, p. 2). Deficiencies in emotion regulation have been found to be associated with ACE exposure in multiple studies (Cameron, Carroll & Hamilton, 2018; Kim & Cicchetti, 2010). Certain ACEs have differential effects on emotion regulation according to the findings from Kim and Cicchetti (2010). They found that exposure to neglect, physical and/or sexual abuse was strongly associated with increased emotion dysregulation, while emotional abuse alone had much less of an association with dysregulation in the 400 children included in the study. Because they studied these factors in children, who had very recently experienced or were still experiencing this adverse exposure, the effects of emotional abuse may not have been evident yet in their emotion regulation. In a different study of 500 adults, higher ACE exposure was found to be strongly associated with poorer emotion regulation skills (Cameron et al., 2018).

Emotion regulation skills have also been found to be associated with certain lifestyle choices and behaviors. One study conducted by Isasi, Ostrovsky and Wills (2013) found a strong association between better emotion regulation and healthier lifestyle choices. The cross-sectional study assessed nutritional choices and physical activity in adolescents and related them with emotion regulation skills. The findings showed a positive association of emotion regulation skills with higher intake of fruits and vegetables and higher rates of physical activity. They also show the association of worse emotion regulation with higher junk food intake and increased sedentary behavior. Another study conducted by Ready, Marquez and Akerstedt (2008) found that poor sleep hygiene is also associated with decreased emotion regulation skills. The study also provides evidence that emotion dysregulation has a stronger negative effect on sleep and physical activity among younger adults than older adults. Because of the associations found between ACEs and emotion regulation and also between emotion regulation and poor physical activity, nutrition, and sleep, it is important to consider how emotion regulation can affect the relation between ACEs and these health-related behaviors.

College Students

College students account for a unique population that has not been studied much in relation to ACEs. In one study, Anders, Frazier and Shallcross (2012) present the idea that the relation between physical health and trauma exposure could be different in undergraduate populations because they tend to be younger and healthier. This link in undergraduate populations has also seldom been studied despite the clearly established link in adults. College students in their state of emerging adulthood present unique qualities that set them apart from general adult samples. In his paper, Arnett (2000) makes the argument for distinguishing emerging adulthood (18-25) as a distinctive period of development. It marks the period between adolescence and actual adulthood. One study found that the majority of respondents aged 18-25 when asked “Do you feel that you have reached adulthood?” responded with “yes and no” rather than choosing one option or the other (Arnett, 2000, p. 472). This finding highlights the distinction of emerging adulthood as a sort of buffer period before full adulthood. Studies also suggest that the period of emerging adulthood marks a period of exploration and discovery that leads to more enduring life choices (Arnett, 2000). Because of this period of exploration, emerging adults, which includes college students, present a malleable target for interventions to combat potential health issues in full adulthood.

College students and health-related behaviors have been extensively studied in the past. First, it is important to acknowledge the guidelines for healthy behaviors that college students should meet. Adults should reach a minimum of 150 minutes of moderate intensity activity, 75 minutes of vigorous intensity activity, or some equivalent combination each week (Downes, 2015). In studies focused on physical activity, there have been mixed results for college students. In one study, only 9.4% of college students in the sample met physical activity guidelines (Downes, 2015). Another study found that 85% of college student respondents met or exceeded physical activity guidelines (Towne et al., 2017). Even another study found that 45.7% of college student participants met aerobic exercise guidelines (Wilson & Bopp, 2021). Wilson and Bopp (2021) conducted their study with the largest sample size (n=215,976) and therefore is more representative of college students in the US. The recommended sleep for ages 18-25 is 7-9 hours per night (Taylor & Bramoweth, 2010). A recent study among college students in the US found that 51% had poor sleep quality based on the Pittsburgh Sleep Quality Index (Vargas, Flores, & Robles, 2014). The mean global PSQI score from the study was 5.9. It has been established in the literature that college students in general tend not to meet recommended sleep or physical activity guidelines, so it will be important to examine if more exposure to ACEs among this population is associated with even more difficulties in sleep and physical activity.

The Current Study

The current study will utilize cross-sectional data from a large online survey of college students across the U.S. to examine the association of ACEs with physical activity and sleep quality. This study will also examine emotion regulation as a possible moderator of this association. Findings will fill gaps in the literature about how ACEs affect college students and provide avenues for interventions in the future to target and mitigate the long-term detrimental effects of ACEs on adult health outcomes. The study will seek to answer the following specific research questions: First, are ACEs associated with the health-related behaviors of physical activity and sleep among college students? We hypothesize that higher ACE scores will be correlated with lower physical activity levels and worse sleep quality. Second, does emotion regulation moderate the relation between ACEs and these behaviors among college students? We hypothesize that emotion regulation will moderate the relation between ACEs and the target health behaviors, such that when emotion regulation is higher, the link between ACEs and the health behaviors will be less strong. In other words, emotion regulation will serve as a protective factor.

Methods

Participants

Participants in this study included 395 undergraduate students from the University of Wyoming, the University of Northern Iowa, and the University of South Carolina. Among our participants, we had 7.8% from University of Northern Iowa, 25.6% from University of Wyoming, and 66.6% from the University of South Carolina. The sample was made up of 332 females (82.8%), 63 males (15.9%), and 5 students who identified outside of the binary gender categories (1.4%). The racial and ethnic makeup of the student sample was 86.8% White, 6.3% Black, 4.6% Latinx/Hispanic, 6.3% Asian, 1% Native American, 1% Pacific Islander/Native Hawaiian, 2.5% Multiracial, and less than 1% Middle Eastern. The annual household incomes of the participants were reported as 58 (14.7%) below $50,000, 84 (21.3%) between $50,000 and $99,999, 93 (23.5%) between $100,000 and $149,999, 97 (24.5%) above $150,000, and 63 (15.9%) who did not know or preferred not to answer. The most commonly endorsed extracurricular activities were volunteering (38.2%), social fraternity or sorority (24.3%), and academic organization or honors society (22.5%), keeping in mind that students were able to endorse multiple extra-curricular activities. The majority of student participants reported their religious affiliation as Christian (62%) or none (24.8%). Other demographic variables and data is represented in Table 1.

Procedure

The undergraduate students were asked to complete an online survey using the secure platform Qualtrics. The survey took about 40 minutes to an hour to complete. The survey included a variety of different measures to assess factors including ADHD symptoms, functional impairment, procrastination, social support, alcohol use, feelings towards alcohol, and the measures described below. Students were recruited through a variety of different methods. Flyers were hung around campus and other places that students frequent. Faculty in the psychology department and professors of large courses were emailed to advertise the survey to their students. The survey was also included in the SONA psychology participant pools for students to complete. Leaders of student organizations were also emailed to advertise the survey to their members. Finally, the survey was advertised on social media pages targeting students. Students who participated in the survey were entered in a drawing to win a $100 Visa gift card. Some students were also offered research credit or extra credit in a class as applicable. All study procedures were approved by the Institutional Review Boards at the respective universities.

Measures

Adverse Childhood Experiences

To measure exposure to adverse childhood experiences, the survey utilized the original Adverse Childhood Experiences (ACE) questionnaire (Felitti et al., 1998). This is a ten-item questionnaire that asks participants about exposure to potentially traumatic events in their first 18 years of life such as abuse, divorce, and neglect. The items include questions such as “Did a parent or other adult in the household often swear at you, insult you, put you down, or humiliate you? Or act in a way that made you afraid that you might be physically hurt?” (Felitti et al., 1998). The participants marked either yes or no in response to the different situations described. A yes response corresponds to one point towards the participant’s ACE score. The total ACE score was used in the current study to represent exposure to ACEs. The ACE questionnaire has been proven as reliable and having good internal consistency with a Cronbach’s alpha coefficient of 0.88 (Murphy et al., 2013; Pinto, Correia, & Maia, 2014).

Physical Activity

The measure used for physical activity was the International Physical Activity Questionnaire short form (Craig et al., 2003). This measure assesses the amount of time spent at different levels of activity in the past week. The measure contains seven questions about the different quantities of various levels of activity. The questionnaire assesses the quantity of vigorous and moderate activity, walking, and sitting by first asking how many days the activity was performed in the last seven days and then asking how much time was spent on the activity on those days. In one study, the validity of the self-report data from the questionnaire was compared with data from accelerometers that the participants were asked to wear for seven days in order to test the validity of this measure. The study found fair to moderate agreement between the measures, with about 80% of estimates having agreement coefficients above 70% (Craig et al., 2003). With the measure tested multiple times with many different samples in the same study, the data showed an average Spearman coefficient of 0.8, indicating very good repeatability and reliability (Craig et al., 2003). For data analysis, we will be using weekly MET minutes as our measure of physical activity, using the generally accepted MET equivalent values for the different types of activity. This value was calculated by multiplying the number of days participating in physical activity by the number of minutes participated each day and the associated MET equivalent values for each activity intensity (Craig et al., 2003).

Sleep Quality

The Pittsburgh Sleep Quality Index (Buysse et al., 1989) was used to measure sleep quality in the current study. The measure begins with five open-ended questions assessing the average amount of sleep over the past month. These questions are then followed by a 10-item matrix table assessing different reasons for difficulties with sleep. The matrix asks participants how often they experienced each difficulty in the last month with ratings ranging from 0: not during the past month to 3: three or more times a week. This is then followed by another matrix that assesses drug use for help with sleep and ways that lack of sleep could affect one's life. This matrix contains three items with ratings the same as the last matrix. The last question asks participants to rate their overall sleep quality from the last month, with 0 being very good and 3 being very bad. The PSQI produces a global sleep quality score which is used in the current study to represent overall sleep quality. This measure was found to have a Cronbach's alpha coefficient of 0.8 for the global PSQI score, indicating good internal consistency. PSQI data was also correlated very highly with related constructs, supporting the measure's validity (Carpenter & Andrykowski, 1997).

Emotion Regulation

The current study used the Difficulties in Emotion Regulation Scale (Gratz & Roemer, 2004) to evaluate emotion regulation skills in participants. This measure includes a 36-item matrix with statements that participants are asked to rate how often apply to them on a scale of 1 to 5, with 1 being almost never and 5 being almost always. The matrix includes statements such as "I am attentive to my feelings" and "When I'm upset, I have difficulty controlling my behaviors." The scores on each item were averaged to give a score that will be used in the current study. The DERS has been determined to have high internal consistency, construct validity, and predictive validity, proving the measure to be psychometrically sound for use (Gratz & Roemer, 2004).

Data analysis plan

In these results, we first report descriptive findings for the measures of interest. Then, we examine the bivariate correlations among total adverse childhood experiences (ACEs) endorsed, physical activity (PA), problems with sleep, difficulties in emotion regulation (DER), biological sex, and annual household income. We then ran linear regression analyses to evaluate the effects of ACEs on PA and sleep problems separately, and then analyzing the effects of DER on PA and sleep as well. Finally, we evaluated the joint effects of ACEs and DER on PA and sleep separately through two multiple regression moderation analyses. In all regression analyses, we controlled for biological sex and annual family income as covariates. The predictor variables, ACEs and DER, were centered for the moderator analyses. IBM SPSS Statistics 27 (2020) and the Process macro by Andrew F. Hayes (2012) were used for all analyses. We used a significance level of $p<.05$ as is customary.

Results

Descriptives and Correlations

The undergraduate participants (N=395) endorsed an average of 1.6 ACEs (SD=1.98). We found that 38.5% of participants had not experienced any ACEs. Therefore, 61.5% of the participants were found to have experienced at least one ACE. This is consistent with the literature which states approximately 58% of the US population experiencing at least one ACE (Giano, Wheeler, & Hubach, 2020). The most commonly endorsed ACE reported were experiencing parental divorce with 32.4% reporting this experience. Growing up with a household member who was mentally ill, depressed, or attempted suicide had 25.3% of participants reporting this experience. The mean score on the sleep quality scale reported was 6.59 (SD=3.469). This is slightly higher than a previous study that found a mean score of 5.9 among a college student sample (Vargas et al., 2014). Only 2 of the 395 total participants reported a score of zero. Fifty-nine percent of the participants reported a score of at least 6 on the PSQI scale. Although the PSQI score scale has a maximum of 21, our population did not reach this maximum, and the highest score recorded was 18. Participants reported an average of 3847.1 (SD=3618.5) metabolic equivalent (MET) minutes per week. This is much larger than the recommended physical activity guidelines which suggests that adults achieve 500 MET minutes per week (Ghrouz et al., 2019). This study also had much higher values than a previous study that found 51% of undergraduate students to fall below 600 MET minutes per week (Ghrouz et al., 2019). In our data, only 16.6% of participants fell below 600 MET minutes per week. The data for physical activity appears to be highly skewed because of the fact that it is much larger than expected. The participants also reported an average score of 2.48 on the difficulties in emotion regulation scale (DERS) (SD=0.749) on a scale from 1 to 5. Another study of undergraduate students had a reported average of 2.43 so our findings are consistent with the literature (Tull, Barrett, McMillan, & Roemer, 2007). Seventy percent of the participants reported an average deficit in emotion regulation of greater than 2, with 30.4% obtaining an average score of 2 and below.

Table 2 displays the bivariate correlations between ACEs, physical activity, sleep problems, difficulties in emotion regulation, biological sex, and annual household income. About half of the correlations were significant. Total ACEs experienced were significantly positively correlated with sleep problems ($r = 0.263$, $p = 0.000$) and difficulties in emotion regulation ($r = 0.285$, $p = 0.000$). Total ACEs were also negatively correlated with annual household income ($r = -0.268$, $p = 0.000$). Sleep problems and difficulties in emotion regulation were significantly positively correlated ($r = 0.398$, $p = 0.000$). Physical activity was negatively correlated with biological sex ($r = -0.145$, $p = 0.006$). Because biological sex was coded with 0 as male and 1 as female, this negative correlation signifies that being male is associated with higher levels of physical activity. Annual household income was positively correlated with physical activity as well ($r = 0.122$, $p = 0.035$).

Regression Analyses

We ran six regression models to address our research questions. The first model (Table 3, Model 1) examined ACEs as a predictor of sleep problems. In the first step of this model, biological sex and household income were entered as covariates. Neither was a significant predictor of sleep problems. In the second step, ACEs was added as a predictor. In this step, ACEs were a significant predictor of sleep problems such that more ACEs were associated with higher reported sleep problems. The overall model explained 9.6% of the variance in sleep problems.

The second model (Table 3, Model 2) examined difficulties in emotion regulation as a predictor of sleep problems. In the first step, biological sex and household income were entered as covariates. Again, neither was a significant predictor of sleep problems. In the second step, difficulties in emotion regulation (DER) was added as a predictor. In this step, DER were a significant predictor of sleep problems such that increased DER were associated with higher reported sleep problems. The overall model explained 15.5% of the variance in sleep problems.

The final regression model for sleep problems (Table 3, Model 3) examined the ACEs by DER interaction. We included biological sex and household income as covariates. ACEs, DER, and the interaction between ACEs and DER were included as predictors of sleep problems. While ACEs and DER were significant predictors of sleep problems, this analysis revealed that the interaction between ACEs and DER was not significant for sleep problems. This model accounted for 19% of the total variance in problems with sleep among the participants.

Next, we ran three more regression analyses to examine physical activity. The first model (Table 4, Model 1) examined ACEs as a predictor of PA. In the first step, biological sex and household income were entered as covariates. Both were significant predictors of PA such that being male and higher annual household income were associated with higher PA. In the second step, ACEs was added as a predictor. In this step, biological sex and household income remained significant predictors of PA, but ACEs were not. This model accounted for 4% of the overall variance in PA.

In the next model (Table 4, Model 2), we examined DER as a predictor of PA. In the first step, biological sex and household income were entered as covariates. Both were significant predictors of PA such that being male and higher annual household income were associated with higher PA. In the second step, DER was added as a predictor. In this step, biological sex and household income remained significant predictors of PA, but DER were not. This model accounted for 4% of the overall variance in PA.

In the final PA model (Table 4, Model 3), we examined the ACEs by DER interaction. We included biological sex and household income as covariates. ACEs, DER, and the interaction between ACEs and DER were included as predictors of PA. Although biological sex and household income were significant predictors of PA, the analysis revealed that the interaction between ACEs and DER was not significant for PA. This model accounted for 4.6% of the overall variance in PA.

Discussion

This study examined the association of adverse childhood experiences (ACEs) with physical activity (PA) and sleep quality. We also sought to determine whether emotion regulation moderates these relations. The findings on this topic add to the body of existing literature on how ACEs can affect health in adulthood. With the previously demonstrated detrimental effects of ACEs on health outcomes, we aimed to find new avenues to intervene and help lessen the risk of poor health outcomes that goes along with ACE exposure. The current study aimed to do this by examining the relations among emotion regulation, ACEs, sleep, and physical activity.

Research Questions

Our first research question examined whether ACEs were associated with the health-related behaviors of PA and sleep among college students. We found that ACEs were significantly correlated with sleep problems. We also found that ACEs were a significant predictor of sleep problems in college students when controlling for biological sex and household income. This is consistent with the literature (Kajeepeta et al., 2015). A potential mechanism for this relation is the theory that childhood trauma can cause circadian dysregulation, which thereby disrupts sleep (Kajeepeta et al., 2015). Another proposed mechanism is the link between childhood maltreatment and increased neuron activity. This increased electrical activity is also exhibited in patients with sleep disorders (Kajeepeta et al., 2015). One other proposed mechanism has a purely social basis. The mechanism proposes that children with exposure to ACEs have increased household chaos and disruption and therefore never learn proper sleep hygiene (Kajeepeta et al., 2015). The association of ACEs with sleep problems is relevant to clinical practice because identification of ACE exposure can be used as an indicator of risk for sleep problems. Being aware of this risk and treating sleep problems early can lead to better health outcomes for adults who have experienced ACEs. The literature shows a clear link between problems with sleep, like short duration, and adverse health outcomes, including mortality, diabetes, hypertension, coronary artery disease, and others (Itani, Jike, Watanabe, & Kaneita, 2017). This link suggests that sleep problems could be another mechanism that adds to the link between ACEs and adverse health outcomes.

There was not a significant relation between ACEs and PA. There is little to no existing research on ACEs and PA. The data obtained for physical activity in this study was highly skewed, and this could account for the fact that the relation was not significant. The average MET minutes found in this study was 3847.1 which is far higher than physical activity guidelines. Possible explanations for the skew in data are discussed below. The relation between ACEs and PA was examined in order to assess if lower levels in ACE-exposed individuals could add to the explanation for how ACEs contribute to adverse health outcomes. Aerobic physical activity has been shown to help with symptoms of post-traumatic stress disorder (PTSD), which sometimes develops after exposure to trauma events, so college students with ACE exposure could participate in more physical activity in order to lessen the effects of their trauma on their lives (Fetzner & Asmundson, 2015).

Our second research question examined whether emotion regulation moderates the relation between ACEs and the two health behaviors among college students. In answering this question, we first looked at how emotion regulation related to sleep, physical activity, and ACEs. Difficulties in emotion regulation (DER) were significantly correlated with ACEs and sleep problems such that higher DER was associated with more ACEs and greater sleep problems. The connection between DER and ACEs is well documented, so this finding is consistent with the literature (Cameron, Carroll & Hamilton, 2018; Kim & Cicchetti, 2010). There are multiple proposed mechanisms for this connection. According to the organizational-transactional model of development, maltreated children are more likely to develop insecure attachments to their primary caregivers and, as a result, are more likely to have difficulties in regulating their emotions, problematic relationship building with peers, and maladapted behaviors (Kim & Cicchetti, 2010). ACEs may also contribute to emotion dysregulation through neurobiological effects. When ACEs contribute to dysregulation of the hypothalamus-pituitary-adrenal (HPA) axis, this makes it harder for individuals to cope with stressors and regulate their emotions (Kim & Cicchetti, 2010). Studies have also found the connection between DER and poor sleep previously (Ready et al., 2008). This could be attributed to a lack of ability to cope with stress that could contribute significantly to difficulties sleeping (Ready et al., 2008). DER was also a significant predictor of sleep problems when controlling for biological sex and household income. Even though ACEs and DER both separately significantly predicted sleep problems, there was no significant interaction between the two variables in predicting sleep problems. Therefore, the proposed mechanism of moderation was not supported by the study results.

As in the previous analysis, no significant relations were found between physical activity and ACEs or DER. In the literature, better emotion regulation is associated with healthier lifestyles (Isasi et al., 2013). In our population, this was not the case with physical activity. This may be due to the physical activity data being highly skewed. The data ended up having an average much higher than the threshold to meet physical activity guidelines. Given previous research findings asserting that college students tend to not meet physical activity guidelines, our data seems unlikely. Possible explanations for this skew in the data could be due to participants misunderstanding items in the measure. Items asked for the number of days that the participant engaged in physical activity and then asked for the amount of time spent engaged in the activity each day. Therefore, in the data analysis, the amount of time recorded was multiplied by the number of days to give the total amount of time per week. It is possible that participants thought they were giving the total amount of time per week in the time portion of the measure, which skewed the data high when we accounted for the number of days that they denoted. There was another point of confusion with the data that was identifiable and fixed, which makes it seem reasonable that there could have been multiple points of confusion. Many of the participants when asked how much time they spent each day doing a specific type of physical activity and given an hours and minutes space, filled the spaces by putting the total time in hours and then converting it to minutes. For example, many participants reported “1.5 hours and 90 minutes” of physical activity per day, rather than the intended response of “1 hour and 30 minutes”. The misunderstanding of the purpose of the two boxes for hours and minutes makes it seem plausible that participants misunderstood the measure in total. Another possible explanation for the skew in the data is social desirability bias. It has been well-documented that participants tend to overreport physical activity in self report measures (Brenner & Delamater, 2014).

Strengths

This study had many strengths that support the external validity of the findings. The relatively large sample size suggests that findings may be fairly representative of the larger population of college students. This study also adds to the body of literature surrounding ACEs and their effects on health outcomes. The findings here can help to explain the relation between ACEs and poor health in adulthood.

Limitations

There were several limitations of the study as well. The fact that we used retrospective self-report to measure ACE exposure poses one limitation. This method provides opportunities for errors in memory. Therefore, the rates of ACE exposure actually experienced by our population could be quite different from the rates that were recorded in the data. Our ACEs data was also limited by the fact that participants were warned about the sensitive nature of the information and given the option to opt out of answering the measure altogether. We do not know how this could have affected the data and associations found in this study. It is possible that people who experienced more ACEs decided to opt out in order to avoid the sensitive topic. It is also possible that some people opted out in order to finish the survey quicker. The inclusion of this missing data could add strength to the associations found or could detract from them, but we have no way of knowing. Another limitation was the use of a self-report measure for physical activity. Again, this provides opportunities for errors in memory. There is also the opportunity for bias in the data in self-report measures. Participants tend to report what they know they should have done rather than what they actually did because of social desirability bias. The potential for bias and error in the self-report data used in this study weakens the significance of the findings. Additionally, there was an issue with how students reported the PA data, as discussed above. It seems that students may have misunderstood the instructions and overreported their physical activity levels as a result. The use of cross-sectional data limits the strength of the relations found in the data. We are unable to determine causality in any of the relations found in this study. The diversity of the sample also presents a limitation of the data. The participants in this study were a majority white female. This makes it more difficult to generalize the findings to college students who are non-white and not female.

Future Directions

Future research could utilize accelerometers, pedometers, or other objective data to measure physical activity. The best way to accurately measure physical activity is to use objective data in conjunction with surveys to determine what types of activity subjects participated in. This would provide the opportunity to obtain a more accurate depiction of the relations among ACEs, DER and physical activity. Longitudinal studies with children exposed to ACEs could be used to demonstrate causality between ACEs and health outcomes. These studies could also provide other insight into the relation between ACEs and health outcomes, like other factors that might affect the link.

Future studies should also examine how DER and sleep problems in college students affect health outcomes in adulthood. It is possible that emotion regulation and sleep contribute to poor health outcomes in adults with ACE exposure, so this should be further examined. With more evidence on this relation, sleep and emotion regulation could present opportunities for interventions to mitigate the effects of ACEs on health outcomes. If the two factors contribute to worse health outcomes, then intervening to help college students achieve better sleep quality and strengthen emotion regulation skills could improve health outcomes later in adulthood. Other variables that could moderate the relation between ACEs and sleep should also be studied. People with a history of ACE exposure are more likely to report anxiety, and this could contribute significantly to sleep problems as well (Karatekin, 2017). Anxiety should be studied in the future to examine its relation to ACEs and sleep in college students. Other health outcomes could also be studied in relation to ACE exposure. Nutrition, body composition, and health history could all be studied to get a better idea of college students' overall health in relation to ACEs. This data could help to determine when the harmful effects of ACEs on physical health begin to show up and provide a timeline for interventions to prevent these harmful effects.

Clinical Implications

The results found in the current study emphasize the importance of early identification of ACE exposure and the need for increased screening. Increased screening for ACEs and awareness of them in clinical settings can help clinicians practice trauma-informed care. With an awareness of ACE exposure, clinicians can help people obtain better health outcomes in adulthood and lessen the harmful effects that ACEs tend to have. With this idea, clinicians and public health professionals can also conduct future interventions to improve health outcomes in those who indicate exposure to ACEs. Although the data on physical activity was not significant, physical activity is often used to produce better health outcomes. Physical activity interventions could help those with a history of ACEs to improve health outcomes and lessen the effects of trauma they may still feel in their lives, as exercise has been proven to reduce symptoms of PTSD (Fetzner & Asmundson, 2014). Other interventions could target emotion regulation to improve health outcomes. Poor emotion regulation has been strongly linked to poorer physical health outcomes (Song, Lu, Hu, Xu, Li, & Liu, 2015). Therefore, it can be reasonably assumed that ACEs' effects on emotion regulation could contribute to their effects on health outcomes. With this assumption, targeting interventions to improve emotion regulation skills in those with exposure to ACEs should improve physical health outcomes. Emotion regulation and physical activity as interventions with ACE-exposed populations should be studied further to measure the strength of any indicated benefits on physical health outcomes.

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Appendix

Table 1

Demographic data from the college student sample (N=395)

Variable	Percentage (%)
University	
University of Wyoming	25.6

University of Northern Iowa	7.8
University of South Carolina	66.6
Biological Sex	
Female	82.8
Male	15.9
Other	1.4
Sexual Orientation	
Heterosexual	86.3
Gay or Lesbian	2.8
Bisexual	6.8
Asexual/Pansexual/other	4.1
Relationship Status	
In a committed relationship	40
Not in a committed relationship	60
Age	
18	19
19	32.9
20	18.5
21	16.7
22 and older	12.9
Year	
Freshmen	42.8
Sophomore	19.5
Junior	21.5
Senior	13.9
Fifth year and beyond	2.3
Racial/ethnic group	
White	86.8
Black	6.3
Latinx/Hispanic	4.6
Asian	6.3
Native American	1
Pacific Islander/Native Hawaiian	1
Multiracial	2.5
Middle Eastern	Less than 1
Annual Household Income	
Below $50,000	14.7
$50,000 - $99,999	21.3
$100,000 - $149,000	23.5
$150,000 and above	24.5
Do not know/prefer not to answer	15.9
Generation	

First generation college student	23.8
Not first generation college student	76.2
Hometown	
Suburban	63
Urban	15.4
Rural	21.5

Table 2

Bivariate correlations among ACEs, physical activity, sleep problems, difficulties in emotion regulation, biological sex, and annual household income.

Variable	1	2	3	4	5	6
1. Total ACEs	-	-0.033	0.263**	0.285**	0.054	-0.268**
2. Physical Activity		-	0.064	0.029	-0.145**	0.122*
3. Sleep Problems			•	0.398**	0.032	-0.093
4. DER				-	0.077	-0.103
5. Biological Sex					-	-0.022
6. Household Income						-

Note: * p < .05, ** p< .01

Table 3

Regression results examining biological sex, income, ACEs, and difficulties in emotion regulation as predictors of sleep problems.

Step and variable	β	R^2	ΔR^2	F for R^2	p
Model 1					
Step 1					
Biological sex	0.039				
Household income	-0.093				
Total step 1		0.010	0.010	1.422	0.243
Step 2					
Biological sex	0.019				
Household income	-0.010				
Total ACEs	0.305**				
Total step 2		0.096	0.086	26.017	0.000
Model 2					
Step 1					
Biological sex	0.039				
Household income	-0.093				
Total step 1		0.010	0.010	1.422	0.243
Step 2					
Biological sex	-0.008				

Household income	-0.049				
DER	0.386**				
Total step 2		0.155	0.145	47.163	0.000
Model 3					
Biological sex	-0.122				
Household income	-0.0014				
Total ACEs	0.384**				
DER	1.445**				
ACEs x DER	-0.0516	0.1906	0.0005	0.1585	0.6909

Note: * p < .05, ** p< .01

Table 4

Regression results examining biological sex, income, ACEs, and difficulties in emotion regulation as predictors of physical activity.

Step and variable	β	R^2	ΔR^2	F for R^2	p
Model 1					
Step 1					
Biological sex	-0.169**				
Household income	0.119*				
Total step 1		0.043	0.043	6.750	0.001
Step 2					
Biological sex	-0.170**				
Household income	0.124*				
Total ACEs	0.016				
Total step 2		0.044	0.000	0.070	0.004
Model 2					
Step 1					
Biological sex	-0.169**				
Household income	0.119*				
Total step 1		0.043	0.043	6.750	0.001
Step 2					
Biological sex	-0.169**				
Household income	0.121*				
DER	0.018				
Total step 2		0.044	0.000	0.095	0.004
Model 3					
Biological sex	-1664.45**				
Household income	320.61*				
Total ACEs	60.15				
DER	73.43				

ACEs x DER	-116.55	0.0460	0.0023	0.6981	0.4041

Note: * p < .05, ** p< .01