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Adverse Childhood Experiences and Quality of Life: A Mediating Role of Physical Activity and Executive Function

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Adverse Childhood Experiences and Quality of Life: A Mediating Role of Physical Activity and Executive Function

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by

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ABSTRACT

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ACEs have been associated with heightened risk for a range of chronic health problems, substance use, and cognition in adulthood (Center for Disease Control (CDC), 2019; Hinojosa et al., 2017). One potential protective factor is physical activity (McEwen, 2016; Wu et al., 2013). Physical activity is associated with sustaining overall health, improving mental health by reducing symptoms of depression and anxiety (Murri et al., 2019; Sharma et al., 2006; Tasci et al., 2019), and maintaining a healthy body weight and BMI (WHO, 2021). Therefore, this study examined whether barriers to physical activity, physical activity levels, and executive outcomes serve as serial mediators to the relationship between adverse childhood experiences (ACEs) and perceived quality of physical health. Participants (n=75) completed several self- report measures related to ACEs, barriers to physical activity, amount of physical activity, and perceived quality of physical health. Following the questionnaires, they completed three executive function tasks (Flanker, Sternberg, Wisconsin Card Sorting) via E PRIME. Results revealed that lack of time, lack of willpower, and lack of energy were the most prevalent barriers to physical activity.

Additionally, a significant serial mediation analysis indicated that barriers to physical activity and physical activity levels mediated the relationship between ACEs and perceived quality of physical health. Specifically, higher ACE scores were associated with more barriers to physical activity, followed by lower physical activity levels, which in turn, lower perceived quality of physical health. However, there was insufficient evidence to conclude that executive function

serially mediates the relationship between ACEs and perceived quality of physical health. The current study provides clarification on specific pathways that contribute to the relationship between ACEs and perceived quality of physical health. Future research should focus on developing interventions and educational efforts that reduce barriers to physical activity and increase physical activity and resilience building in populations that are more prone to early adversity efforts, as it may be linked to perceived quality of physical health.

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Chapter 1. Introduction

It is estimated that up to 1 billion children have experienced neglect and physical, sexual, or emotional violence in the past year (World Health Organization (WHO), 2020). These adverse experiences during the first eighteen years of life are commonly referred to as adverse childhood experiences (ACEs). ACEs have been associated with heightened risk for health disparities, substance use, and poor academic performance/cognition in adulthood (Center for Disease Control (CDC), 2019; Hinojosa et al., 2018). Although some researchers argue that ACEs have the potential to have enduring effects on individual life trajectories (Dannefer, 2003), others highlight countervailing mechanisms that reduce the effects of early adversity on physical health (Ferraro & Kelley-Moore, 2003). One resilience or protective factor on the relationship between ACEs and later physical health is physical activity/exercise (McEwen, 2016; Wu et al., 2013). Higher levels of physical activity have been associated with various outcomes including lower risk of health disparities (Mathews et al., 2020; Moore et al., 2016), higher cognitive functioning (Dik et al., 2003), and overall higher quality of life (Gill et al., 2013). While direct relations between physical activity and various outcomes have been examined previously, the full picture of how the individual pieces may all fit together has yet to be explored. Therefore, identifying and targeting the potential links between ACEs and adult physical activity, executive function, and perceived quality of physical health may help to reduce one potential cause of health disparities throughout the life course.

The current study was guided by the life course perspective (Elder, 1998) which considers how opportunities, constraints on social structure, culture, and life transitions (e.g., entry to high school, birth of first child) impact an individual's social trajectories (Elder, 1998) and health outcomes (Hayward & Gorman, 2004) later in life. Researchers have used the life course perspective to explore the relationship between health disparities and environmental experiences in childhood that affect individuals throughout their lives (Hayward & Gorman, 2004). There are a multitude of childhood experiences that can be potential predictors of adult circumstances and health outcomes including exposure to adversity in utero, nutritional deficits, childhood poverty, stressful home environments, and family dynamics (Hayward & Gorman, 2004). The life course perspective consists of four phases: cohort, turning point, transition, and life event. The cohort phase represents people who were born during the same time period and experienced similar environmental/social changes within a given culture (i.e., COVID-19). Turning point is a life event or transition that produces a lasting change in someone's life (i.e., how someone views themself in relation to the world). Transition is defined as a major change in role or statuses (i.e., single to married, changing schools). Life event is when there is a significant abrupt change that might produce serious long-lasting effects on one's life (i.e., experiencing death or traumatic experience; Hutchinson, 2019). The current study attempted to encapsulate the life course perspective by examining how adversity in childhood and other life experiences affect perceived quality of physical health, physical activity, and executive function later in life. Additionally, it aimed to examine pathways that may link ACEs to perceived quality of physical health. Specifically, the current study investigated whether ACEs were associated with lower perceived quality of physical health through barriers to physical activity, physical activity levels, and executive function. Although these pathways were not exhaustive of all potential mechanisms, they provide useful starting points for understanding the links between ACEs, physical activity, executive function, and perceived quality of physical health.

To maintain consistency and clarity throughout the document, the following concise definitions of physical activity and physical health are provided. Physical activity and physical health are often used interchangeably with one another. However, for this dissertation, they represent two different concepts. Physical activity is any bodily movement produced by skeletal muscles that requires energy expenditure. It refers to all daily and leisurely physical activity (WHO, 2020). Physical health is the well-being of the body (CDC, 2021). It covers a wide range of areas that include but are not limited to, healthy diet, personal hygiene, energy, or sleep (Koipysheva et al., 2018).

Chapter 2. Literature Review

Adverse Childhood Experiences

Felitti and colleagues (1998) created the Adverse Childhood Experiences questionnaire to unify the research related to child abuse and neglect. The original ACE survey is a 10-item yes/no questionnaire that assesses retrospective adverse experiences in adults (Felitti et al., 1998). In this questionnaire there are a total of nine categories, - emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, domestic violence, household substance abuse, household mental illness, and incarcerated household member (Felitti et al., 1998). Furthermore, Felitti and colleagues (1998) were able to clearly demonstrate associations between adverse childhood events and metrics of physical health for adults such as heart disease, cerebrovascular disease, chronic lung disease, and cancer. Subsequent research has also linked ACEs to depression, PTSD, negative health attitudes, and poor health behaviors and choices (Kendall-Tackett, 2002). It is important to note that these findings were all correlational and thus do not provide causal explanations for the relationship between ACEs and various health outcomes. Nonetheless, the literature does highlight the importance of early childhood experiences on the development of physical and mental health later in life and overall quality of life.

Although the original ACE questionnaire is widely used, it does have its limitations. For example, the ACE questionnaire does not collect information related to the frequency, intensity, or chronicity of exposure to an ACE, nor does it account for differences in the timing of exposure (Anada et al., 2020; Elder 1998). Another limitation is there needs to be a more comprehensive range of possible adversities on the questionnaire (Finekelhor et al., 2013). Researchers have started to explore ways of expanding the ACE framework by integrating other childhood events that compromise development and functioning (Cronholm et al., 2015, Finkelhor et al., 2015, Karatekin & Hill, 2019). For example, treating measures of economic adversity or peer victimization as ACEs rather than as confounding variables to be controlled (Finkelhor et al., 2013, Green et al., 2010). Getting a better picture of the breadth of adversities by examining adversities in different contexts may improve the generalizability of ACE assessment tools.

To try and account for the limitations of the original ACEs questionnaire, this study will use a modified Philadelphia ACEs questionnaire. The Philadelphia ACEs measures the original ACE indicators and expansion items to include questions about stressors manifesting outside the household. The expanded ACEs were identified through a review of the literature which resulted in the addition of five more categories: witness violence, felt discrimination, adverse neighborhood experience, bullied, and lived in foster care (Cronholm et al., 2015). The result was a standardized questionnaire examining abuse, household dysfunction, and criminal behavior within the home.

Quality of Life

"The World Health Organization (WHO) defines quality of life as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns" (WHO, 2012, p. 11). Quality of life in adulthood has been related to experiencing adversity in childhood (Nelson et al., 2020), as well as physical, mental, emotional, and social functioning (CDC, 2019).

Several mechanisms have been proposed to explain the relationship between ACEs and quality of life. One such mechanism is the adoption of coping strategies. Coping strategies may be maladaptive or adaptive in relation to quality of life. Maladaptive coping strategies may include behaviors such as smoking, heavy alcohol consumption, drug use, or poor diet (Bellis et al., 2014; Campbell et al., 2016). In contrast, adaptive coping strategies include behaviors such as physical activity and exercise. Previous research indicates that adults who experienced ACEs were more likely to engage in maladaptive coping strategies than adaptive strategies (Monant & Chandler, 2015). Additional support for this mechanism is provided by research indicating that adults that experienced at least one ACE reported worse physical health were more likely to report functional limitations (i.e., limits in activity due to physical, mental, or emotional problems), and were significantly more likely to report a diagnosis of diabetes or heart attack than respondents who did not report an ACE (Monat & Chandler, 2015). The current dissertation focused on the adaptive coping mechanism of physical activity.

Physical Activity

The WHO recommends adults aged 18-64 participate in 150-300 minutes of moderate intensity exercise weekly (WHO, 2021). Physical inactivity is the fourth leading risk factor for noncommunicable diseases and global mortality, implicated in 3.2 million deaths globally (WHO, 2021). Meeting these daily physical activity guidelines may prevent and manage noncommunicable diseases such as heart disease and diabetes (Eckert & Kholer, 2014; Lee et al., 2020; Sheikholeslami et al., 2018), stroke and cancer (Budreviciute et al., 2020; WHO, 2021), and hypertension (Diaz & Shimbo, 2013; Pescatelo et al., 2004). The daily physical activity guidelines have also been associated with improvements in mental health by reducing symptoms of depression and anxiety (Murri et al., 2019; Sharma et al., 2006; Tasci et al., 2019) and physical health by helping maintain healthy body weights and BMIs (WHO, 2021).

However, one in three women and one in four men do not meet the recommended daily physical activity levels (WHO, 2018). According to the 2014 National Health Interview Survey (NHIS), women were less likely to meet the physical activity guidelines than men based on age (NHIS, 2014). Additionally, African American individuals participated in less physical activity and were less likely to meet physical activity guidelines (43.3%) compared with non-Hispanic Caucasian individuals (51.2%; CDC, 2014; Mama et al., 2015; Matthews et al., 2008). These potential individual differences highlight the importance of identifying and reducing barriers to physical activity in minority groups, with hopes of reducing health disparities across diverse populations.

Barriers to Physical Activity

Barriers to physical activity are commonly categorized into barriers related to personal factors (e.g., cost of gym memberships, lack of time, lack of motivation, health conditions and lack of guidance; Barbosa et al., 2014; Bethancourt et al., 2014; Cavalcante et al., 2015; Herazo et al., 2017) or environmental factors (e.g., weather, social influence, not feeling safe exercising outside, and being intimidated by others; Bethancourt et al., 2014). Moreover, researchers have examined barriers to physical activity in minority groups. For instance, Latinx and African American people from underserved populations report health disparities (Joseph et al., 2015), fear of injury, muscle soreness (Bautista et al., 2011), financial constraints (Smith et al., 2017), being married and having children a home (D'alonzo et al., 2008; Mendoza- Vasconez et al., 2016) as common reasons or barriers to completing physical activity.

Barriers to physical activity increased during the COVID-19 pandemic as individuals' environment and daily routines were disrupted. This disruption has been associated with an increase in mental health challenges and a decrease in physical activity (Maher et al., 2021). Farah and colleagues (2021) asked Brazilian adults about barriers to physical activity during the pandemic and found that social isolation, lack of appropriate facilities/equipment and space were the most common barriers reported and these were associated with an increase in sedentary behavior. Engaging in physical activity is vital, because it plays a special role in reducing health disparities, especially during COVID-19 (Hasson et al., 2021). Thus, it was critical to examine the potential impact of barriers to physical activity in the current dissertation because the impact of the COVID-19 pandemic may still be influencing individuals' choices when it comes to meeting basic physical activity needs. Moreover, the relationship between ACEs and physical activity may depend on or be explained by perceived barriers of physical activity. Specifically, individuals with higher ACE scores may report more barriers to physical activity leading to greater health disparities compared to individuals with lower ACE scores.

Physical Activity and ACEs

There are only a few studies to specifically examine the relationship between ACEs and physical activity levels in adulthood. Monat and Chandler (2015) found that people who experienced at least one ACE exercised less within the last month compared to people who have not experienced any ACE. Similarly, Krinner and colleagues (2020) found that higher ACEs increased the odds of poor self-reported health within a sample of US college students. Interestingly, adherence to a balanced diet and physical activity guidelines reduced risk for poor self-reported health (Krinner et al., 2020). Furthermore, higher ACE scores have been related to risky health behaviors such as eating out and lower self-report of exercise/physical activity levels (Gwin et al., 2019). However, when researchers investigated exercise alone it did not relate to ACEs (Gwin et al., 2019).

Physical Activity and Quality of life

Research also demonstrates that meeting daily physical activity guidelines can enhance overall quality of life (Berger et al., 2007; Bize et al., 2022; Kokandi et al., 2019). For example, 12- to 23- year-old participants in Spain who engaged in physical activity at least four times a week had a higher quality of life, psychological well-being, positive emotions, and life satisfaction compared to participants who did not regularly participate in physical activity (Rodriguez- Fernandez et al., 2016). Furthermore, higher levels of subjective and objective measures of physical activity were associated with a better quality of life in a sample of adults. Interestingly, the subjective measure of physical activity (i.e., physical activity questionnaire) had a stronger, positive relationship with physical health related quality of life than the objective measure of physical activity (i.e., daily accelerometer data; Anokye et al., 2012). A possible explanation for this could be that people tend to over- report their participation levels in physical activity (Beyler et al., 2008).

Finally, work from Gill and colleagues (2013) suggests that quality of life is a key motivator to physical activity. Indicating that people not only get involved in physical activity, but they stay involved in physical activity because it contributes to their overall quality of life. Thus, physical activity enhances quality of life, and enhanced quality of life motivates participation in physical activity, which creates a positive health cycle (Gill et al., 2013). This work is consistent with the self-determination theory (SDT). SDT is commonly used to explain the relationship between quality of life and physical activity. While physical activity has positive associations with quality of life, the explicit nature of how physical activity impacts the relationship between ACEs and quality of life is poorly understood. The next section of the document examines the literature on executive function and how it may mitigate the relationship between ACEs, quality of life, and physical activity.

Executive Function

The operational definition of executive function varies across time and research areas but broadly, executive function refers to higher level cognitive processes that contribute to organizing and controlling thoughts and behaviors (Banich, 2009; Best, 2010). Some researchers believe that executive function primarily consist of three domains: inhibitory control, cognitive flexibility and working memory (Miyake et al., 2000, Diamond, 2013). While other researchers believe that executive function has several different components (Lezak ,1995; Reynolds & Horton, 2008; Naglieri & Goldstein, 2013) that include planning, inhibitory control, conceptualizing, abstract thinking, working memory, decision-making, implementing feedback, scheduling of events, consciously controlling thoughts, and cognitive flexibility (Ji & Wang, 2018). For the purpose of this dissertation, the relationships among ACEs, perceived quality of physical health, physical activity, and three domains of executive function (e.g., cognitive flexibility, inhibitory control, and working memory) were examined.

Executive Function and ACEs

Recent meta-analyses and systematic reviews suggest there is a strong relationship between maltreatment and executive function deficits among children (Kelder et al., 2018; Lund et al., 2020). Moreover, extensive literature within neurobiology and health psychology suggests that ACEs are associated with modifications in the biological systems response to toxic stress (Center on the Developing Child, 2022; Jacob et al., 2018; Jiang et al., 2019). In general, our biological systems are able to maintain allostasis (e.g., physiological and behavioral stability) to constantly respond to our changing environments and stressful circumstances (Boullier & Blair, 2018; Sheng et al., 2021). However, if the stress is severe and/or consistent, then it can lead to dysregulation and long-term changes in how the systems function (Boullier & Blair, 2018). Toxic stress may actually "rewire" the brain making individuals more vulnerable to subsequent stressors. For example, exposure to adversity as a child is linked to alterations of the molecular and genetic makeup of a child as well as altering the way the neurological, immune, and endocrine systems develop and function (Boullier & Blair, 2018). In addition to molecular and genetic alterations, neuroimaging studies indicate that early adversity is related to physical changes in the brain (Siddiqui et al., 2008; Yavas et al., 2019). Exposure to ACEs can negatively impact the structure and functioning of the amygdala and hippocampus (Hanson et al., 2015) as well as the dorsal prefrontal cortex (Hart & Rubia, 2012). These brain structures and regions are involved in attention, memory, and other cognitive functions.

Expectedly, experiencing toxic stress factors during childhood and adolescence is related to impaired executive function and cognitive performance later in life. Ji and Wang (2018) found a positive correlation between ACEs and inhibitory control, cognitive flexibility, and working memory, indicating that higher ACE scores were related to longer reaction times on each task. Furthermore, Trossman and colleagues (2021) examined executive function difficulties as a mediator on the relationship between adverse childhood experiences and various aspects of health in both an undergraduate sample and a community sample. In the undergraduate sample, they found that executive function difficulties mediated the relationship between ACEs and mental health, but not ACEs and health risk behaviors. In contrast, in the community sample, they found that executive function difficulties mediated the relationship between ACEs and mental health and ACEs and health risk behavior, but not ACEs and physical health status

(Trossman et al., 2021). In summary, executive function mediated the association between ACEs and mental health in both samples, but executive function only mediated health risk behaviors not physical health status in the community sample. It should be noted that the measure of physical health status was not completed in the undergraduate sample. The authors speculated that the results could have differed between the undergraduate and community sample due to the online community sample having more diversity than the undergraduate sample.

The current dissertation aimed to extend the work of Trossman and colleagues (2021) on the potential mediating role of executive function on the relationship between ACEs and quality of life by (1) examining three components of executive function (i.e., inhibitory control, working memory and cognitive flexibility) rather than relying on a single executive dysfunction score from the Barkley Deficits in Executive Functioning Scale—Short Form: Self-Report (BDEFS-SF:SR) and (2) focusing on a global, physical health outcome measure (i.e., perceived quality of physical health) that was not included in Trossman et al.'s (2021) undergraduate sample.

Executive Function and Quality of Life

Previous research suggests that executive function and health life behaviors (i.e., physical activity) "are synergistic" and reciprocally linked via a positive feedback loop, meaning that executive function enhances health life behaviors, which in turn helps with sustainability of executive function and good health (Allan et al., 2016) and students with better executive function scores report better mental health and physical health measured by the quality of life scale (Cushman et al., 2019). Also, researchers have found that lower executive function is related to lower quality of life in people with medical conditions and mental health difficulties (Hemphill et al., 2018; Love et al., 2016; Sanz et al., 2018; Schraegle et al., 2016). Schraegle and colleagues (2016) examined executive function and quality of life in a sample of youth with epilepsy. The data included parents' perception of child's executive function and physical health quality of life. Approximately half the parents reported that their child struggles with executive function. In addition, researchers found a moderate to large relationship between parents' perception of their child's quality of life and executive function.

Additional research has examined whether executive function predicts variability in health behaviors such as stress processes or chronic illnesses (see Gray-Burrows et al., 2019 and Williams et al., 2017 for reviews). A meta-analysis found that executive function had an overall significant, yet small positive correlation with health behaviors (Gray-Burrows et al., 2019). For example, in a sample a community sample, researchers found that errors on the Stroop task was positively associates with health risk behavior (i.e., smoking, substance use and sleep behaviors) and negatively associated with health protective behavior (i.e., exercise; Hall et al., 2006). Both executive function and quality of life are complex, therefore additional clarity around what specific components of executive function may be beneficial to physical health behaviors are important.

Executive Function and Physical Activity

Recall that early adversity may impact the development of specific brain structures and regions. Similarly, research on physical activity indicates that it can affect brain plasticity leading to lasting structural and functional changes in the brain with cascading consequences on one's cognitive function and overall well-being (Fernandes et al., 2017; Mandolosei et al., 2018). One proposed mechanism for these structural and functional brain changes related to physical activity is through the release of neurotrophic factors such as peripheral brain derived neurotrophic factor (BDNF) during physical exercise. (Hötting et al., 2016). BDNF has been shown to increase blood flow, cerebrovascular health, and cognitive functioning (Mandolesi et al., 2017). Another proposed mechanism is that physical activity increases gray matter volume in the frontal and hippocampal brain regions (Mandolesi et al., 2017). Gray matter allows individuals to control memory, emotions, and movement (Mercadante & Tadi, 2021) and helps with information processing in the brain (Mercadante & Tadi, 2021; Pilcher, 2004). A final mechanism is that physical activity influences network topology (Foster, 2015). Indicating that physical activity and mental stimulation may reconfigure the brain networks, which are essential in learning, memory, and executive function. This mechanism is reciprocal in nature, wherein direct stimulation (physical or mental) of the brain and muscles enhances the communication process between the brain and muscles. Regardless of the specific mechanism(s), it is clear that there is a relationship between physical activity and neurological changes.

Additionally, previous research suggests that the relationship between physical activity and executive function may vary by gender and age. For example, Sals-Gomez et al. (2020) and Johnson and Loprinzi (2019) found that the association between physical activity and executive function was stronger in women compared to men. Indicating that the more physical activity women completed the better they performed on executive function tasks and women completed the task faster than males, on average. Comparably, a meta-analysis found that exercise was associated with larger effects on cognition in studies with a higher percentage of women compared to studies with a lower percentage of women (Barha et al., 2017). Moreover, physical changes in the brain of older individuals could interfere with perceptual speed and the ability to respond to stimuli efficiently and accurately as some cognitive abilities have been shown to decline with age (Murman et al., 2015; Weir et al., 2014). While the current study included a fairly limited age range of participants, it was still important to consider whether the age of the participant impacted daily physical activity rates and executive function.

Chapter 2. Current Study

Physical activity and ACEs have both been independently associated with executive function, but previous research has not examined the potential mediating role of physical activity and executive function on the relationship between ACEs and perceived quality of physical health. Furthermore, there is previous literature documenting the relationship between barriers to physical activity and physical activity levels, but research has yet to explore whether barriers to physical activity serves as a serial mediator on the relationship between ACEs and perceived quality of physical health. Thus, the current study examined the interrelations of ACEs, physical activity, barriers to physical activity, executive function, and perceived quality of physical health within a single sample and research study. The goals of the current dissertation were to integrate the individual research silos and examine the interrelations among adversity, physical activity, executive function, and physical health. The following research questions were formulated to help accomplish those goals.

Research Question 1: What are the most prevalent physical activity barriers reported in college students in this region of Appalachian? It was hypothesized that the most prevalent physical activity barriers would be lack of time and lack of energy.

Research Question 2: Do barriers to physical activity serve as a serial mediator with self-reported physical activity and executive function (i.e., inhibitory control, cognitive flexibility, and working memory) in the relationship between ACES and perceptions of perceived quality of physical health? At the bivariate level, it was hypothesized that ACEs would be positively associated with barriers to physical activity and negatively associated with self-reported physical activity, and positively associated with reaction times of inhibitory control, cognitive flexibility, working memory, and perceived quality of physical health. At the multivariate level, it was hypothesized that the linkage of ACEs and perceived quality of physical health would be serially mediated by barriers to physical activity, self-reported physical activity, and executive function. That is, higher ACE scores would be associated with more barriers to physical activity and, in turn, lower levels of physical activity and executive function, and lower perceived quality of physical health.

Chapter 3. Methods

Participants

The study sample consisted of 75 individuals. This sample size was adequate to detect a (f^2= 0.15) based on a G*Power analysis (Faul et al., 2009). All participants were undergraduate or graduate students attending East Tennessee State University (ETSU) in Johnson City, TN. Participants were recruited via the ETSU Psychology SONA subject pool, psychology courses, and various ETSU listservs (e.g., graduate programs). The study protocol was approved by East Tennessee State University Institutional Review Board.

Procedure

This study was approved by East Tennessee State University Institutional Review Board (IRB). Individuals signed up for a timeslot to participate in the research study. When they arrived at the research lab, they were provided with informed consent, the research procedures were described, and all questions were answered. Following informed consent, participants were asked to complete five online questionnaires related to their demographics, barriers to physical activity, physical activity levels, ACEs, and perceived quality of physical health. All questionnaires were administered in the same order for every participant via REDCAP. Then, participants completed three tasks of executive function in random order (i.e., Flanker Task, Wisconsin Card Sorting Task, and Sternberg Working Memory Task). These three executive tasks were completed via E-prime (Version 1.0.2.41). Following completion of the executive function tasks, participants were thanked for their participation, debriefed, and the contact information for psychological support services on campus was provided. Students who were enrolled in a course in the Psychology Department at East Tennessee State University were eligible to receive three SONA course credits for participation. Participants also had the option of enrolling in a random drawing for one of ten $25 dollar gift cards.

Measures

Demographics

A variety of demographics and supplementary questions were administered through a demographic survey (See Appendix G). Examples of the demographic information collected include height, weight, race/ethnicity, age, and gender. Examples of supplementary questions include but are not limited to "What's your favorite thing about working out?", "What's your least favorite thing about working out?", "What is your favorite form of physical activity?", and "Do you make use of virtual fitness classes?".

CDC Barriers To Being Active

This is a 21-item self-report questionnaire. There are seven categories with three questions per category: lack of time, social influences, lack of energy, lack of willpower, fear of injury, lack of skill, and lack of resources. Examples of items include, "I'm embarrassed about how I look when I exercise with others", "I know of too many people who have hurt themselves by overdoing it with exercise.", and "It's just too expensive. You have to take a class or join a club or buy the right equipment.". Items were summed, and a score of 5 or above in any category indicated that this was an important barrier to physical activity for the individual (CDC, 2020). The lowest possible score on this measure is a 0 and the highest score is a 9. The seven barrier categories were dichotomized into "0" or "1". If a participant received a summed category score between 0 and 4, that barrier category was coded as "0" suggesting that that barrier is not a critical barrier to physical activity for the individual to overcome. If a participant received a summed category score between 5 and 9, that barrier category was coded as “1” indicating that that barrier was an important barrier to physical activity for the individual to overcome. A prior study indicates the total score of the measure to be internally consistent (α = .87) with most of the subscales having adequate internal consistency as well (α > .70) except for the lack of resource scale (α = .45; Sawchuk et al., 2011). Internal consistency in the current study indicates lack of time, social influence, lack of energy, lack of willpower and lack of skill subscales were adequate (α = .69 - .88), excluding the fear of injury (α = .56) and lack of resources subscales (α = .142).

International Physical Activity Questionnaire-Short Form (IPAQ-SF)

The IPAQ-SF (International Physical Activity Questionnaire, 1998, 2002) is a seven item self-report measure that assesses participation in different types of physical activity and sitting time. Participants are asked to answer the questions about their physical activity by inputting the number of days (frequency) and the number of minutes per day (duration) of their participation in all kinds of vigorous, moderate, and walking physical activities during the last seven days (International Physical Activity Questionnaire, 1998). In addition, a seventh question asks participants to report the time they spend sitting during an average weekday (Papathanassiou et al., 2009). Examples of items include, “During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?”, “How much time did you usually spend doing moderate physical activities on one of those days?”.

The questions estimate physical activity metabolic equivalent task (MET)-min/week and time spent sitting. MET represents the amount of energy expended carrying out physical activity, weighting each type of physical activity by energy requirements defined by the MET (IPAQ, 2004). A simple calculation was used to get the MET minutes a week. Multiply the MET value given (walking = 3.3, moderate activity = 4, vigorous activity = 8) by the minutes the activity was carried out and by the number of days that the activity took place. For example, if someone reported moderate physical activity for 30 minutes 6 days a week, then the total MET minutes for moderate physical activity are equal to 4 x 30 x 6= 720 MET minutes a week. Then, the overall MET was calculated, buy summing the MET minutes achieved in each category (i.e., walking, moderate activity, and vigorous activity) to get total MET minutes of physical activity a week. The IPAQ-SF has high test-rest reliability (α <.80) but lower validity (ρ = .09 - .39; Lee et al., 2011). Recent meta-analyses have suggested the IPAQ-SF provides an overestimation of physical activity (Lee et al., 2011). This limitation was considered during data analysis and interpretation. The inter-rater reliability for the MET calculations for each activity area and overall METs were both perfect (k = 1.00).

Philadelphia ACES Questionnaire

To try and account for the limitations of the original ACES questionnaire, this study will use a modified Philadelphia ACES questionnaire. The Philadelphia ACES measures the original ACES indicators and expansion items to include questions about stressors manifesting outside the household. The expanded ACES were identified through a review of the literature which resulted in the addition of five more categories: witness violence, felt discrimination, adverse neighborhood experience, bullied, and lived in foster care (Cronholm et al., 2015). The Philadelphia ACE questionnaire consists of 21 questions in which each item is equivalent to 1 point. Eight of the questions are formatted as yes/no questions similar to the original ACE questionnaire (Felliti, 1998). For example, “Did you live with anyone who was a problem drinker or alcoholic?”. If the participants answered “yes” to the question, then they received 1 point. If they answered “no”, they did not receive a point for that question. Three questions were answered by choosing “never”, “once”, “a few times”, or “many times”. An example of these items includes, “While you were growing up how often did a parent, stepparent, or another adult who is helping raise you being slapped, kicked, punched, or beaten up?”. If the participant answered “many times” or a “few times” they received 1 point, if they answered “once” or “never” they did not receive a point. Three of the questions were answered with responses “very often true”, “often true”, “sometimes true”, “rarely true” or “never true”. An example of one these items include “Your family sometimes cut the size of meals or skipped meals because there was not enough money in the budget for food?”. If a participant answered, “very often true” or “often true” for the question they received one point. If they answered sometimes true; rarely true; never true they did not receive a point for that question. Four of the questions were answered by choosing “more than once”, “once”, “never”. An example of one of these items include “While you were growing up did a parent, step-parent, or another adult living in your home, push, grab, shove or slap you?”. If the participant answered “more than once” or “once” they received a point for that question. If they answered “never” they did not receive a point for that question. Three of the questions could be answered with “All of the time”, “Most of the time”, “Some of the time”, “None of the time”. An example of one of these include “Did you feel safe in your neighborhood”. If participants responded “some of the time” or “none of the time” they received a point. If they responded with “All of the time” or “Most of the time” they did not receive a point. A total Philadelphia ACE score was calculated by summing the number of responses that received a point. Participants could receive a total score that ranged from 0-21. The Philadelphia ACE assessment has demonstrated good test–retest reliability with adult samples (Dube et al., 2004, Pinto et al., 2014). The internal consistency of the Philadelphia

ACEs questionnaire has not been investigated previously. However, Holden and colleagues (2020) and Bethell and colleagues (2017) provide reviews of the psychometric properties of similar ACE questionnaires. Internal consistency in the current study for total ACEs (α =.854), conventional ACEs subscale (α =.852) were adequate, excluding the expanded ACEs subscale (α = .561).

Quality of Life (WHOQOL) - BREF

The Quality of Life-BREF includes a subset of items from the original 25 domain, 100 item quality of life questionnaire was developed to assess quality of life cross-culturally (WHO, 1996). The WHOQOL-BREF was designed to measure a person's perception of their health, beyond traditional health indicators such as mortality and morbidity, and include measures that assess the impact a disease or condition has on daily activities, behavior, and overall quality of life (World Bank, 1993; WHO, 1991). There are four domains to the BREF version of this quality-of-life measure (i.e., physical health, psychological, social relationships, and environment) and 26 questions that are answered on a Likert scale (i.e., not at all, not much, moderately, a great deal, and completely). Six questions are from the physical health domain. Examples include, “To what extent do you feel that physical pain prevents you from doing what you need to do?” and “How satisfied are you with your sleep?”. Two questions are from the psychological domain, “To what extent do you feel your life to be meaningful?” and “How satisfied are you with yourself?” Three questions are from the social relationships domain. Examples include, “How satisfied are you with your personal relationships?” and “How satisfied are you with the support you get from your friends?”. Eight questions are from the environment domain. Examples include, “Have you enough money to meet your needs?” and “How satisfied are you with your transport?". Scores are scaled in a positive direction (e.g., higher scores denote higher perceived quality of life).

The current study only focused on the subscale of physical health given our interest in health-related outcomes and previous literature linking self-reported perceptions of health to objective health functioning (Frostholm et al., 2007; Lichtenstein & Thomas, 1987; Trice, 2016). Furthermore, the WHOQOL's measurement of overall quality of life is assessed via a single question (i.e., "How would you rate your quality of life?"). Therefore, rather than relying on a single question for the outcome variable, the physical health domain score was selected as the outcome variable. The mean score of items within the physical health domain was used to calculate the participants perceived quality of physical health domain score. Mean scores were then multiplied by 4 to make domain scores comparable with the scores used in the WHOQOL-100. Domain scores can range from 0-100 (WHO, 1996). Prior studies (Ilić et al., 2019; Kalfloss et al., 2021) indicates the measure to be internally consistent (α = .74- .85). Internal consistency in the current study for the physical health domain (α =.70) was adequate.

Executive Function Measures

There is a general consensus among scholars that executive function can be divided into three at least partially independent components: inhibitory control, working memory, and cognitive flexibility (Diamond, 2013; Lehto et al., 2003; Miyake et al., 2000). To measure executive function among the participants, response accuracy and reaction time were recorded on attentional inhibitory control, working memory, and cognitive flexibility tasks. These three components of executive function were selected because of the previous research suggesting they are independent components (Miyake et al., 2000). The selection of specific tasks within each component of executive function was guided by the National Institutes of Health (NIH) Toolbox: Cognition Battery. The NIH Toolbox Cognition Battery is the result of an interdisciplinary initiative to create a common set of instruments to evaluate cognitive, emotional, sensory, and motor health across the lifespan. The current study selected the Eriksen Flanker task to measure inhibitory control, the Sternberg Working Memory Test to measure working memory, and the Wisconsin Card Sorting Test to measure cognitive flexibility.

Eriksen Flanker Task. This task has been used to measure attention and inhibitory control. Attention is a person's ability to be alert and engage with surroundings (Oken et al., 2006; Lindsay et al., 2020). Inhibitory control is a central component of executive function that develops in early childhood (Diamond, 2004; Liu et al., 2015) and is defined as a person's ability to withhold or suppress a thought or an action (Lyons & Zelazo, 2011; Williams et al., 1999). Inhibitory control has two main components: inhibition-response and interference control (Diamond, 2013; Friedman & Miyake 2004). The current task focused on the component of interference control or inhibition of attention.

Within the Flanker task, participants were asked to respond to a target stimulus (left- or right-facing arrow, “<” or “>”) while inhibiting attention to distractor stimuli (congruent, incongruent arrows or a neutral stimulus, diamond) flanking it. Participants were instructed to press “1” for a target arrow facing left and “2” for a target arrow facing right. The target stimulus was surrounded by two distractor stimuli on each side. Each trial began with a fixation cross presented for 1000ms, followed by the arrow stimuli (Figure 1). Each trial had a max duration of 1000 ms. If participants did not respond within the time limit, the trial was marked as incorrect and the fixation cross for the next trial would automatically appear. Feedback was provided to the participants after each trial. For one-third of the trials the “flankers” were pointing in the same direction as the target stimulus (congruent). For another third of the trials the “flankers” were pointing in the opposite direction as the target stimulus (incongruent), and during the final third of the trials the flankers were neutral. After six practice trials, the participants completed 120 test trials. The test took approximately four minutes to complete. The reaction time for correct trials and percent correct of correct trials extracted. Reaction time was calculated in excel by averaging the reaction times of the correct trials. Furthermore, percent correct was calculated in excel by dividing the number of correct trials by the total number of trials (120). Reaction time was utilized in the mediation analyses because of the lack of variability with the percent correct measure.

Sternberg Working Memory Test. Working memory is the cognitive process that stores and manipulates a limited amount of information over a brief period of time (Baddeley, 1987). Working memory has been related to intelligence, ability to plan, overall comprehension, information processing, and learning (Cowan, 2014). In order to successfully complete an executive function task, one must be able to retain and manipulate the presented information. (Chai et al., 2018). Thus, in this study participants were instructed to memorize certain letters and ignore others. During memorization, a list of eight letters was sequentially presented at a rate of 1000 ms per letter. The list consisted of a mix of black and green letters. Participants were instructed to memorize the black letters and ignore the green letters. A brief pause following memorization made up the maintenance period. Following the maintenance period, the test period started. A list of letters was again sequentially presented that included letters the participants were asked to memorize and new letters that were not presented previously. Participants indicated via key press whether the letter was one they were asked to memorize (“1”) or a new letter (“2”). After a short practice block, participants completed two test blocks consisting of memorization, maintenance, and recall periods. During the first block, memorization consisted of eight letters, seven of which were black and one which was green. Recall consisted of fourteen letters, seven in which the letter presented during recall was also in the memorization period and seven in which the letter presented during recall was new. During the second block, memorization consisted of eight letters, five of which were black and three of which were green. Recall consisted of ten letters, seven in which the letter presented during recall was also in the memorization period, and three in which the letter presented during recall was new. The dependent measures were percent of correct letters recalled and average reaction time of the correct trails. Reaction time was calculated in excel by averaging the reaction times of the correct trials. Furthermore, percent correct was calculated in excel by dividing the number of correct trials by the total number of trials. Reaction time was utilized in the mediation analyses because of the lack of variability with the percent correct measure.

Wisconsin Card Sorting Test. This test is related to attention, working memory, visual processing, and cognitive flexibility. (Grant & Berg, 1948). Several subdomains of cognitive function (i.e., inhibitory control, working memory, switching and attention) coherently implement cognitive flexibility. Cognitive flexibility is the ability to shift attention between mental processes to generate an appropriate response (Dajani & Uddin, 2015). Participants were instructed to categorize cards according to different criteria (i.e., color, number, shape). Participants had a maximum of 10000 ms to click on the correct category. If no answer was provided within that time, the trial was coded as incorrect and the next trial started. After an undisclosed number of trials, the criteria or sorting rule changed. The participants were not informed of this switch in any way except through the feedback that they had sorted incorrectly. After a short practice block, the participants were asked to sort cards based on the changing categorization criteria. There was a total of 30 trials, ten for each category type (e.g., color, shape, number). The percent of correct responses and reaction time for correct responses were extracted. Reaction time was calculated in excel by averaging the reaction times of the correct trials. Furthermore, percent correct was computed through the Tobi software. Reaction time was utilized in the mediation analyses because of the lack of variability with the percent correct measure.

Chapter 4. Data Analysis

Numerous individual-level characteristics may influence executive function (Assari et al., 2021; Friedman et al., 2008; Hook et al., 2013; Litkowski, 2017; Rhoades et al., 2011) or physical activity (Alharbi, 2019; McMinn et al., 2013; Molnar et al., 2004; Wilk et al., 2018) such as race/ethnicity and SES. Any demographic covariates that were not significant across models were removed, and hypothesized multivariate models were re-analyzed in accordance with the principle of parsimony, which posits that preference should be given to models containing the fewest numbers of assumptions or variables, without compromising predictive or explanatory value (McCullagh & Nelder, 1989). Frequencies for demographic characteristics were calculated.

All analyses were conducted using the Statistical Package for Social Sciences (SPSS), Version 26. Pearson's product-moment bivariate correlations were utilized to examine associations between, and independence of, ACE score, reported barriers to physical activity, self-reported physical activity, measures of executive function, and perceived quality of physical health. To minimize risk of biased parameter estimates and consistent with recommendations put forth in the social sciences, a cutoff of $r > .80$ was used to determine multicollinearity (Abu-Bader, 2011).

Multivariate mediation analysis was conducted using Model 6 from the PROCESS macro for SPSS, Version 2.16 (Hayes, 2013). Barriers to physical activity was examined as a first-order mediator, self-reported physical activity as a second-order mediator, and executive function (each measure of executive function in a separate model) as a third order mediator, in the relation between ACEs, and perceived quality of physical health. In the serial mediation models we controlled for demographic characteristics that include- age, race and gender. In serial mediation analyses, several indirect and direct associations can be examined among the study variables. A specific indirect effect refers to the effect of the independent variable on the dependent variable through three mediators. In the current study, the following specific indirect effects can be observed: ab = The total indirect effect, denoted as $a_{123}b_{123}$ in our study, is the sum of all specific indirect effects.; a_1b_1 = ACEs related to perceived quality of physical health through barriers to physical activity; a_2b_2= ACEs related to perceived quality of physical health through physical activity levels; a_3b_3= ACEs related to perceived quality of physical health through one of the domains of executive function (i.e., inhibition, cognitive flexibility, and working memory); $a_1d_{21}b_2$= ACEs is related to perceived quality of physical health through barriers to physical activity and physical activity levels; $a_1d_{31}b_3$= ACEs related to perceived quality of physical health through barriers to physical activity and one of the domains of executive function; $a_2d_{32}b_3$=ACEs related to perceived quality of physical health through physical activity levels and one of the domains of executive function $a_1d_{21}d_{32}b_3$= ACEs related to perceived quality of physical health through barriers to physical activity, physical activity levels and one of the domains of executive function.

Additionally, c symbolized the total effect of the IV on the DV which, in our study, represents the association between ACEs and perceived quality of physical health prior to considering the mediators of barriers to physical activity, physical activity and executive function. By contrast, *c*` represents the direct effect, or the effect of the IV on the DV after controlling for all mediators. Thus, in our study, *c*` represents the relation between ACEs and perceived quality of physical health, accounting for the effects of barriers to physical activity, physical activity levels and executive functioning.

As a methodological technique, there are several advantages to using serial mediation (Preacher & Hayes, 2008). First, comparison of mediator contribution to the linkage between IV and DV, relative to the presence or absence of other variables in the model, is possible. Second, potential confounding variables can be included as mediators or covariates, reducing likelihood of biased parameter estimates. Third, bootstrapping is utilized, which is a resampling technique that involves taking n cases, with replacement, from the original sample, allowing for an estimating of the indirect effects in each resampled data set and the calculation of confidence intervals. Bootstrapping lowers risk of Type 1 error and elevates power, especially for small sample sizes, by creating empirical approximations of the sampling distributions and increasing the likelihood of it resembling the actual distribution within the general population. Thus, serial mediation via bootstrapping procedure represents a strong methodological approach to data analysis and interpretation in correlational-based research, such as this study.

Chapter 5. Results

Preliminary Analyses

Sample Demographics

The mean age of participants was 21.81 (SD = 4.75) years of age. Approximately 70% of the sample identified as female (n = 53, 69.7%), 25% (n=19) of the sample identified as male, 2.7% (n=2) of the sample indicated that their gender was not listed, and one individual did not respond. Most participants identified as White/Caucasian (72.0 %, n = 54), 14.7% (n=11) identified as African/Black, 6.7% (n=5) identified as Hispanic/Latino/a, 2.7% (n=2) identified as Asian, 1.3% (n=1) identified as American Indian/ Alaskan Native, and 1.3% (n=1) identified as Pacific Islander. One participant did not respond (1.3%) to this question. The sample primarily consisted of undergraduate students (82.7%; n=62); however, 17.3% (n=13) identified as a graduate student. Most of the sample reported being right-handed (89.3%, n=67) and the remaining participants reported being left-handed (10.7%, n= 8). Complete summary statistics related to the demographic data collected from the participants can be found in Table 1.

Table 1

Demographic Characteristics of the Sample

	M (SD) / Frequency (%)
Age	21.81 (4.75)
Height	169.15 inches (10.43)
Weight	172.81 lbs. (45.21)
Gender (Female)	53 (69.7)
Race (White)	54 (72.0)
Undergraduate	62 (82.7)
Right-handed	67 (89.3)
Full time enrollment	68 (90.7)
Bachelor's degree	56 (74.7)
Job status (Yes)	44 (58.7)
Hometown (Rural)	39 (52.0)
Married/Domestic Partnership	8 (10.7)

Barriers to Physical Activity

Descriptive statistics were conducted to examine the most prevalent barriers to physical activity reported in the current sample. Recall that barriers to physical activity were categorized into seven different categories (see Table 2). On a category level, the most prevalent barriers to physical activity reported were within the lack of energy (57.3%, n=43), lack of willpower (57.3%, n=43) and lack of time categories (56%; n=42). On an individual barrier to physical activity level, the most prominent barriers to physical activity were, “My day is so busy now, I just don’t think I can make the time to include physical activity in my regular schedule” (66.7%; n=50; from the lack of time category), “I’m just too tired after work to get any exercise” (65.3%; n=49; from the lack of energy category), and “It’s easier for me to find excuses not to exercise than to go out to do something” (60.0%; n=45; from the lack of willpower category). On average, out of the seven barrier categories, participants response scores indicated that 2.31 (SD = 1.75) barriers to physical activity categories are important to overcome. In other words, 2.31

barrier categories create problems for participants engaging in physical activity. See Table 3 for the frequency of the number of category barriers to physical activity reported in the sample.

Table 2

Frequencies of Barriers to Physical Activity

	Frequency (%)
Lack of Energy	43 (57.3%)
Lack of Willpower	43 (57.3%)
Lack of Time	42 (56%)
Social Influence	28 (37.3%)
Fear of Injury	1 (1.3%)
Lack of Skill	9 (12.0%)
Lack of Resources	7 (9.3%)

Note. Frequency = the number of people from the sample that struggle with that barrier (received a score of >5 or higher in the category)

Table 3

Frequencies of the Number of Category Barriers to Physical Activity

Number of Category Barriers	Frequency (%)
0	18 (24.0%)
1	8(10.7%)
2	12(16.0%)
3	18(24.0%)
4	10(13.3%)
5	7(9.3%)
6	2(2.7%)
Total	75

ACEs

We summed the Conventional ACEs and Expanded ACEs to get the total Philadelphia ACEs. The lowest ACE score reported in this sample was zero and the highest ACE score was seventeen. The average Philadelphia ACE score was 4.85 (SD = 4.262), see Table 4 for summary statistics. When examined the conventional ACEs the average score was a mean score of 3.63 out of 15 and expanded ACE score of 1.187 out 5. On an individual question level, there are two items from the conventional ACEs that impacted a larger percentage of the sample were, "While growing up they lived with someone who was depressed or mentally ill" (60%; n=45), "While growing up a parent, step-parent, or another adult living in their home, swore at them, insulted them or put them down" (48%; n=36), and one item from the expanded ACEs that impacted to population, "Did not feel that people in their neighborhood looked out for each other, stood up for each other, and could be trusted" (41.3%; n=31).

Physical Activity Levels

Recall that MET represents the estimated amount of energy expended when being physically active. Moderate, vigorous, and walking physical activity levels through the calculation of MET scores/values. The average days and hours per week for each activity level are presented in Table 4 along with average METs. Approximately, 13% (n=10) of the sample reported that there was something that prevented them from doing their normal physical activity in the last week. Some of the responses included sickness, injury, and starting a new job. Furthermore, there was a statistical difference between the reported amount of days of physical activity participants completed prior to the COVID-19 pandemic (M = 4.30, SD = 1.73 days) and moderate physical activity at the time of data collection (M = 3.34, SD = 1.94 days), $t(34) = 2.30$, $p = .028$, but no statistical difference for reported duration (hours) of physical activity completed prior to the COVID-19 pandemic (M = 1.86 hours, SD = 1.33) and at the time of data collection (M = 1.79 hours, SD = 1.55), $t(46) = .200$, $p = .843$.

A small percentage reported that (13%, n=10) reported that they were sick in the last week, or something prevented them from participating in their normal physical activity. Examples include sickness (e.g., cold, stomach issues), starting a new job and mental health. In addition, a small percentage (7.9%, n=6) of the sample reported that they have permanent health issues that interfere with regular physical activity. Some of the permanent health issues that make it more difficult to engage in physical activity include physical injuries (e.g., back, hip, ankle), mental health issues and asthma. All participants who reported sickness within the last week or permanent health issues, still had the opportunity to report their physical activity (vigorous, moderate, walking) within the last 7 days. If they reported any type of physical activity, their total MET was still calculated and included in the analysis. If participants reported that they did not engage in any form of physical activity within the last 7 days, they received a score of '0' for their total (MET). For instance, if a participant received a score of 0 for vigorous physical activity (MET), score of 0 for moderate physical activity (MET), and a score of 0 for walking (MET) their total MET would be equal to 0. If a participant received a score of 0 for vigorous physical activity (MET) and a score of 600 for moderate physical activity (MET), and a score of 462 for walking (MET) their total MET would be equal to 1,062.

Executive Function Tasks

Descriptive statistics were conducted on the reaction time and percent correct dependent variables on Flanker Task, Sternberg Working Memory Task, and Wisconsin Card Sorting Task and are presented in Table 5. The bivariate correlations between reaction time and percent correct for the executive function tasks are presented in Appendix F.

Perceived Quality of Physical Health

Descriptives were conducted on the overall quality of life questions and perceived quality of physical health. See table 4.

Table 4

Descriptive Statistics for Expanded ACE Questionnaire, International Physical Activity Questionnaire, and Executive Function Tasks

	n	Mean (SD) / Frequency (%)
Barriers to Physical Activity	75	2.31 (1.75)
IPAQ		
Vigorous PA METs	75	2130.17 (2128.09)
Vigorous PA Days/week		3.68 (1.69)
Vigorous PA Hours/day		1.55 (1.20)
Moderate PA METs	75	1220.98 (1898.70)
Moderate PA Days/week		3.34 (1.94)
Moderate PA Hours/day		1.79 (1.55)
Walking METs	75	2852.00 (2686.65)
Walking Day/week		5.24 (1.85)
Walking Hours/day		1.70 (1.57)
Total	75	4499.99 (4798.8)
ACEs		
Philadelphia ACEs	75	4.84 (4.26)
Conventional ACEs	75	3.65(3.51)
≥ 1	62	62 (83.1%)
Expanded ACEs	75	1.19 (1.28)
≥ 1	43	43 (58.4%)
WHOQOL		
Overall Quality of life	75	64 (85.3%)
Satisfaction with Health	75	39 (52.0%)
Perceived Quality of Physical Health	74	68.32 (16.07)
Executive Function		
Flanker (RT)	75	432.33 (57.48)
Flanker (% correct)	75	.940 (.088)
Sternberg (RT)	75	2585.93(1021.65)
Sternberg (% correct)	75	.650 (.079)
Wisconsin CS (RT)	75	1679.16 (502.65)

Wisconsin CS (% correct)	75	.725 (.117)

Notes. Mean and standard deviations of physical activity (PA), RT (reaction time), % correct (percent correct), Wisconsin CS (Card Sorting). Overall Quality of life frequency represents the participants who rate their quality of life as "good" or "very good". The satisfaction of health frequency represents participants that "satisfied or "very" satisfied with their health. ≥ 1 represents participants that experienced 1 or more ACEs.

Bivariate Correlations

Bivariate correlations were utilized to look at the relationship among the variables. Critical relations were present, but multicollinearity was not an issue because r's < .8 (Table 7). ACE scores were positively correlated with barriers to physical activity (r = .348, p =.002), inhibitory control (r = .098, p =.403), working memory (r = .085, p = .466), cognitive flexibility (r = .148, p =.206), and physical activity levels (r = .226, p =.051), and negatively correlated with perceived quality of physical health (r = -.385, p <.001) (See table 5).

Table 5

Bivariate Correlations of Variables in the Serial Mediation Model

	n	1.	2.	3.	4.	5.	6.	7.
1. ACEs	75	---						
2. Barriers to PA	75	.348**	---					
3. PA levels (MET)	75	.226	-.238*	---				
4. Flanker (RT)	75	.098	.101	-.141	---			
5. Sternberg (RT)	75	.085	.239*	.142	.213	---		
6. Wisconsin CS (RT)	75	.148	.156	-.108	.044	.118	---	
7. Quality of Life	74	-.385**	-.418**	-.315**	.065	-.093	-.104	---

Note: SD= Standard Deviation, ** Correlation is significant at the p < 0.01 level (2-tailed). *Correlation is significant at the p < 0.05 level (2-tailed). MET (metabolic equivalent task), ACEs (Philadelphia adverse childhood experiences), PA (physical activity), RT (reaction time), Wisconsin CS (card sorting).

Serial Mediation

Inhibitory Control

Because of the multiple indicators of executive function, three separate serial mediation models were conducted. The first model examined inhibitory control as one of the serial mediators of perceived quality of physical health (Figure 1, Tables 6). A significant total effect was observed in the model (c = -1.61, SE = .416, *p* = .0003, 95% CI [-2.44, -.775]). The direct effect of ACEs on perceived quality of physical health was nonsignificant when mediators were controlled (c'= -.664, SE =.430, *p* =.127, 95% CI [-1.52, .195]). Additionally, several indirect effects were observed in this model. First, the total indirect effect of ACEs on perceived quality of physical health (ab = -.94, SE =.31, 95% CI [-1.68, -.445]) was significant. Second, higher ACE scores were associated with more barriers to physical activity and, in turn, lower perceived quality of physical health (a_1b_1= -.53, SE = .26, 95% CI [-1.14, -.13]). Third, higher ACE scores were associated with higher physical activity levels, which in turn, related to lower perceived quality of physical health (a_2b_2= -.58, SE = .31, 95% CI [-1.28, -.09]). Finally, higher ACE scores were associated with more barriers to physical activity, lower physical activity levels, which in turn, related to lower perceived quality of physical health ($a_1d_{21}b_2$ =.15, SE =.10, 95% CI [.02, .39]).

There were also several hypothesized indirect effects that were nonsignificant. ACEs and perceived quality of physical health were not serially mediated through barriers to physical activity, physical activity levels, and inhibitory control ($a_1d_{21}d_{32}b_3$= .00, SE = .01, 95% CI [-.02, .02]). Furthermore, inhibitory control did not mediate the relationship between ACEs and perceived quality of physical health (a_3b_3= .02, SE =.08, 95% CI [-.15, .20]). Additionally, a specific indirect effect was not observed for ACEs through barriers to physical activity and inhibitory control ($a_1d_{31}b_3$= .00, SE = .02, 95% CI [-.03, .06]), indicating that barriers to physical activity and inhibitory control do not mediate the relationship between ACEs and perceived quality of physical health. Lastly, physical activity levels and inhibitory control did not mediate the relationship between ACEs and perceived quality of physical health ($a_2d_{32}b_2$ = -.01, SE = .04, 95% CI [-.10, .06]).

Table 6

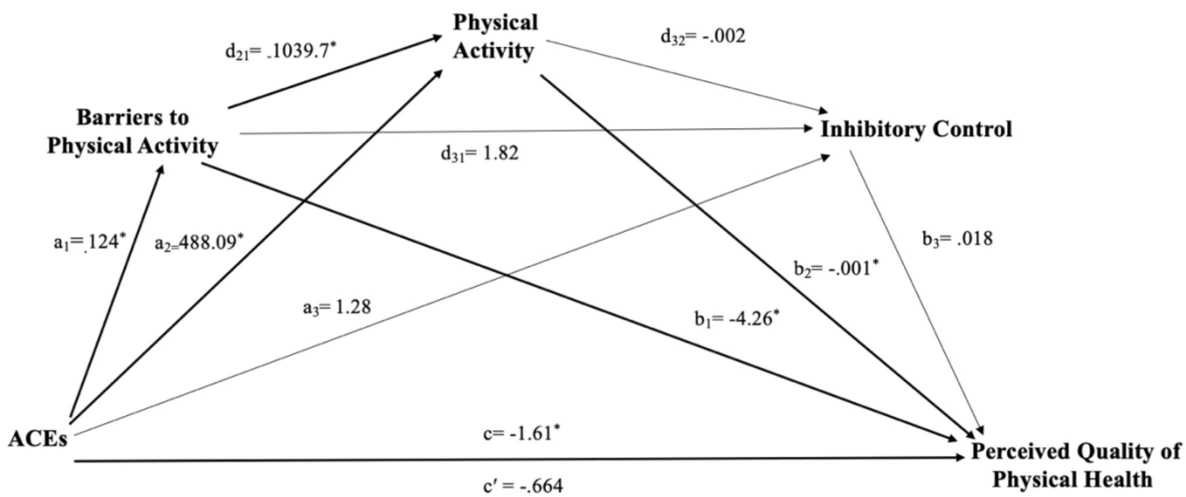
Specific Indirect Effects Between ACEs and Quality of Life Serial Mediation Utilizing Barriers to Physical Activity, Physical Activity Levels and Executive Function (Reaction Time).

	Effect	*b*	95% CI Lower	95% CI Upper
Inhibitory Control	***ab***	**-.94**	**-1.68**	**-.46**
	$\boldsymbol{a_1b_1}$	**-.53**	**-1.14**	**-.13**
	$\boldsymbol{a_2b_2}$	**-.58**	**-1.28**	**-.09**
	a_3b_3	.02	-.15	.20
	$\boldsymbol{a_1d_{21}b_2}$	**.15**	**.02**	**.39**
	$a_1d_{31}b_3$	.00	-.03	.06
	$a_2d_{32}b_3$	-.01	-.10	.06
	$a_1d_{21}d_{32}b_3$	.00	-.02	.02
	R^2	.385***		
Working Memory	***ab***	**-1.00**	**-1.74**	**-.47**
	$\boldsymbol{a_1b_1}$	**-.56**	**-1.21**	**-.12**
	$\boldsymbol{a_2b_2}$	**-.63**	**-1.37**	**-.10**
	a_3b_3	.04	-.17	.13
	$\boldsymbol{a_1d_{21}b_2}$	**.17**	**.02**	**.41**
	$a_1d_{31}b_3$	.03	-.02	.17
	$a_2d_{32}b_3$	.04	-.09	.17
	$a_1d_{21}d_{32}b_3$	-.01	-.05	.02
	R^2	.388***		
Cognitive Flexibility	***ab***	**-.98**	**-1.70**	**-.46**
	$\boldsymbol{a_1b_1}$	**-.52**	**-1.12**	**-.12**
	$\boldsymbol{a_2b_2}$	**-.60**	**-1.32**	**-.09**
	a_3b_3	-.01	-.15	.12
	$\boldsymbol{a_1d_{21}b_2}$	**.16**	**.02**	**.38**
	$a_1d_{31}b_3$	-.00	-.05	.04
	$a_2d_{32}b_3$	.00	-.05	.01
	$a_1d_{21}d_{32}b_3$	-.00	-.02	.01
	R^2	.382***		

Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on executive function; b_1 = direct effect of barriers to PA on quality of life; b_2 = direct effect of PA levels on quality of life; b_3 = direct effect of executive function on quality of life; d_{21}= direct effect of barriers of physical activity to physical activity levels; d_{31}= direct effect of barrier to physical activity to executive function; d_{32}= direct effect of physical activity levels to executive function. *ab* = Total Indirect Effect; a_1b_1 = specific indirect effect through barriers to PA; a_2b_2 = specific indirect effect through PA levels; a_3b_3 = specific indirect effect through executive function;$a_1d_{21}b_2$= specific indirect effect through barriers to PA and PA levels; $a_1d_{31}b_3$ = specific indirect effect through barriers to PA and executive function; $a_2d_{32}b_3$= specific indirect effect through physical activity levels and executive function; $a_1d_{21}d_{32}b_3$=specific indirect effect through barriers to physical activity, physical activity levels, and executive function. R^2 = total indirect effect variance accounted for by the model. CI = 95% confidence interval; 5,000 bootstrap samples; age, sex, race/ethnicity used as covariates.*** p < .001. bolded indirect effects are significant indirect effects.

Figure 1

Serial Mediation with Inhibitory Control (reaction time) as a Third-order Mediator



Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on executive inhibitory control; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of inhibitory control on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity to physical activity levels; d_{31}= direct effect of barrier to physical activity to inhibitory control; d_{32}= direct effect of physical activity levels to inhibitory control; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathways.

Working Memory

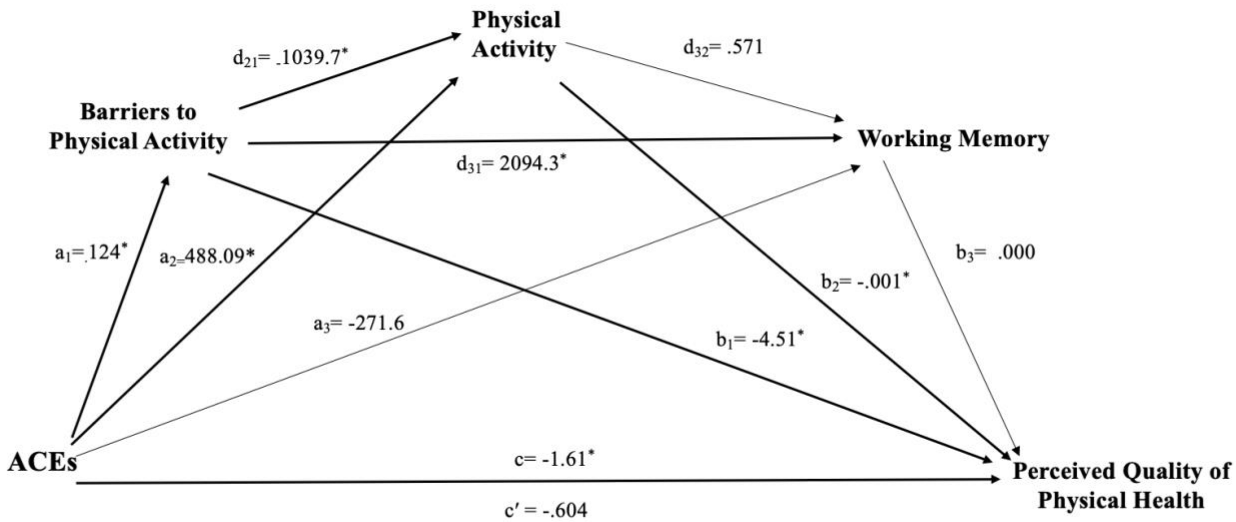
The second model observed working memory as one of the mediators of perceived quality of physical health (see Figure 2, Table 6). A significant total effect was observed (c = -1.61, SE = .416, *p* =.0003, 95% CI [-2.44, -.775]). The direct effect of ACEs on perceived quality of physical health was nonsignificant when mediators were controlled (c'= -.604, SE =

.429, *p* =.1646, 95% CI [-1.46 to .254]). Additionally, four significant indirect effects were observed in this model. First, the total indirect effect of ACEs on perceived quality of physical health (ab= -1.00, SE=.34, 95% CI [-1.74, -.468]) was significant. Second, higher ACE scores were associated with more barriers to physical activity and, in turn, lower perceived quality of physical health (a_1b_1= -.56, SE = .28, 95% CI [-1.20, -.122]). Third, higher ACE scores were associated with higher physical activity levels, which in turn, related to lower perceived quality of physical health (a_2b_2= -.63, SE = .32, 95% CI [-1.36, -.103]). Fourth, higher ACE scores were associated with more barriers to physical activity, lower physical activity levels, and in turn, lower perceived quality of physical health ($a_1d_{21}b_2$=.17, SE = .20, 95% CI [.02 to .41]).

All other indirect effects in this model were nonsignificant. ACEs and perceived quality of physical health were not serially mediated through barriers to physical activity, physical activity levels and working memory ($a_1d_{21}d_{32}b_3$= -.01, SE = .02, 95% CI [-.05, .02]). Working memory did not mediate the relationship between ACEs and perceived quality of physical health (a_3b_3= -.04, SE=.07, 95% CI [-.17, .13]). Additionally, a specific indirect effect was not observed for ACEs through barriers to physical activity and working memory ($a_1d_{31}b_3$= .03, SE = .05, 95% CI [-.02, .17]), indicating that barriers to physical activity and working memory did not serially mediate the relationship between ACEs and perceived quality of physical health. Lastly, physical activity levels and working memory did not serially mediate the relationship between ACEs and perceived quality of physical health ($a_2d_{32}b_2$= .04, SE = .06, 95% CI [-.09, .17

Figure 2

Serial Mediation with Working Memory (reaction time) as a Third-order Mediator



Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on working memory; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of working memory on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity on physical activity levels; d_{31}= direct effect of barrier to physical activity on working memory; d_{32}= direct effect of physical activity levels on working memory; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathways.

Cognitive Flexibility

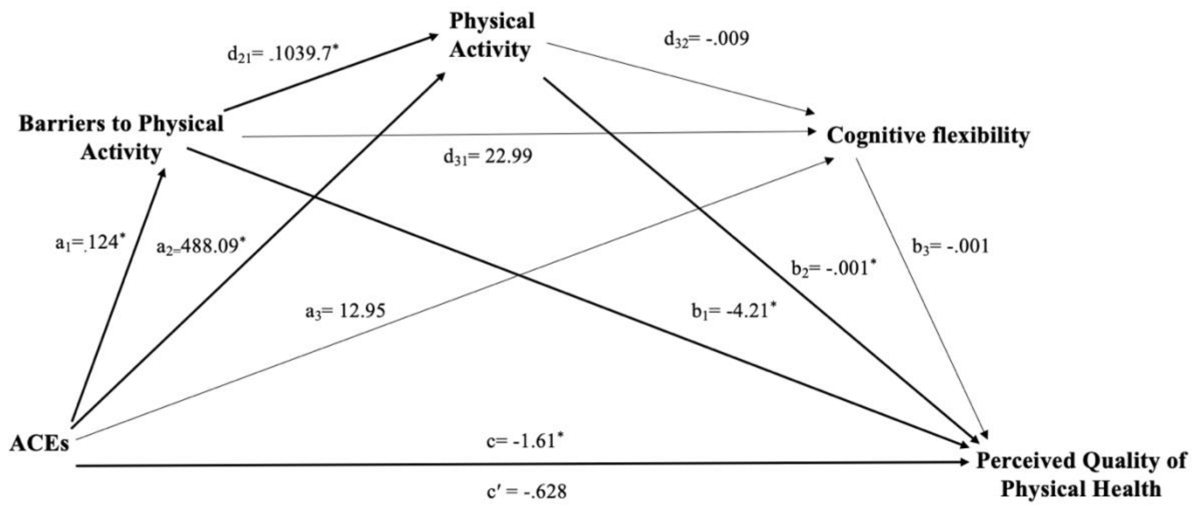
The third model examined cognitive flexibility as one of the mediators of perceived quality of physical health (see Figure 3 for indirect effects, Table 6). A significant total effect was observed (c = -1.61, SE = .42, p =.003 95% CI [-2.44, -.775]). The direct effect of ACEs on perceived quality of physical health was nonsignificant when mediators were controlled (c'= -.628, SE = .43, p = .15, 95% CI [-1.49, .23]). Additionally, four significant indirect effects were observed in this model. First, the total indirect effect of ACEs on perceived quality of physical health (ab = -.98, SE = .31, 95% CI [-1.70, -.46]) was significant. Second, higher ACE scores were associated with more barriers to physical activity and, in turn, lower perceived quality of physical health (a_1b_1= -.52, SE = .16, 95% CI [-.70, -.07]). Third, higher ACE scores were associated with higher physical activity levels, which in turn, related to lower perceived quality of physical health (a_2b_2= -.38, SE =.25, 95% CI [-1.12, -.12]). Fourth, higher ACE scores were associated with more barriers to physical activity, lower physical activity levels, and in turn, lower perceived quality of physical health ($a_1d_{21}b_2$ =.16, SE = .09, 95% CI [.02, .38]).

All other indirect effects were nonsignificant. ACEs and perceived quality of physical health were not serially mediated through barriers to physical activity, physical activity levels, and cognitive flexibility ($a_1d_{21}d_{32}b_3$= -.00, SE = .01, 95% CI [-.02, .01]). Cognitive flexibility did not mediate the relationship between ACEs and perceived quality of physical health (a_3b_3= -.01, SE = .06, 95% CI [-.15, .12]). Additionally, a specific indirect effect was not observed for ACEs through barriers to physical activity and cognitive flexibility ($a_1d_{31}b_3$= -.00, SE = .02, 95% CI [-.05 to .04]), indicating that barriers to physical activity and cognitive flexibility did not mediate the relationship between ACEs and perceived quality of physical health. Lastly, physical activity levels and cognitive flexibility did not mediate the relationship between ACEs and perceived quality of physical health ($a_2d_{32}b_2$= .00, SE = .01, 95% CI [-.05, .06]).

In summary, the patterns of indirect and direct effects were consistent across all three domains of executive function. However, the hypothesized serial mediation model was only partially supported. Barriers to physical activity and physical activity levels serially mediated the relationship between ACEs and perceived quality of physical health. Contrary to the hypothesis, the relationship between ACEs and perceived quality of physical health was not serially mediated by the third-order mediator, executive function

Figure 3

Serial Mediation with Cognitive Flexibility (reaction time) as a Third-order Mediator



Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on cognitive flexibility; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of cognitive flexibility on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity on physical activity levels; d_{31}= direct effect of barrier to physical activity on cognitive flexibility; d_{32}= direct effect of physical activity levels on cognitive flexibility; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathways.

Chapter 6. Discussion

This dissertation examined the interrelations of ACEs, barriers to physical activity, physical activity levels, executive function, and perceived quality of physical health in a sample of seventy-five undergraduate students. This study found that barriers to physical activity and physical activity levels were serial mediators to the relationship between ACEs and perceived quality of physical health. However, the current study had insufficient evidence to support the hypothesized third-order mediator, executive function, in the relationship between ACEs and perceived quality of physical health. Overall, the results suggest that adversity during childhood is related to perceived quality of physical health in adulthood, “through” barriers to physical activity and physical activity levels. The term “through” means that barriers to physical activity and physical activity levels are important factors in understanding the relationship between the independent variable (ACEs) and dependent variable (perceived quality of physical health).

Barriers to Physical Activity

On average, the participants reported struggling with approximately three out of the seven possible category-level barriers to physical activity. Specifically, more than half of the participants reported that they struggled with lack of energy, lack of willpower, and lack of time. These results align with previous research indicating the most common barrier to physical activity is lack of time (Chang et al., 2018; El Gilany et al., 2011) and lack of willpower (Chang et al., 2018). It may be that college students are under immense pressure to stay on top of school, work, and family responsibilities that they are overwhelmed and simply cannot find the time in the day to engage in physical activity. In the Appalachian region, a high proportion of students work part- or full-time jobs (Pollard & Jacobsen,2021;Scommegna et al.,2012) and likely have increased family responsibilities due to the pandemic (Uppercue, 2020) in addition to being a college student. Moreover, even if college students are finding time to exercise between classes, studying, and work, the COVID-19 pandemic altered access to public and private gyms, university physical activity centers, and community centers. The current study took place during the COVID-19 pandemic but after access had been restored to various community resources for physical activity. It is quite possible that individuals still felt unsafe to use these facilities given the ongoing pandemic and the overall exhaustion from pandemic contributed to the prevalence of perceived barriers to physical activity.

Most of the previous literature examining physical activity levels failed to concurrently examine perceived barriers to physical activity. The current study highlights the importance of considering perceived barriers to physical activity whenever one is interested in measuring physical activity. The two variables were highly correlated such that if a person is experiencing more barriers to physical activity, they are more likely to have lower physical activity levels. Moreover, in research investigating physical activity levels, it is important to consider *why* some individuals are reaching activity goals and others are not. Including a measure of perceived barriers to physical activity sheds some light on the why. If someone is unable to reach their personally desired or CDC recommended level of physical activity each week *because* of the extensive barriers they are facing it is not that the individual does not know the mental and physical benefits of engaging in physical activity, it is that there are societal barriers making it more difficult for them to complete it. Identifying the barriers to physical activity within various communities and groups of people may allow for the development of better policies, better use of funding, and eventually increased levels of physical activity and improved overall physical health. Thus, increasing rates of physical activity for individuals who report experiencing barriers to physical activity becomes more about breaking down those barriers and less about providing education about the importance of physical activity.

Previous literature explains that barriers to physical activity causes an increase in sedentary behaviors (Farah et al., 2021). Similarly, our results revealed there was a significant negative association between barriers to physical activity and physical activity levels. The more barriers to physical activity an individual reported, the lower their reported physical activity (e.g., METs). Additionally, barriers to physical activity were negatively associated with perceived quality of physical health indicating that the more barriers to physical activity someone experiences the lower their perception of quality of physical health. This is consistent with research that reveals that participating in physical activity can enhance a person's overall quality of life (Berger et al., 2007; Kokandi et al., 2019).

ACEs

The current study was interested in using the Philadelphia ACE measure within the mediation analysis to capture additional ACEs that were not within the original 10 proposed by Feletti and colleagues (1998). The average ACES score for the Philadelphia ACE measure is 4.85 out of 21. However, we could also examine the number of conventional ACEs within this sample. When looking at the more conventional ACEs (e.g., emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, domestic violence, household substance abuse, household mental illness and incarcerated household member) the population had a mean score of 3.63 out of 15 and expanded ACE score (e.g., felt discrimination, adverse neighborhood experiences, bullied and lived in foster care) of 1.187 out 5. Our samples ACEs scores were inconsistent with previous literature, because other researchers have reported an average of 2 on the conventional ACE score and a score of 3 on the expanded ACEs (Le-Scherban et al., 2018). However, our data is more consistent with data reported from participants within Appalachian populations in which 50 - 62% participants reported experiencing at least one ACE (Chanlongbutra et al., 2018; Iniguez & Standowski, 2016). Moreover, the current data is consistent with work of Wade and colleagues (2016) in which 67.5% of participants endorsed experiencing ≥ 1 conventional ACEs, and 58.8% endorsed experiencing ≥ 1 expanded ACEs. Conventional ACEs might be more common in this region than the experiences included within the expanded ACEs. This would need to be replicated in a much larger sample before further generalizations.

Physical Activity Levels

The total METs and walking METs reported in the current study are twice as high as rates reported in previous research (Wong et al., 2018). Vigorous physical activity and moderate physical activity METs were nearly 10 times larger than previously reported METs (Calestine et al., 2017; Wong et al., 2018). These results were very surprising given the similarities between samples (e.g., predominately White college students) and the number of barriers to physical activity reported in the sample. It is possible that the current sample is not representative of the average physical activity levels of college students. Perhaps this research opportunity was more appealing to individuals who are more inclined to be physically active than individuals who do not particularly enjoy physical activity. It is also possible that the participants included in the study were more active because of the number of opportunities at the university and within our region for students to engage in physical activity (e.g., hiking, walking, biking, kayaking, campus gym, group fitness). Furthermore, it is important to consider that MET values may not represent the true energy exerted during physical activity and METs are likely overestimates of actual physical activity amounts (Lee et al., 2011). Finally, each person's physical activity will vary based on certain factors (e.g., weight, age and health, intensity with which each activity being performed; Metabolism, 2020).

Another important consideration is that the participants had METs that were so high, they were potentially indicative of over-exercise. Perhaps, participants were coping with adversity or stress by exercising beyond what is adaptive for physical and mental health. Furthermore, the IPAQ-SF lists examples of physical activity that include digging and carrying light loads, which may be completed as part of physical labor for a job rather than leisurely physical activity. More labor-intensive jobs often are related to lower incomes, which may indicate more financial hardship. To try to investigate these possibilities within the measures of the current study, post hoc correlations were examined with specific items on the WHO quality of life measure (i.e., "are you able to accept your bodily appearance" and "have you enough money to meet your needs?") and overall MET score. However, neither correlation was statistically significant and thus there is insufficient evidence to support this speculation in the current study. In the future, it may be better for researchers to use the longer version of this measure, because it separates physical activity and physical labor at work or at least consider collecting data related to the participant's current occupation. Future research may also wish to include a survey on body satisfaction to better understand potentially unhealth levels of physical activity.

Executive Function Tasks

The average reaction times for cognitive flexibility and working memory in the current study were twice as long as the average reaction times reported in previous research (Ji & Wang, 2018). However, the average reaction time for inhibitory control in the current study was faster than previous research (Ji & Wang, 2018). Although our study was looking at the same domains of executive function (i.e., inhibitory control, cognitive flexibility, and working memory) as previous research, different tasks were used to assess each domain. For instance, Ji and Wang (2018) used the Go-No-Go task to assess inhibitory control), N-back task to assess working memory, and alphabetical switching to assess cognitive flexibility.

In addition to the specific task differences, it is also possible that these discrepancies could be due to the fact that performance on executive function tasks is influenced by other factors such as tiredness, caffeine consumption, emotional state, and motivation (Marcora et al., 2009; McLennan et al., 2016; Pessoa, 2009). Factors such as time of day and caffeine intake should be more closely examined in future research. Moreover, even within previous work that has used the same tasks as the current study (i.e., Flanker, Wisconsin Card Sort, Sternberg Working Memory) the specific procedures of each task may differ from study to study (e.g., maximum trial length, number of trials) and these small differences may result in large performance differences.

Perceived Quality of Physical Health

This study examined the physical health domain of the WHO questionnaire 68.33. The average physical health domain score (M = 68.33) is consistent with the general norms (M = 70) for the physical health domain (Hawthorne et al., 2006; Purba et al., 2018; Wong et al., 2018).

Bivariate Correlations

It was hypothesized that ACEs would be positively associated with barriers to physical activity, reaction times of inhibitory control, cognitive flexibility, and working memory and negatively associated with self-reported physical activity levels and perceived quality of physical health. Some of our hypotheses were supported while others were not. There was a positive association between ACEs and barriers to physical activity, indicating that a higher ACE score was related to more perceived barriers to physical activity. This result is consistent with previous research that reported participants who had higher ACEs reported that they did not engage in physical activity because of health problems, lack of time, lack of motivation, lack of work, or family obligations (Gwin et al., 2019).

Additionally, ACEs and perceived quality of physical health were negatively related such that individuals with more ACEs had lower perceptions of the quality of their physical health. This association is also consistent with previous research indicating that quality of life in adulthood is related to adversity in childhood (Nelson et al., 2020), as well as physical, mental, emotional, and social functioning (CDC, 2019). Moreover, adults that experienced at least one ACE reported worse physical health were more likely to report functional limitations (i.e., limits in activity due to physical, mental, or emotional problems) and were significantly more likely to report diagnosis of diabetes or heart attack than respondents who did not report an ACE (Monat & Chandler, 2015).

The associations between ACEs and reaction time of correct trials on all three executive function tasks were nonsignificant. This was unexpected given the relationship between executive function and ACEs is well-supported in the literature (Ji & Wang, 2019; Kelder et al., 2018; Lund et al., 2020). The current study differs slightly from previous research on ACEs and executive function. For example, the current study used the Philadelphia ACEs questionnaire (Cronholm et al., 2015) whereas the childhood trauma questionnaire (Ji & Wang, 2019), Behavioral Risk Factor Surveillance Analysis (Ji & Wang, 2019), and the traditional ACEs questionnaire (Maja et al., 2021) were used in previous work. The Philadelphia ACEs questionnaire covers a more comprehensive range of possible adversities. It expanded the original ACEs questionnaire by adding five more categories: witness violence, felt discrimination, adverse neighborhood experience, bullied, and lived in foster care (Cronholm et al., 2015). In addition, the original ACEs questionnaire utilized a rating system that only had yes/ no answers, while the Philadelphia ACEs questionaries had a more complex rating scale, that included multiple different answer choices (e.g., some yes/ no answers", some "once", "a few times", or "many times" answers). When we examined the association between conventional ACEs (9 categories, 15 questions) and executive function and expanded ACEs (5 categories, 6 questions) and executive function, the correlations were still nonsignificant. Indicating that no matter how we separate the ACEs questionnaire it was still indicating a nonsignificant correlation. Furthermore, it is also possible that the executive function tasks did not replicate previous work, this may be due to some of the methodological decisions that were made. Which might include the decision to complete the executive function task after the surveys. It is possible that the participants felt uneasy while completing executive function task, because prior they were asked to reflect on two sensitive topics- their childhood adversities and their health. Another methodological decision that might have impacted the results is the fact that the inhibitory control task and the cognitive flexibility task required participants to respond in a certain amount of time, and no response is considered an incorrect trial. If we measured participants true reaction time without any parameters, we may possibly see different results. Finally, additional factors such as caffeine intake, fatigue, and motivation may have impacted participants performance on the executive function tasks.

The association between ACEs and total physical activity levels (i.e., METs) was not significant. This result is surprising because Monat and Chandler (2015) found that people who experienced at least one ACE exercised less within the last month compared to people who have not experienced any ACE. Our results may have differed due to the fact that physical activity is being measured differently in previous literature (Monat & Chandler, 2015) or because the current sample reported a surprisingly high amount of physical activity. Perhaps, participants were already engaging in physical activity as an adaptive coping mechanism for stress or adversities. Future research should consider adding measures of motivation or reasons for engaging in physical activity.

Serial Mediation

Across models, the relationship between ACEs and perceived quality of physical health was serially mediated through barriers to physical activity and physical activity levels. Higher ACE scores were associated with more barriers to physical activity, lower physical activity levels, which in turn, resulted in lower perceived quality of physical health. Moreover, a specific indirect effect was observed through barriers to physical activity indicating that higher ACE scores were associated with more barriers to physical activity, which in turn, was associated with lower perceived quality of physical health. To our knowledge there is not research that examines barriers to physical activity and physical activity levels. However, there is research that reveals that people who have higher ACEs scores are likely have lower physical activity levels (Monat & Chandler, 2015).

However, the specific indirect effect through physical activity level indicated that higher ACE scores were associated with *higher* physical activity levels, which in turn, was associated with lower perceived quality of physical health. This indirect effect is the opposite of what one would predict given the previous literature on ACEs, physical activity, and physical health. Past research suggest that higher ACE scores are associated with lower physical activity levels (Krinner et al.,2020; Monat & Chandler, 2015) and higher physical activity is associated with better physical health (Anokye et al., 2012; Gill et al., 2013) Therefore, it seems that the serial mediators of barriers to physical activity and physical activity levels function best together.

Conversely, we found that higher physical activity levels were associated with lower perception of quality of physical health. These findings are inconsistent with the literature that says physical activity can be seen as a potential resilience factor that can maintain/enhance physical health. A potential explanation might be the decision to use the total metabolic equivalent task (MET)-min/week (e.g., vigorous, moderate, walking) within the last 7 days to represent physical activity levels, as opposed to using the number of minutes someone participated in physical activity in the last 7 days. The overall MET utilizes a special calculation to sum the amount of energy expended carrying out three types of physical activity (vigorous, moderate, and walking). For example, if someone reports moderate physical activity for 30 minutes 6 days a week then the total MET minutes for moderate physical activity are 4 X 30 X 6= 720 MET minutes a week. Then, the overall MET was calculated by summing the MET minutes achieved in each category (walking, moderate activity, and vigorous activity) to get total MET minutes of physical activity a week. It is possible that this calculation was too complex and included too many different types of physical activity (vigorous, moderate, and walking), making it difficult to understand the relationship between the two constructs. Perhaps, if we used the number of minutes someone participated in moderate physical activity (e.g., bicycling, carrying light loads, doubles tennis), it would provide more clarity around this relationship. It would focus on the amount of time spent engaging in one type of physical activity as opposed to the amount of energy expended engaging in multiple types of physical activity.

Furthermore, across all three serial mediation models, when executive function was included as a third-order mediator, the serial mediation was no longer significant. This demonstrated that executive function was not a serial mediator, nor mediator, between ACEs and perceived quality of physical health. This was unexpected, considering it is well cited that ACEs are associated with executive function performance (Ji and Wang et al., 2018; Kelder et al., 2018; Lund et al., 2020: Maja et al., 2021; Trossman et al., 2021), and previous research highlights the "synergistic" reciprocal role executive function plays with physical activity (Foster, 2015) and quality of life (Allan et al., 2016). However, others have observed multiple domains of executive function and report a non-significant association between childhood adversity and cognitive flexibility (Augusti & Melinder, 2013; Bucker et al., 2012) and inhibitory control (Augusti & Melinder, 2013; Bruce et al., 2013; Carrion et al., 2008) similar to the current study. The inconsistent patterns in previous research could also be due to the wide variety of specific tasks available to assess the various domains of executive function. The current study selected tasks based on those highlighted within the NIH Toolbox Cognitive Battery; however, including multiple assessments of inhibitory control, working memory, and cognitive flexibility may lead to more stable results. Perhaps, certain domains of executive function or even performance on specific tasks within the same domain of executive function are impacted differently by early adversity.

This could also be due to the wide variety of specific tasks available to assess the various domains of executive function. The current study selected tasks based on those highlighted within the NIH Toolbox Cognitive Battery; however, including multiple assessments of inhibitory control, working memory, and cognitive flexibility may lead to more stable results.

It is also possible that the use of executive function tasks rather than a questionnaire led may explain the inconsistency of the current study with previous work (Cushman et al., 2021; Maja et al., 2021; Trossman et al., 2021). For example, Trossman and colleagues (2021) measured executive dysfunction with the Barkley Deficits in Executive Functioning Scale—Short Form: Self-Report (BDEFS-SF:SR). This scale asks participants to reflect on the last six months, and rate if they experienced difficulty in the last 6 months with time management, planning, organization and emotion regulations. Other researchers have used questionnaires that ask participants to rate how well statements related to motivational drive, strategic planning, organization, impulse control, and empathy describes them. Therefore, measuring one's perception of executive function as opposed to measuring participants' executive function objectively via tasks that utilize various domains of executive function may explain the current results. It is also possible that the executive function task did not fit well in the model because it was the only construct measured objectively rather than subjectively in the study.

Another possible explanation is that there are other resilience or protective factors at play that were not measured in the current study. Some of the protective factors might include relationship with caregivers, problem solving skills, self-regulation (Jamieson, 2019). If adequate protective factors are in place, then a person is less likely to have developmental problems (Jamieson, 2019). For example, if a participant was able to feel safe after the toxic stress they experienced, the developing brain could have been protected from negative effects (Jamieson, 2019). In addition, it could be that examining executive function and physical health does not directly capture the relationship. Perhaps, it could be due to the fact that executive function is related to quality of life in populations that may have a disability or have chronic health conditions (Love et al., 2016; Ratiu et al., 2017; Stern et al., 2017), as opposed to healthy populations. Suggesting that executive function might help individuals who may experience a lower quality of life, maintain or improve their overall quality of life.

Lastly, one may look back to the life course perspective for an explanation as to why executive function did not serve as a third-order mediator. Based on the results of serial mediation we saw the connection between the phases of the life course perspective and study variables that include ACEs, barriers to physical activity, physical activity levels, and perceived quality of physical health. For example, people who experienced multiple ACEs (cohort) were likely to have more barriers to physical activity (turning point, transition), which in turn lower quality of life (life event). Suggesting that people endorsing more ACEs, may have difficulties transitioning through different stages/milestones in life and may not use adaptive coping strategies to help mitigate the lasting effects of ACEs, which could potentially affect their health in adulthood. This connection between the life course perspective and the serial mediation results supports the idea of executive function not being a third order mediator because executive function does not directly connect with any of the four phases of the life course perspective.

Limitations and Future Directions

This current study is not without limitations. The use of in-person, self-report methodology for physical activity, early adversity, barriers to physical activity, and perceived quality of physical health may have been affected by external bias. That is participants may have picked the more socially desirable answer or may not have been able to accurately assess themselves (Athubaiti, 2016). Additionally, two of the subscales of the barriers to physical activity survey had unacceptable estimates of internal consistency. The psychometric properties of the barriers to physical activity have not been extensively considered in other research. However, Sawchuk and colleagues (2011) also found low internal consistency for items within the lack of resources subscale. This restricted the ability of the current study to detect an effect in this particular barrier category.

Moreover, research indicates that people tend to overestimate physical activity levels when using self-report measures (Boon et al., 2010; Corder et al., 2010). Thus, researchers may want to consider including subjective and objective measures of physical activity (e.g., anticgraph, accelerometry) to better understand the extent to which physical activity impacts the relationship between ACEs and perceived quality of physical health. Moreover, research reveals that anonymous survey methods promote greater disclosure of sensitive or stigmatizing information as opposed to non-anonymous survey methods (Murdoch et al., 2014). Although we reassured participants that survey responses would not be linked to their name, there is the possibility that participants did not feel the in-person study was anonymous, which could have potentially impacted survey responses. Future research might consider collecting the survey measures via an online platform and then asking participants to come to the lab for collection of any objective measures.

Participants who reported sickness within the last seven days still had the opportunity to report their physical activity within the last seven days and if that resulted in an MET calculation it was included in the current analysis. This decision criterion could have decreased the average METs in the current study because participants who were sick or injured completed less than their typical amount of physical activity. Perhaps, if researchers decide to use a self-report questionnaire to measure physical activity, they may want to ask participants to reflect on their normal physical activity schedule as opposed to their physical activity within the last 7 days. Another potential limitation is that the perceived quality of physical health variable only examines quality of life in terms of physical health, as opposed to overall quality of life. However, there are multiple aspects of quality of life (physical health, psychological, social relationships and environment) in adulthood that have been related to adversity in childhood

(Nelson et al., 2020). The current investigation was focused on physical health, but future research could examine whether barriers to physical activity and physical activity levels serially mediate the relationship between childhood adversity and the psychological health, social relationship health, and environmental health domains.

In addition, our results are limited in terms of generalizability because the sample size is relatively small and consisted of predominantly White, female college students. Although we statistically controlled for the impact of certain demographic variables (i.e., sex, age, and race), it is important for future research to include more diversity. For example, the current study included participants from a very narrow age range limiting the generalizability of results within the context of age. Most participants in the current study identified as White. Barriers to physical activity are more likely to be reported by minority groups. For instance, Latinx and African American people from underserved populations report chronic health conditions (Joseph et al., 2015). Similarly, Hispanics engaged in physical activity the least (31.7%), followed by non-Hispanic Blacks (30.3%) and non-Hispanic Whites (23.4%; CDC, 2020). Therefore, the current results only extend to other majority White samples. Future research is required with a more racially diversity sample in order to extend the current patterns on the interrelations of barriers to physical activity, physical activity and quality of physical health.

Despite the empirical research/rationale surrounding my study variables, there may be additional variables to consider. Researchers might want to examine the impact of other protective factors (i.e., relationship with caregivers, problem solving skills, self-regulation) that serve as a pathway in the interrelations of ACES, physical activity, executive function, and perceived quality of physical health. Perhaps, researchers should examine how resiliency plays a moderating role in the relationship between ACEs and perceived quality of physical health.

Future research may consider examining additional ways of measuring executive function or perhaps examine academic performance instead of or in addition to executive function. This may provide more insight on the role cognition plays in the relationship. Moreover, research questions should examine the interrelations of ACEs, physical activity, and quality of physical health in a diverse adolescent sample. Gaining clarity around the factors that play a role in adolescents' physical health, could allow researchers to intervene at a younger age. Intervening at a young age could serve as a potential resilience factor of ACEs that could improve health outcomes in adulthood. Interventions and educational efforts may want to focus efforts on reducing barriers to physical activity, increasing physical activity and resilience building efforts in populations that are more prone to early adversity efforts and health disparities, as it may be linked to quality of physical health and may represent important avenues for interventions.

Conclusions

The current study contributes to the existing literature regarding the impact of ACEs on perceived quality of physical health by highlighting the role of barriers to physical activity and physical activity levels as potential explanatory mechanisms of action linking ACEs and perceived quality of physical health. This study reiterates the importance of implementing physical activity in your daily life to enhance or maintain overall quality of physical health. Barriers to physical activity were linked to amount of physical activity and overall perceived quality of physical health. Thus, interventions aimed at reducing barriers to physical activity should be prioritized when trying to increase physical activity in populations that are more prone to early adversity efforts.

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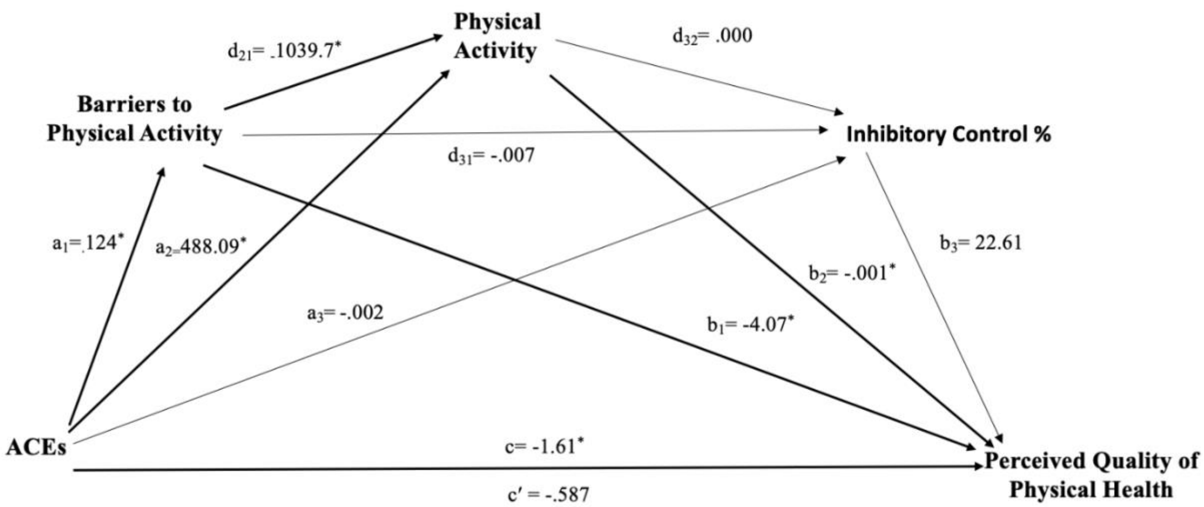
APPENDICES

Appendix A: Specific Indirect Effects between ACEs and Quality of Life Serial Mediation Utilizing barriers to PA, PA levels and Executive function (% correct).

			95% CI	
	Effect	*b*	Lower	Upper
Inhibitory control	***ab***	**-1.01**	**-1.70**	**-.51**
	$\boldsymbol{a_1b_1}$	**-.51**	**-1.10**	**-.12**
	$\boldsymbol{a_2b_2}$	**-.58**	**-1.26**	**-.09**
	a_3b_3	-.05	-.26	.13
	$\boldsymbol{a_1d_{21}b_2}$	**.15**	**.02**	**.38**
	$a_1d_{31}b_3$	-.02	-.07	.03
	$a_2d_{32}b_3$	-.01	-.12	.03
	$a_1d_{21}d_{32}b_3$	.00	-.01	.03
	R^2	.394***		
Working Memory	***ab***	**-.99**	**-1.75**	**-.46**
	$\boldsymbol{a_1b_1}$	**-.52**	**-1.14**	**-.12**
	$\boldsymbol{a_2b_2}$	**-.59**	**-1.29**	**-.09**
	a_3b_3	-.02	-.34	.18
	$\boldsymbol{a_1d_{21}b_2}$	**.16**	**.02**	**.39**
	$a_1d_{31}b_3$	-.00	-.03	.06
	$a_2d_{32}b_3$	-.01	-.09	.12
	$a_1d_{21}d_{32}b_3$	.00	-.04	.03
	R^2	.381***		
Cognitive Flexibility	***ab***	**-.99**	**-1.66**	**-.48**
	$\boldsymbol{a_1b_1}$	**-.54**	**-1.14**	**-.12**
	$\boldsymbol{a_2b_2}$	**-.61**	**-1.33**	**-.10**
	a_3b_3	-.02	-.17	.12
	$\boldsymbol{a_1d_{21}b_2}$	**.16**	**.02**	**.40**
	$a_1d_{31}b_3$	.01	-.04	.08
	$a_2d_{32}b_3$	.02	-.06	.15
	$a_1d_{21}d_{32}b_3$	-.00	-.03	.01
	R^2	.383***		

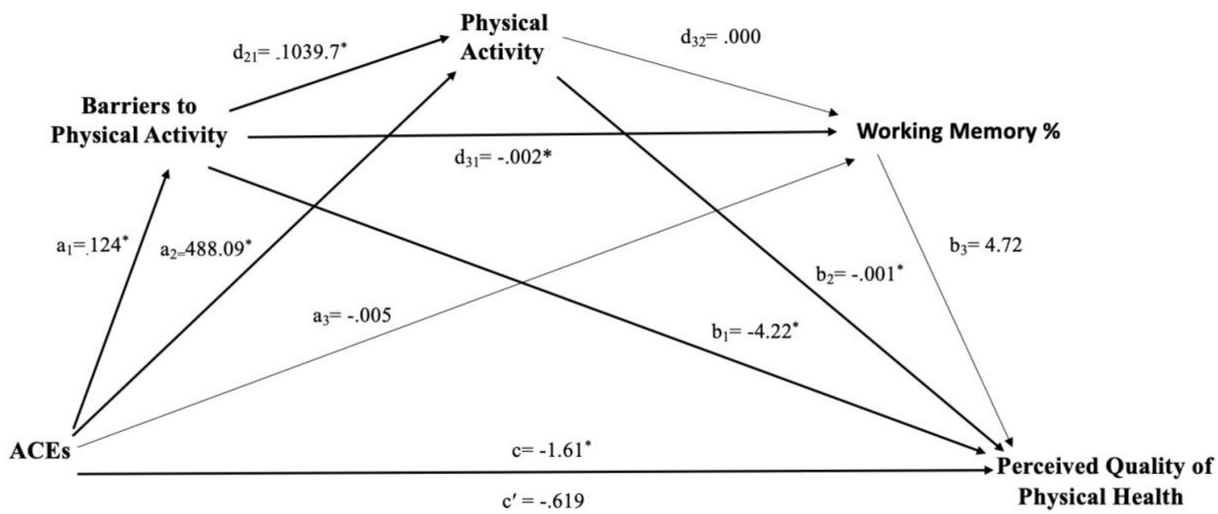
Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on executive function; b_1 = direct effect of barriers to PA on quality of life; b_2 = direct effect of PA levels on quality of life; b_3 = direct effect of executive function on quality of life; d_{21}= direct effect of barriers of physical activity to physical activity levels; d_{31}= direct effect of barrier to physical activity to executive function; d_{32}= direct effect of physical activity levels to executive function. *ab* = Total Indirect Effect; a_1b_1 = specific indirect effect through barriers to PA; a_2b_2 = specific indirect effect through PA levels; a_3b_3 = specific indirect effect through executive function;$a_1d_{21}b_2$= specific indirect effect through barriers to PA and PA levels; $a_1d_{31}b_3$ = specific indirect effect through barriers to PA and executive function; $a_2d_{32}b_3$= specific indirect effect through physical activity levels and executive function; $a_1d_{21}d_{32}b_3$=specific indirect effect through barriers to physical activity, physical activity levels, and executive function. R^2 = total indirect effect variance accounted for by the model. CI = 95% confidence interval; 5,000 bootstrap samples; age, sex, race/ethnicity used as covariates.*** $p < .001$. bolded indirect effects are significant indirect effects.

Appendix B: Serial Mediaton Model with Inhibtory Control (% Correct) as a Third Order Mediator



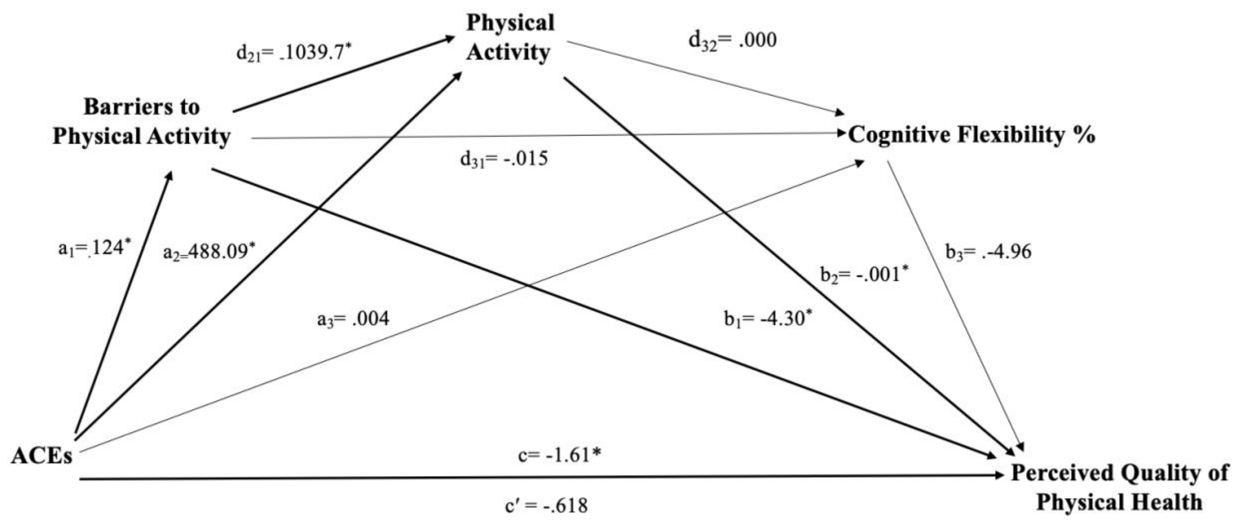
Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on executive inhibitory control; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of inhibitory control on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity to physical activity levels; d_{31}= direct effect of barrier to physical activity to inhibitory control; d_{32}= direct effect of physical activity levels to inhibitory control; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathways.

Appendix C: Serial Mediaton Model with Working Memory (% Correct) as a Third Order Mediator



Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on working memory; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of working memory on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity on physical activity levels; d_{31}= direct effect of barrier to physical activity on working memory; d_{32}= direct effect of physical activity levels on working memory; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathways.

Appendix D: Serial Mediaton Model with Cognitive Flexiblity(% Correct) as a Third Order Mediator



This model shows the coeffiects for the direct pathways. * and bolded arrow represents the sigfnifcant direct effects.

Note. a, b, c, and c' represent unstandardized regression coefficients: a_1 = direct effect of ACEs on barriers to PA; a_2 = direct effect of ACEs on PA levels; a_3 = direct effect of ACEs on cognitive flexibility; b_1 = direct effect of barriers to PA on perceived quality of physical health; b_2 = direct effect of PA levels on perceived quality of physical health; b_3 = direct effect of cognitive flexibility on perceived quality of physical health; d_{21}= direct effect of barriers of physical activity on physical activity levels; d_{31}= direct effect of barrier to physical activity on cognitive flexibility; d_{32}= direct effect of physical activity levels on cognitive flexibility; c= total effect of ACEs on perceived quality of physical health; c'= direct effect of ACEs on perceived quality of physical health. * <.05 and bolded arrows are significant direct pathway.

Appendix E: Bivariate Correlations of variables in the Serial Mediation Model

Bivariate Correlations of Variables in the Serial Mediation Model

	n	1.	2.	3.	4.	5.	6.	7.
1. ACEs	75	---						
2. Barriers to PA	75	.348**	---					
3. PA levels (MET)	75	.226	-.238*	---				
4. Flanker (%)	75	-.161	-.068	-.037	---			
5. Sternberg (%)	75	-.406**	-.152	-.243*	.213	---		
6. Wisconsin CS (%)	75	-.037	-.111	-.076	.044	.118	---	
7. Quality of Life	74	-.385**	-.418**	-.315**	.245*	.185	.073	---

Note: SD= Standard Deviation, ** Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). MET (metabolic equivalent task), ACEs (Philadelphia adverse childhood experiences), PA (physical activity), % correct(percent correct), Wisconsin CS(Wisconsin Card Sorting).

Appendix F: Bivariate Correlations of Reaction times and Percent correct on the Executive function task

	N	1	2	3.	4.	5.	6.
1.Flanker (%)	75	---					
2.Sternberg (%)	75	.213	---				
3.Wisconsin CS (%)	75	.044	.118	---			
4.Flanker (RT)	75	-.227	- .103	-.119	---		
5.Sternberg (RT)	75	-.075**	-.445**	.025	-.129	---	
6. Wisconsin CS (RT)	75	-.402**	-.168	-.446**	.424**	-.108	---

Note: SD= Standard Deviation, ** Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). MET (metabolic equivalent task), ACEs (Philadelphia adverse childhood experiences), PA (physical activity), RT(reaction time), % (percent correct) Wisconsin CS(Wisconsin Card Sorting).

Appendix G: Demographics Questionnaire

Demographics

Please complete the survey below that will ask you basic demographic questions.

Thank you!

What type of student are you enrolled as at ETSU?	◯ Undergraduate ◯ Graduate
What type of degree are you pursuing at ETSU?	◯ Bachelors degree ◯ Masters degree ◯ Doctoral degree
What is your enrollment status at ETSU?	◯ Part-Time ◯ Full-Time
What undergraduate or graduate Program are you enrolled in?	______________________
Gender	◯ Male ◯ female ◯ Gender Fluid ◯ I prefer not to answer
Age	______________________
Race/ Ethnicity	◯ American Indian/Alaskan Native ◯ Asian ◯ Black/ African American ◯ Hispanic/Latino ◯ White ◯ I prefer not to answer
Marital Status	◯ Married/Domestic Partnership ◯ Never Married ◯ Divorce ◯ Separated ◯ I prefer not to answer
Do you have a Job?	◯ Yes ◯ No
How many hours a week do you work?	______________________
What is the residential location of your home, before you were a student at ETSU?	◯ Rural ◯ Urban
What is your approximate height?	______________________
What is your approximate weight?	______________________
What is your favorite thing about working out/exercising?	______________________

What is your least favorite thing about working out/exercising?	__________________________________
What is your favorite form of physical activity?	◯ Running ◯ Walking ◯ Hiking ◯ Strength Training/weight lifting ◯ biking ◯ Yoga ◯ Kick boxing ◯ Dancing ◯ Rock Climbing ◯ cycling ◯ swimming ◯ tennis ◯ basketball ◯ stair stepping ◯ resistance bands ◯ rowing ◯ golf ◯ Other
What is your favorite form of physical activity?	__________________________________
Do you use the CPA(ETSU Gym)?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
Do you use a gym off campus (e.g., planet fitness)?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
Do you make use of virtual fitness classes (e.g., fitness classes over zoom or YouTube)?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
Do you participate in group fitness (e.g., cycling)?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
Your support system participates in regular physical activity?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
While growing up you saw your support system participating in regular physical activity?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always

Your support system encourages you to participate in physical activity ?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always
How often did you participate in physical activity prior to COVID- 19 pandemic?	◯ Never ◯ Rarely ◯ Sometimes ◯ Often ◯ Always

Appendix H: Philadelphia Adverse Childhood Experiences Questionnaire

ACES

Please complete the survey below.

Thank you!

1)	While you were growing up how often did a parent, step parent or another adult living in your home swear at you, insult you, or put you down.	◯ More than once ◯ Once ◯ Never
2)	While you were growing up how often did a parent, step parent, or another adult living in your home act in a way that made you afraid that you would be physically hurt?	◯ More than once ◯ Once ◯ Never
3)	While you were growing up did a parent, step parent, or another adult living in your home push, grab, shove, or slap you?	◯ More than once ◯ Once ◯ Never
4)	While you were growing up did a parent, step parent, or another adult living in your home hit you so hard that you had marks or were injured?	◯ More than once ◯ Once ◯ Never
5)	During the first 18 years of life, did an adult or older relative, family friend, or stranger who was at least 5 years older than yourself ever touch or fondle you in a sexual way or have you touch their body om a sexual way?	◯ Yes ◯ No
6)	During the fiest 18 years of life, did an adult or older relative, family friend, or stranger attempt to have or actually have any type of sexual intercourse, oral, anal, or vaginal with you?	◯ Yes ◯ No
7)	There was someone in your life who helped you feel important or special	◯ very often true ◯ often true ◯ sometimes true ◯ rarely true ◯ never true
8)	Your family sometimes cut the size of meals or skipped meals because there was not enough money in the budget for food	◯ very often true ◯ often true ◯ sometimes true ◯ rarely true ◯ never true
9)	How often, if ever, did you see or hear in your home a parent, step parent, or another adult who was helping to raise you being slapped, kicked, punched , or beaten up?	◯ Many times ◯ A few times ◯ Once ◯ Never
10)	How often, if ever did you see or hear in your home a parent, step parent, or another adult who was helping to raise you being hit or cut with an object , such as a stick, cane, bottle, club, knife or gun?	◯ Many times ◯ A few times ◯ Once ◯ Never
11)	Did you live with anyone who was a problem drinker or alcoholic	◯ Yes ◯ No

12)	Did you live with anyone who used illegal street drugs or who abused prescription medications	◯ yes ◯ no
13)	While you were growing up did you live with anyone who was depressed or mentally ill?	◯ Yes ◯ No
14)	Did you live with anyone who was sucidal?	◯ Yes ◯ No
15)	Did you live with anyone who served time or was sentenced to serve time in prison, jail, or other correctional facility	◯ Yes ◯ No
16)	How often, if ever, did you see or hear someone being beaten up, stabbed or shot in real life?	◯ Many times ◯ A few times ◯ Once ◯ Never
17)	While you were growing up, how often did you feel that you were treated badly or unfairly because of your race or ethnicity?	◯ Very often true ◯ Often true ◯ Sometime true ◯ Rarely true ◯ Never true
18)	Did you feel safe in your neighborhood?	◯ All of the time ◯ Most of the time ◯ Some of the time ◯ None of the time
19)	Did you feel people in your neighborhood looked out for each other, stood up for each other, and could be trusted?	◯ All of the time ◯ Most of the time ◯ Some of the time ◯ None of the time
20)	How often were you bullied by a peer or classmate?	◯ All of the time ◯ Most of the time ◯ Some of the time ◯ None of the time
21)	Were you ever in foster carre	◯ Yes ◯ No

Appendix I: CDC Barriers to Physical Activity Questionnaire

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Barriers to Physical Activity

Please complete the survey below.

Directions: Listed below are reasons that people give to describe why they do not get as much physical activity as they think they should. Please read each statement and indicate how likely you are to say each of the following statements:

1)	My day is so busy now, I just don't think I can make the time to include physical activity in my regular schedule.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
2)	None of my family members of friends like to do anything active, so I don't have a chance to exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very Unlikely
3)	I'm just too tired after work to get any exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat Unlikely ◯ Very Unlikely
4)	I've been thinking about getting more exercise, but I just can't seem to get started.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
5)	I'm getting older so exercise can be risky.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
6)	I don't get enough exercise because I have never learned the skills for any sport.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
7)	I don't have access to jogging trails, swimming pools, bike paths, etc.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
8)	Physical activity take too much time away from other commitments-time, work, family, etc.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
9)	I'm embarrassed about how I will look when I exercise with other.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
10)	I don't get enough sleep as it is. I just couldn't get up early or stay up late to get some exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely

11)	It's easier for me to find excuses not to exercise that to go out to do something.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
12)	I know of too many people who have hurt themselves by overdoing it with exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
13)	I really can't see learning a new sport at my age.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
14)	It's just too expensive. You have to take a class or join a club or buy the right equipment.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
15)	My free times during the day are too short to include exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
16)	My usual social activities with family or friends do not include physical activity.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
17)	I'm too tired during the week and I need the weekend to catch up on my rest.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
18)	I want to get more exercise, but I can't seem to make myself stick to anything.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
19)	I'm afraid I might injure myself or have a heart attack.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
20)	I'm not good enough at any physical activity to make it fun.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely
21)	If we had exercise facilities and showers at work, then I would be more likely to exercise.	◯ Very likely ◯ Somewhat likely ◯ Somewhat unlikely ◯ Very unlikely

Appendix J: International Physical Activity Questionnaire (IPAQ)

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International Physical Activity Questionnaire

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise, or sport.

Please complete the survey below.

Thank you!

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time. 1.During the last 7 days, did you particpate in vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?	◯ Yes ◯ No
1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?	________________
During the last 7 days, on how many hours per day did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?	________________
During the last 7 days, on how many minutes per day did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?	________________
Think about all the moderate activities you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	◯ Yes ◯ No
During the last 7 days, how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	________________
During the last 7 days, how many hours per day did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	________________

During the last 7 days, how many minutes per day did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	__________________
Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure. 5. During the last 7 days, did you walk for at least 10 minutes at a time?	◯ Yes ◯ No
5. During the last 7 days, how many days did you walk for at least 10 minutes at a time?	__________________
During the last 7 days, how many hours per day did you walk for at least 10 minutes at a time?	__________________
During the last 7 days, how many minutes per day did you walk for at least 10 minutes at a time?	__________________
This question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television. 7. During the last 7 days, how many hours per day did you spend sitting on a weekday?	__________________
7. During the last 7 days, how many minutes per day did you spend sitting on a weekday?	__________________
Did you participate in any type of physical activity (vigorous, moderate, walking) prior to the COVID-19 pandemic?	◯ Yes ◯ No
How many days per week did you participate in any type of physical activity prior to the COVID-19 pandemic?	__________________
How many minutes per days did you participate in any type of physical activity prior to the pandemic?	__________________
Were you sick last week, or did anything prevent you from doing your normal physical activities?	◯ Yes ◯ No
If yes, what prevented you from your normal physical activity?	________________________
Do you have permanent health issues that do not allow you to exercise?	◯ Yes ◯ No

If yes, what permanent health issues do you have that prevent you from exercising?

____

Appendix K: The WHO Quality of Life Questionnaire

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The WHO quality of life

Please complete the survey below. This assessment asks how you feel about your quality of life, health, or other areas of your life. Please answer all the questions. If you are unsure about which response to give to a question, please choose the one that appears most appropriate. This can often be your first response. Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last two weeks.

Thank you!

1) How would you rate your quality of life?
   - ◯ Very poor
   - ◯ poor
   - ◯ Neither poor nor good
   - ◯ Good
   - ◯ Very Good

2) How satisfied are you with your health?
   - ◯ Very dissatisfied
   - ◯ Dissatisfied
   - ◯ Neither satisfied nor dissatisfied
   - ◯ Satisfied
   - ◯ Very Satisfied

3) To what extent do you feel that physical pain prevents you from doing what you need to do?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

4) How much do you need any medical treatment to function in your daily life?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

5) How much do you enjoy life?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

6) To what extent do you feel your life to be meaningful?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

7) How well are you able to concentrate?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

8) How safe do you feel in your daily life?
   - ◯ Not at all
   - ◯ A little
   - ◯ A moderate amount
   - ◯ Very much
   - ◯ An extreme amount

9)	How healthy is your physical environment	◯ Not at all ◯ A little ◯ A moderate amount ◯ Very much ◯ A extreme amount
10)	Do you have enough energy for your everyday life?	◯ Not at all ◯ A little ◯ Moderately ◯ Mostly ◯ Completely
11)	Are you able to accept your bodily appearance?	◯ Not at all ◯ A little ◯ Moderately ◯ Mostly ◯ Completely
12)	Have you enough money to meet your needs?	◯ Not at all ◯ A little ◯ Moderately ◯ Mostly ◯ Completely
13)	How available to you is the information that you need in your day-to-day life?	◯ Not at all ◯ A little ◯ Moderately ◯ Mostly ◯ Completely
14)	To what extent do you have the opportunity for leisure activities?	◯ Not at all ◯ A little ◯ Moderately ◯ Mostly ◯ Completely
15)	How satisfied are you with your sleep?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
16)	How satisfied are you with your ability to perform your daily living activities?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
17)	How satisfied are you with your capacity for work?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
18)	How satisfied are you with yourself?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied

19)	How satisfied are you with your personal relationships?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
20)	How satisfied are you with your sex life?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
21)	How satisfied are you whit the support you get from your friends?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
22)	How satisfied are you with your physical safety and security?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
23)	How satisfied are you with the conditions of your living place?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
24)	How satisfied are you with your access to health services?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
25)	How satisfied are you with your transportation?	◯ Very dissatisfied ◯ Dissatisfied ◯ Neither satisfied nor dissatisfied ◯ Satisfied ◯ Very Satisfied
26)	How often do you have negative feelings such as blue mood, despair, anxiety, depression?	◯ Never ◯ Seldom ◯ Quite often ◯ Very often ◯ Always

VITA

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