The Impact of COVID-19 Pandemic Stress on Mental Health among Young Adults Exposed to Adverse Childhood Experiences

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ABSTRACT

Exposure to Adverse Childhood Experiences (ACEs) has been shown to significantly impact mental health. The governmental responses to the COVID-19 pandemic, such as school and workplace closures, physical distancing measures, mandatory isolation, and quarantining, may also negatively influence mental health. However, it was unclear how ACEs and COVID-19-related stressors would impact mental health outcomes (*depression, anxiety, hostility, perceived stress, and overall emotional* and *general health*). Moreover, as young adults are likely affected to a greater extent by governmental responses than different adult cohorts, they may be in a particularly vulnerable life stage to the adverse effects of COVID-19. Therefore, this thesis aims to assess whether COVID-19-related stressors negatively impact mental health independently of exposure to ACEs among young adults and to assess whether young adults with greater exposure to ACEs were more vulnerable to the negative effects of COVID-19-related stressors on their mental health. The data used come from the Niagara Longitudinal Heart Study (NLHS), a prospective, longitudinal study that has pre-COVID-19 data (from the NLHS study) and during COVID-19 data (from a follow-up NLHS-COVID-19 sub-study survey). There were 171 participants in the study (43.7% males and 57.3% females), with 22.2% of them being exposed to 4 or more ACEs and 16.4% with no exposure to ACEs. It was found that, while exposure to COVID-19-related stressors leads to a greater reduction in mental health among young adults independent of different levels of exposure to ACEs, young adults with higher levels of ACEs were more vulnerable to the negative effects of COVID-19-related stressors on mental health. This suggests that this subgroup may benefit from intervention programs and resources directed at mental health in times of crisis, such as the COVID-19 pandemic.

Keywords: adverse childhood experiences (ACEs); COVID-19; stress; mental health; young adults

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[1] *Sunan Abī Dāwūd,* Narration number: 4811

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CHAPTER 1: INTRODUCTION

1.1 Preface

Globally, the mental health of young adults is becoming increasingly recognized as a significant public health challenge. Domestically, the situation is not any better as almost 20% of Canadian youth from 14 to 24 years of age have expressed having an emotional or mental problem to a family member, while about 12% have tried to reach out to a phone service, only 3% of them ended up seeking professional help (Findlay & Sunderland, 2014). Adverse childhood experiences (ACEs) are generally defined as exposure to traumatic experiences such as abuse and maltreatment, severe household dysfunction, intimate partner violence involving parents/caregivers, and other types of adversities before the age of 18 (Felitti et al., 1998). Being exposed to ACEs has been identified as a significant risk factor to many health problems among adults including obesity, mental disorders such as depression, health-risk behaviors such as smoking and substance use (Lee, Kim, & Terry, 2020; Wiens, Gillis, Nicolau, & Wade, 2020), chronic diseases such as diabetes and cardiovascular disease, and early mortality (Felitti, 2009). Moreover, the negative impact of severely stressful situations during adulthood among those with exposure to childhood ACEs may be more intensified and be further catalysts for subsequent mental and physical health problems. That is, while exposure to ACEs is related to poor mental health outcomes generally (Felitti, 2009; Lee et al., 2020), exposure to additional stressors, including natural or man-made disasters such as global pandemics, may accentuate the likelihood of poor outcomes. Population-level events, regardless of their level of intensity, all seem to share some distinct attributes such as being able to affect individuals on both personal and societal levels, disrupting the daily routines of people at best, or threatening their lives and livelihood at worst (Marques de Miranda, da Silva Athanasio, Sena Oliveira, & Simoes-e-Silva, 2020). As such, the

attributes of these population-level events such as natural or man-made disasters may be more severe on those exposed to higher numbers of ACEs.

One such population-level event is the ongoing COVID-19 pandemic that began in March, 2020. The pandemic, as a population-level event, had a large effect on both individuals and societies, disrupting daily routines, and even threatening some people's lives. As such, like other pandemics, the COVID-19 pandemic likely had a negative effect on the mental health of both individuals and society more generally (Dubey et al., 2020). Moreover, the resulting social isolation due to governmental responses to the pandemic such as school and workplace closures, physical distancing measures, and mandatory quarantining further disrupted peoples' lives and, more importantly, likely also negatively influenced mental health. However, it is unclear how exposure to previous childhood ACEs operates in this environment and whether they increase one's vulnerability to being negatively impacted by stressors associated with COVID-19- putting them at even greater risk than the general population for negative health outcomes. While limited studies have examined COVID-19 in relation to ACEs, a few studies have examined this connection in relation to other population-level events and experiences. For example, one study examined the impact of ACEs on 549 Syrian child and adolescent refugees fleeing their civil war (Karam et al., 2019). Karam and colleagues (2019) found that exposure to ACEs was clearly the most important predictor of PTSD and was independent of the more proximal stressors associated with exposure to the civil war and refugee experience (Karam et al., 2019). Increased exposure to the war increased sensitivity to PTSD in groups with no exposure to ACEs and groups with 1-3 exposure to ACEs. However, there was no notable impact of the increased exposure to war on sensitivity to PTSD in children with exposure to 4 or more types of ACEs. Another study, that examined veterans who had actively served during different wartime eras and to what extent

exposure to ACEs may have impacted their health behaviours, found that higher exposure to ACEs was associated with poorer mental and general health independently of their service (Hein, Muz, Ahmadi-Montecalvo, & Smith, 2020).

As such, high levels of exposure to ACEs on subsequent mental health problems, while independent of these population-level events, may make people more vulnerable to these subsequent exposures such as war. Therefore, while mass trauma such as war is an important predictor of mental health problems, and by extension other types of disasters such as earthquakes and hurricanes, and pandemics such as the current pandemic of COVID-19, it is unclear as to the roles of ACEs and whether they increase one's vulnerability to stressors linked to these events. These examples of Syrian refugee children and war veterans are not likening the effects of war to the effects of the COVID-19 pandemic as if they were equivalent. Rather, they illustrate that the impact of man-made or natural disasters on someone with previous exposure to ACEs may be greater compared to others with a low ACE profile. That is, if with wartime experiences described above, which is far worse than the current pandemic, ACEs had a notable effect on both children and veterans, then it may be informative to assess whether there is a similar effect with other traumatizing events such as the pandemic of COVID-19. In this study, I will examine whether ACEs and the stresses associated with the COVID-19 pandemic operate independently, cumulatively, or multiplicatively on mental health outcomes among young adults. That is, do higher levels of exposure to ACEs compound the negative impact of these COVID-19-related exposures on mental health?

Young adults (18-24 years of age), as a cohort in a transitional life course stage, may be particularly affected by the COVID-19 pandemic and the governmental responses to mitigating the spread and severity of its cases. On the developmental level, young adults (18-25) encounter

a shift in their cognitive, emotional, and behavioural growth while in this transitioning period. This maturation process is sensitive to young adults' environment and experiences (Baltes & Staudinger, 2000; Tanner & Arnett, 2016). Also, young adults are at a stage of continuing neural development, especially in the pre-frontal cortex, impacting how their brains process socioemotional information (Tanner & Arnett, 2016). Interruptions to their social life may influence young adults, negatively impacting their social skills and cognitive and emotional growth and development.

Aligned with this, the pandemic has also interrupted the personal aspects of their lives. At a life stage where they are forming long-term relationships, especially intimate relationships, the stresses surrounding the pandemic including quarantining and social distancing, studying and working online, etc. Impeding and delaying these opportunities among young adults for forming such relationships may adversely affect their mental and emotional health. Young adults have been shown to be more dependent on their social networks than older adults to cope with negative emotional responses (Waselewski, Waselewski, & Chang, 2020), which is threatened by lockdowns and the movement to online higher education, limits on gatherings, and quarantining reduces the opportunity to initiate and develop intimate relationships (Hamza, Ewing, Lexi, Heath, Nancy L., & Goldstein, Abby L., 2020).

Finally, young adults, many who are transitioning from being students to being employees, are less likely to have secure, stable, full-time employment with benefits and sick-leave compared to older adults (Ganson, Tsai, Weiser, Benabou, & Nagata, 2021). In fact, young adults make up a large part of the service and retail sectors (e.g., restaurants, tourism, retail stores), sectors known to be generally low paying with few benefits. Compounding this, these sectors were severely impacted by the pandemic of COVID-19 leading to a high rates of job loss and work reductions

combined with fewer resources to endure unemployment. In fact, a recent federal report indicated that those between 15-24 years of age suffered the greatest job loss/work reduction in Canada due mainly to their over-representation in tourism and retail industries (Industry Strategy Council, 2020).

1.2 Rationale

Previous studies have examined ACEs and their relation to mental health (Baier, Hong, Kliem, & Bergmann, 2019; Karatekin, 2018; H. Lee et al., 2020) while other research has examined the impact of the COVID-19 pandemic on the mental health of young adults (Anjum et al., 2020; Heitzman, 2020; Marques de Miranda et al., 2020; Singh et al., 2020). However, I am unaware of any studies that have examined how ACEs may influence mental health in relation to the influence of the stressors related to the COVID-19 pandemic longitudinally in a cohort of young adults. To better understand the relationship between ACEs and COVID-19-related stress on mental health, it would be most informative to examine this prospectively in a longitudinal analysis to assess how changes in mental health from before to during the COVID-19 pandemic differ based on exposure to ACEs. Longitudinal data is also necessary to examine within-individual mental health changes over time to better understand the independent, cumulative, and multiplicative effect of COVID-19-related stress among young adults with differential exposure to ACEs. Since young adults, as a cohort, may be more exposed to the stressors surrounding COVID-19 compared to older and younger cohorts, I propose to examine changes in mental health from pre-COVID-19 to during the COVID-19 pandemic in a sample of young adults and examine effects across varying levels of exposure to ACEs. This will allow us to explore whether youth adults are differentially vulnerable to mental health problems related to COVID-19 stress based on their exposure to ACEs and

whether exposure to ACEs will compound the negative impact of COVID-19-related stressors on mental health.

1.3 Research Questions

The research questions examine the potential independence and interaction between childhood exposure to ACEs and current exposure to COVID-19-related stress on changes in mental health outcomes. Specifically, the questions are as follows:

- Does greater exposure to COVID-19 associated stressors lead to a greater reduction in mental health among young adults independent of different levels of exposure to ACEs?
- Do higher levels of ACEs compound the negative effects of COVID-19-related stressors on mental health among young adults, making those who experience higher levels of ACEs more vulnerable to stress related to COVID-19?

CHAPTER 2: LITERATURE REVIEW

2.1 Adverse Childhood Experiences (ACEs)

The research on ACEs generally includes maltreatment such as exposure to sexual, physical, or emotional abuse, and severe household dysfunction such as forced separation from family, witnessing domestic intimate partner violence, a family member with a substance use problem or severe mental illness, and homelessness (Felitti et al., 1998). In addition, other ACEs outside the home such as natural disasters, bullying, and/or accidents and injuries, have also been shown to have long-term effects on the psychological well-being of children (Almuneef et al., 2016). The harmful consequences of these types of experiences that are labeled Adverse Childhood Experiences (ACEs) generally follow a person throughout their adult lives (Iniguez & Stankowski, 2016). In fact, there is a large body of literature identifying these negative longer term, life-course effects on both the physical and mental health of older adults (e.g., Bellis et al, 2019).

The seriousness of ACEs is highlighted by the prevalence rates that are considerably higher than commonly thought. For example, nearly half (49.1%) of 1207 participants in Alberta, Canada, reportedly experienced at least one form of household dysfunction and around 27% of them experienced at least one type of abuse before the age of 18 (Tough & McDonald, 2016). In another study by Afifi and colleagues, it was found that 32% of Canadian adults have experienced child abuse (Afifi et al., 2014). In countries such as the US, among 214,157 adults across 23 states, 61.55% reported being exposed to at least one type of ACEs, while around 25% reported three or more types of ACEs (Merrick, Ford, Ports, & Guinn, 2018). Another study estimated that between 60% and 85% of US adults have experienced at least one form of ACEs (H. Lee et al., 2020). Based on population-based studies in both the US and Canada, between 20%-50% of males and females have been exposed to ACEs (Tink, Tink, Turin, & Kelly, 2017). In a longitudinal study

that consisted of 1093 high school seniors, 27.5% of students reported parental separation, 11.7% of girls reported sexual abuse, 19.9% of boys witnessed an injury or murder, and 15.5% of boys reported being threatened, held captive or kidnapped (Schilling, Aseltine, & Gore, 2007). Besides having higher than expected proportions of exposure to ACEs in general, proportions in different ethnic and socioeconomic status groups tend to worsen as their odds of facing potential consequences of ACEs increase (Schilling et al., 2007). For instance, Lee and colleagues (2020) found that Hispanics and African Americans had higher levels of exposure to ACEs. Moreover, individuals of specific races, such as African Americans, are less likely to be diagnosed with mental health problems despite showing higher levels of exposure to ACEs, which, according to Lee and colleagues, may indicate a limited access to mental health services for certain ethnicities and racial minorities (Lee et al., 2020). This under-identification can be serious in times of mass traumas and pandemics, as I will discuss later in this thesis in the COVID-19 section.

When investigating ACEs, research has shown that the accumulation of different toxic experiences is associated with increased negative outcomes. As such, being exposed to one ACE may have less effect on a person than being exposed to two or three types of ACEs (Wiens et al., 2020). Wiens and colleagues found that the clustering of 3 types of ACEs, specifically sexual and physical maltreatment and witnessing intimate partner violence, had greater impact on their adult mental health than the clustering of 2 types of ACEs, and the clustering of 2 types of ACEs had more impact than exposure to one type of ACEs. Moreover, Wiens and colleagues found that the impact of exposure to ACEs was additive rather than multiplicative (Wiens et al., 2020). Afifi and colleagues (2014) found similar results when assessed high numbers of child abuse types and found them to be aligned with more mental conditions (Afifi et al., 2014). This suggests that when looking at exposures to types of ACEs, it may be more important to consider the cumulative

number of types of ACEs rather than trying to look at multiplicative relationships between different types of ACEs, which is consistent with the original study by Felitti and colleagues (Felitti et al., 1998).

2.1.1 ACEs and mental health

Exposure to ACEs is related to many mental health problems (H. Lee et al., 2020). Those problems include depression, personality disorders, substance use disorders, and/or antisocial behaviors (Turner et al., 2020). For example, Turner and colleagues found that the rate of exposure to ACEs reported by young offenders was higher than that of the general population. In addition, when Turner et al. (2020) investigated the association between exposure to ACEs and mental health problems in young offenders, they reported that the risk of developing a mental health problem increased when the number of types of exposure to ACEs increases despite the differences in the type of ACEs experienced between males and females. This adds support to the findings by Wiens and colleagues (2020) that the influence of ACEs is additive rather than multiplicative (Wiens et al., 2020). Exposure to ACEs is also linked to suicidal tendencies. Fuller-Thomson and colleagues (2016) found that exposure to ACEs is associated with higher chances of suicide attempts across the lifetime. They also found that depression and anxiety partially mediate the relation between exposure to ACEs and suicide attempts, and that nearly 30% of the association between child sexual abuse and attempting suicide is accounted for by depression alone (Fuller-Thomson, Baird, Dhrodia, & Brennenstuhl, 2016).

One way exposure to ACEs can contribute to an increased risk of mental health problems is when this exposure becomes a biologically embedded psychological stress in those exposed to ACEs (Miller, Chen, & Parker, 2011). According to Hobfoll (1988), the definition of psychological stress can be “a reaction to an environment where there is a threat of loss of

resources, an actual loss of resources, or a lack of gain after an investment" (Hobfoll, 1988, p. 54). Actual loss of resources such as emotional and physical safety and the threat of loss of resources are both present in the environments within which one is exposed to ACEs. The embedded psychological stress, which does not cease with the end of the exposure (Iniguez & Stankowski, 2016), has long-term consequences for those exposed to ACEs. For example, besides being harmful by itself, the stress of exposure to ACEs can lead to other types of stress young adults may face. That is, both exposure to ACEs and the potential mental health consequences can affect the ability and stability of intimate relationships and employment, which can lead to additional serious stressors that young adults may face. For example, Cambron and colleagues found that depression could impose a serious barrier to work for women when accompanied by high exposure to ACEs (Cambron, Gringeri, & Vogel-Ferguson, 2015). Besides the negative impact of job loss, the associated financial strains can seriously affect mental health (Pearlin, Menaghan, Lieberman, & Mullan, 1981). By extension, poor mental health contributing to job instability may be reduced or exacerbated due to the job instability itself (Price, Choi, & Vinokur, 2002).

Constant psychological stress resulting from exposure to ACEs may also affect biological systems to the extent that it changes the way the nervous system and inflammatory system react to subsequent stressors. For example, exposure to ACEs can influence the biological and neuro-psychological development of individuals by causing chromosomal damage (Turner et al., 2020). In this way, the impact of ACEs on mental health can be deeply engraved into the genetics of those young adults, further exacerbating the chronic harm of ACEs. In their integrated review of longitudinal studies of normal human brain development, Pechtel and Pizzagalli found that for brain areas with prolonged developmental trajectories, including the prefrontal cortex (PFC) hippocampus, and amygdala, those exposed to increased levels of ACEs may be at higher risk of

cognitive and affective impairments resulting from damages to these brain areas (Pechtel & Pizzagalli, 2011). Poorer cognitive function linked to the PFC, hippocampus and amygdala may be linked to mental illnesses as they impair emotional regulation (Gotlib & Joormann, 2010). Moreover, affective functions such as emotional regulation and the brain areas that are associated with these functions actually develop differently and are found to be more resistant to recovery among those exposed to ACEs (Pechtel & Pizzagalli, 2011). As such, the influence of ACEs on mental health can have long-term consequences on health and can make persons less prepared to deal with future stress across the life course.

2.2 COVID-19

At the end of 2019, the novel coronavirus, called the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-Cov-2), which is the virus responsible for COVID-19, was first detected in Wuhan, China. The COVID-19 virus is transmitted via the respiratory tract (Baloch, Baloch, Zheng, & Pei, 2020). Since its emergence, COVID-19 has spread across the globe triggering a series of government actions that were aimed to contain it through what is called “flattening the curve” (Fitzgerald, Nunn, & Isaacs, 2020). These actions included quarantine and stay-at-home orders, social distancing, school and workplace shutdowns and, in some cases, a total local and/or national lockdown (Mukherjee, 2020). As a result, there has been a total disruption of the daily life routines of people in many nations across the globe. The onset of the virus and these reactions to this pandemic, as indicated by Marques de Miranda and colleagues, have made it akin to a global natural disaster (Marques de Miranda et al., 2020).

2.2.1 COVID-19 and mental health

Besides its physiological impacts, COVID-19 and the associated lockdowns in an effort to control its spread and reduce deaths can have notable impacts on the mental health of both those

in direct contact with the virus and the general public. Through these lockdown responses, COVID-19 can impact the mental health of those who are infected as well as those who may be exposed to potential infection such as family members, close contacts, and frontline health workers. Patients with confirmedCOVID-19 in particular have been experiencing various types of stressors that include uncertainty, isolation, and feeling of helplessness which may lead to mental problems such as depression, anxiety, posttraumatic stress symptoms, fear, and insomnia (Wei et al., 2020). For example, Zhang and colleagues found that the prevalence of depression in COVID-19 patients was 29.2% and the prevalence of depression comorbid with anxiety was 21.1% (Zhang et al., 2020). In general, psychological problems are significantly higher amongst COVID-19 patients when compared to the general public and health workers (Krishnamoorthy, Nagarajan, Saya, & Menon, 2020).

Posttraumatic stress symptoms are also apparent among COVID-19 patients. In their study that included 714 clinically stable older adult COVID-19 patients, Bo and colleagues found that 96.2% of the participants had significantly higher posttraumatic stress symptoms (Bo et al., 2020). Others also found that levels of depressive symptomatology were elevated in younger COVID-19 patients (Mazza et al., 2020). Moreover, knowing someone with COVID-19 can have a negative impact on the mental health of young adults. Among college students in China, Cao and colleagues found that merely knowing someone with COVID-19 was a risk factor for distress (Cao et al., 2020). However, one study found no significant difference in mental health between university students who were quarantined with COVID-19 and those who were not (Brooks et al., 2020) which may simply be due to the fact that shutdowns, social distancing and self-isolation affect everyone. Another study by Son and colleagues investigated 195 Texas college students (2020). In their paper, the authors stated that 71% of students reported having increased stress and anxiety

levels, 86% reported having trouble sleeping, and 86% reported having decreased social interactions (Son, Hegde, Smith, Wang, & Sasangohar, 2020). These results are informative for assessing current responses to COVID-19 in that those experiencing quarantine and lockdowns do not only face the potential physiological consequences of the disease itself. The consequences of COVID-19 and the associated lockdowns and quarantines such as social isolation, fear of others, uncertainty, as well as the negative news and social media, may have negative consequences for mental health (Wu, Chan, & Ma, 2005).

In terms of scale, the COVID-19 pandemic has affected the global population. As such, the impact of the COVID-19 pandemic and the various governmental responses to control its spread such as workplace and school shutdowns, social distancing, and even total lockdowns, appear to be having a negative population-wide effect on mental health (Orsini et al., 2020). In a systematic review, almost one third of the general public reported a significant presence of mental health problems such as psychological distress (34%) due to the COVID-19 pandemic (Krishnamoorthy et al., 2020). Some of the factors that may play a role in the extent to which the COVID-19 pandemic affects mental health include the seriousness of the disease, its unpredictability and uncertainty, and the misinformation, social isolation, and economic difficulties (Rajkumar, 2020). When investigating the young Chinese adult population, the long-term impact on mental health was significantly greater compared to older adults (Lee, 2020). Among adolescents, Zhou and colleagues (2020) reported that around 44% of their Chinese participants, whose ages were from 12-18, reported having depressive symptoms and around 37% reported anxiety symptoms (Zhou et al., 2020). In their study, consisting of 584 participants from 14 to 35 years of age, Liang and colleagues also found that 40.4% of participants reported having psychological problems only two

weeks after COVID-19 erupted in China (Liang et al., 2020). In terms of anxiety, around 25% of college students in China reported at least mild anxiety levels (Cao et al., 2020).

These results are similar to studies from the US. For instance, when Ettman and colleagues investigated the difference in depressive symptoms of a cohort between 18 and 39 of age, they found that the percentage of those who reported 9 or more symptoms out of 10 in the Patient Health Questionnaire had increased by around 4 fold after the COVID-19 pandemic – rising from 9% before the pandemic to 39% after it- (Ettman et al., 2020). In another paper, Wang and colleagues found that 71.3% of the 2031 Texas A&M University students surveyed had reported increased stress and anxiety levels during the pandemic (Wang et al., 2020). However, it is worth mentioning that many of these studies were either cross-sectional studies (see Cao et al., 2020; Liang et al., 2020; Zhou et al., 2020), or reviews that relied heavily on many cross-sectional studies (see Krishnamoorthy et al., 2020; Marques de Miranda et al., 2020), making it difficult to establish temporal relationships. Yet, these studies still provide clues as to increases in the prevalence of the mental issues resulting from COVID-19.

While much of this work has been done in China, the epicenter for the pandemic, these results inform us as to the potential mental health consequences of COVID-19 across the globe. While the higher prevalence in mental health issues noted above may not be associated with COVID-19 alone. For example, Liang and colleagues (2020) identify additional factors such as psychological problems of youth included low education level (having junior high school education or below), PTSD symptoms, enterprise employment[1], and the use of negative coping mechanisms that may also result in these higher prevalence rates (Liang et al., 2020). Moreover, stressors such as economic restraints, academic delays, and daily life interruptions associated with

[1] Enterprise employment is a Chinese term in business referring to corporation with physical facilities, and enterprise employees are any employees who work on site in these facilities.

COVID-19 were positively associated with anxiety symptoms among college students according to Cao and colleagues (Cao et al., 2020). Although there is little data about the impact of the economic crises on adolescents in the COVID-19 pandemic in particular, some researchers reported that the decrease of income was the highest predictor of psychological disorders after the SARS outbreak back in 2003 in Beijing, China (Guessoum et al., 2020).

When looking at the data on the subject in Canada and the US, the results are not much different. In their cross-sectional study, Horigian and colleagues reported elevated levels of loneliness, depression, anxiety, and alcohol and drug use amongst their young adult population. Around 80% reported significant depressive symptoms while 45% reported moderate anxiety, and 17% reported severe anxiety (Horigian, Schmidt, & Feaster, 2021). As a cohort, young adults may be particularly at risk by the governmental responses (i.e. lockdowns) as they are less likely to have secure and stable jobs and therefore more likely to lose such jobs (Arora, 2021). With higher rates of mental problems such as depression and anxiety, the likelihood of young adults being more strongly affected by governmental responses like lockdowns increased compared to other cohorts (Ganson et al., 2021). In summary, a variety of factors both exacerbated by, and independent of, natural disasters and population-level events such as COVID-19, such as school related issues, job and financial instability, and social factors were already general areas that may influence mental health of young adults during the pandemic of COVID-19.

2.2.2 COVID-19 and exposure to ACEs

To my knowledge, few studies have investigated the relationship between COVID-19 and certain mental health outcomes with respect to exposure to ACEs of which most are cross-sectional studies occurring after the start of the pandemic. One study, for instance, investigated whether the psychological impact of exposure to COVID-19 was stronger in adolescents with pre-pandemic

maltreatment experiences in rural Chinese adolescents, and found that during a pandemic where lockdown and social isolation were imposed, adolescents with higher exposure to cumulated types of ACEs such as neglect and family abuse are most at risk psychologically (Guo et al., 2020). However, since this is a cross-sectional study, it cannot establish a causal relationship between COVID-19-related stressors and psychological risks in relation to exposure to ACEs. Guo and colleagues did not investigate whether exposure to ACEs impacted mental health independent of COVID-19, and suggested that there might be issues in transferring the instruments with which ACEs are measured from the US and other western nations to China due to the many differences between the two societies (Guo et al., 2020).

Another study that investigated early life adversities (maltreatment in particular) in relation to a perceived threat such as from COVID-19 on anxiety found that individuals exposed to maltreatment reported a higher perceived threat from COVID-19 and higher anxiety levels (Kalia, Knauft, & Hayatbini, 2020). This cross-sectional study was not designed specifically for young adults as it recruited across the adult age spectrum of those who were older than 18 years of age (Kalia et al., 2020). And while ACEs, by definition, occur prior to age 18 and exposure to ACEs among these adults did occur before exposure to COVID-19-related stressors indicating temporality, changes in mental health from pre- to during-COVID-19 among those exposed to ACEs and COVID-19-related stressors were not examined due to the cross-sectional nature of these studies. As such, these studies were unable to examine the association between exposure to ACEs and changes in mental health and whether ACEs compound the harmful effects of the pandemic of COVID-19 on these changes in mental health.

Another cross-sectional study that investigated the association of ACEs with depressive symptoms during the pandemic of COVID-19 assessed depressive symptoms of a cohort of middle

aged Germans (with a mean of 40.1 years) retrospectively before the pandemic, as well as present depressive symptoms during the pandemic (between May and July 2020) in an attempt to identify change in depressive symptoms (Clemens, Köhler-Dauner, Keller, Ziegenhain, & Fegert, 2022). In this study, they found that exposure to ACEs was a significant predictor of elevated depression symptomatology during the pandemic. Besides its natural limitations with collecting retrospective information of depressive symptomatology, this study did not examine the potential moderating effects of ACEs on COVID-19-related stressors.

There are only two prospective studies identified that assessed the relationship between ACEs and mental health outcomes during the pandemic of COVID-19. The first is a longitudinal study that assesses the influence of exposure to ACEs on early adolescence mental health during the pandemic of COVID-19 (Stinson et al., 2021). In this paper, Stinson and colleagues investigated parent-reported internalizing symptoms in young adolescents. They discovered significant increases in melancholy and fear/worry and a significant reduction in positive affect. The focus of this paper is whether there is a moderating effect of race or ethnicity on mental health changes due to COVID-19. The authors reported finding no significant interaction regarding their focus (Stinson et al., 2021). Moreover, the authors did not investigate how ACEs may aggravate the effect of COVID-19-related stressors on mental health outcomes.

The second prospective study examined changes in mental health, well-being, and substance use during the pandemic of COVID-19 (Haydon & Salvatore, 2022). In this paper, Haydon and Salvatore investigated whether ACEs and pandemic disruptions were linked to long-term changes in depressive symptoms, stress, sleep, relationship satisfaction, drug use, concurrent anxiety, and peritraumatic distress in an adult cohort (with a mean of 30.3) (Haydon & Salvatore, 2022). This is the only study that used a prospective, longitudinal design to examine how ACEs

influence the association between adverse pandemic-related events and changes in mental health. The impact of ACEs on mental health outcomes and drug use among their sample was mediated by negative pandemic-related events; however, Haydon and Salvatore only found one negative interaction between ACEs and pandemic-related events on increased drug use over time.

There are several studies that found a relationship between previous mental problems and vulnerability to the impacts of COVID-19 pandemic (Liang et al., 2020; Marques de Miranda et al., 2020; Vindegaard & Benros, 2020). However, when investigating the impact of population-level events including disasters on people with ACEs, whether natural disasters (such as hurricanes or earthquakes) or man-made disasters (such as war), it is still unclear whether the effect of ACEs on mental health is independent of the disaster or whether exposure to ACEs was a moderating factor making people more or less vulnerable to stress associated with the population-level disaster. In their study of 549 Syrian refugee children and adolescents, Karam and colleagues (2019) found that exposure to ACEs was the most important predictor of PTSD in their sample. High exposure to ACEs was a stronger predictor than exposure to war and dislocation. And somewhat surprisingly, they found that children with fewer ACEs were more vulnerable to the effect of war on PTSD suggesting that these participants may be more sensitive (Karam et al., 2019). In another study, Hein and colleagues investigated the association between exposure to ACEs and health behaviors among veterans in active service across different eras as a proxy for active participation in war. They found that exposure to ACEs was associated with increased mental health problems regardless of the era of their service (Hein et al., 2020). In summary, it is still unclear how exposure to ACEs may contribute to negative mental health in the presence of the COVID-19 pandemic and its related stressors. And results from previous research linking ACEs to other population-level events are equivocal, making it unclear as to whether ACEs operate

independently or whether exposure to childhood toxic experiences also make individuals more or less vulnerable to mental health problems due to COVID-19 and the stressors associated with the pandemic.

2.3 Thesis Rationale

Previous literature on the impact of ACEs and COVID-19 reviewed above emphasizes the importance of both on mental health. Beginning with ACEs, the studies exploring the impact of ACEs on the general public established their long-term effects on mental and physical health throughout the life course. In addition, the studies that explored COVID-19 and its impact on those infected, as well as the population at large, identified its connection with mental health deficits across various age groups including young adults. A few studies have examined how ACEs and COVID-19 influence mental health together. However, as most of studies are cross-sectional, they are unable to examine intra-individual changes prospectively to assess whether exposure to COVID-19-related stressors had a differential impact on mental health among those with higher ACE profiles. The two prospective studies that assessed the impact of exposure to ACEs on changes in mental health during the pandemic focused on different age cohorts or different moderating factors. Moreover, the two other studies that did examine the combined effect of ACEs and other population-level experiences including the Syrian war on children and among veterans across different eras found conflicting results (Hein et al., 2020; Karam et al., 2019). There is no study, to my knowledge, that has investigated whether changes in mental health differed by previous exposure to ACEs during the pandemic of COVID-19 longitudinally in young adults to explore whether exposure to ACEs had an impact on susceptibility to COVID-19-related stressors.

2.4 Research Questions and Hypotheses

Based on the review above, the proposed research questions and hypotheses examine the potential independence and interaction between childhood exposure to ACEs and current exposure to COVID-19-related stress on mental health outcomes (Figure 1). Specifically, the questions and hypotheses are as follows:

1. Does greater exposure to COVID-19 associated stressors lead to a greater reduction in mental health among young adults independent of different levels of exposure to ACEs?

Hypothesis 1) Young adults exposed to higher levels of COVID-19-related stress will have increased levels of mental health problems independent of exposure to ACEs.

2. Do higher levels of ACEs make young adults more vulnerable to the negative effects of COVID-19-related stressors on mental health?

Hypothesis 2) Young adults with higher levels of ACEs and higher levels of COVID-19-related stress will be at the greatest risk for increases in mental health problems.

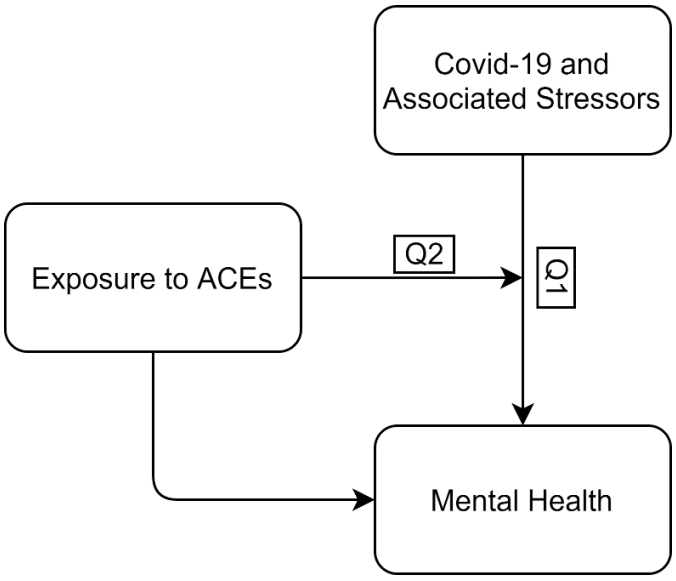


Figure 2.1. An illustrating diagram of the course of relations between exposure factors (Exposure to ACEs and COVID-19-related stressors) and the impacted area (Mental Health). The relations are labelled in accordance with the research question that is aimed to cover it.

CHAPTER 3: METHODOLOGY

3.1 Study and participants

The data used in this study was taken from the Niagara Longitudinal Heart Study (NLHS) (Wade et al., 2019) and the follow-up NLHS-COVID-19 sub-study survey. These will be referred to as Phase 1 (pre-COVID-19) and Phase 2 (During COVID-19) respectively to differentiate them. The NLHS includes 248 participants from the region of Niagara whose age is 18 years or older tested between March 2017 and March 2020 just prior to the university-wide shutdown of all research testing due to COVID-19. The participants of the NLHS were recruited due to their participation in three previous studies almost a decade earlier that collected detailed non-invasive cardiovascular assessments using doppler ultrasound. The three previous studies described elsewhere (see Wade et al. 2019) include the Health Behavioral and Environmental Assessment Team (HBEAT) study, the Physical Health, and Activity Study Team (PHAST) study, and the Brock Active Movement (BAM) study.

Briefly, the HBEAT study was from 2007-2012 and included a large sample of 1,836 children aged 10-14 years (grades 5-8) from the Niagara Catholic District School Board. Of these, 334 participants selected based on blood pressure levels for a detailed lab-based sub-study to collect detailed assessment of cardiovascular health. From 2012-2018, the PHAST study included a cohort of 2,278 grade 4 students (in 2012) from the Niagara Public School system that were followed over a six-year period to assess the physical activity and related factors among children suspected of having developmental coordination disorder (DCD) compared to other students. Of the total participants, 126 participants stratified across DCD status were selected at age 12 to participate in the lab-based cardiovascular study component. The BAM study from 2010-2013 tested a community sample of 291 children from 8-18 years of age to assess physical activity. A

subsample of 104 participants were selected at random for participation in the detailed cardiovascular sub-study.

Based on these three baseline studies, the total number of potential participants was 564 for the NLHS. Prior to the COVID-19 shutdown of testing in March 2020, 248 of the potential 564 participants were recruited to the NLHS study. These participants were contacted and informed of the NLHS study and all procedures including lab testing and self-reported questionnaire, the amount of time needed to collect the data, and that their time would be compensated with $100. Upon agreement to participate, they received a package either via mail or email with a letter explaining the study and all other information that they need until reaching the lab (directions to Brock University where the testing took place, free parking directions, testing time schedule, and lab contacts that can be used to reschedule if needed). Once they arrived at the lab for testing, participants completed an informed consent where contact information was collected for potential future follow-up. After all cardiovascular and biospecimen data collection, participants were given a self-report questionnaire to complete including questions on ACEs and mental health. To minimize bias, the questionnaire was handed to the participants in an envelope containing only the questionnaire and their unique study ID. They were also reminded that no personal information would be linked to the data and that all their personal data would be kept strictly confidential with secured access limited to the investigators and their designates. While participants completed the questionnaire, a research assistant, who was not sitting close to the participant, was present to help if needed. Upon finishing, participants sealed the questionnaire in the envelope provided and handed it back to the research assistant. The entire testing session including lab testing and the self-report questionnaire took between 3.5 to 4 hours. At the end, they were given $100 to

compensate them for their time and participation. The Research Ethics Board at Brock University granted an approval to this study (#16-078; #18-288) (Wade et al., 2019).

The NLHS questionnaire included a variety of instruments pertinent to the current study including measures of ACEs and mental health. The COVID-19 sub-study questionnaire, or phase 2 (During COVID-19), included all of the same items as the NLHS with respect to mental health measures to permit longitudinal, repeated measures, prospective panel analyses. It also included a series of questions specific to COVID-19 and the factors surrounding the pandemic and lockdown. Specific to this analysis, these questions are linked to the proximal stressors associated with COVID-19 including social isolation, financial strains, physical inactivity, poor diet, and interpersonal arguments with family or roommates. Unlike the NLHS, this phase was administered as an online survey that was sent to the participants with a unique code to ensure the ability to link with phase 1 (pre-COVID-19) data and maintain the confidentiality of the participant. The online survey was distributed for completion using Qualtrics XM online survey software (Qualtrics, Provo, UT, USA). to all 248 participants who participated in the lab during phase 1 (pre-COVID-19). All 248 participants were contacted for the COVID-19 supplementary study as all consented to be contacted again during phase 1 (pre-COVID-19) using the contact information provided in the previous consent form including email, Facebook, Twitter, etc. Of the 248 contacted, 171 participants responded positively and completed the COVID-survey with a response rate of 69% and a mean of age 22.11 (SD 1.49). Upon completion, participants were provided with an honorarium, specifically a $20 gift card for Amazon or another retailer to compensate them for their time and participation in the survey. The time to finish the survey was around 45 minutes. Data collection occurred just over a 2-month period between July 27, 2020, and Oct 5, 2020 when Ontario, and Canada more generally, appeared to have the pandemic under relative control and

were loosening social restrictions. The COVID-19 sub-study was approved by the Brock University Research Ethics Board as a modification to the original approval (#18-288) and for this Masters' research study (#20-313).

3.2 Study Measures

3.2.1 ACEs

ACEs were assessed (pre-COVID-19) using the Childhood Trust Events Survey v.2.0 (CTES 2.0)—a 26-item inventory adapted from the Traumatic Stress Survey (Baker, Boat, Grinvalsky, & Geracioti, 1998) that screens for exposure to traumatic childhood events occurring prior to the age of 18 years (Pearl et al., 2011). This survey is a 26-item questionnaire that was based on the CDC-Kaiser study ACEs questionnaire, which is suitable for young adults, and includes a wide variety of ACEs topics and areas (Felitti et al., 1998). For comparability, we included 14 items of the CTES 2.0 that mirrored the 8 ACE domains identified in the original ACE study (Felitti et al., 1998). These items focused on experiencing childhood maltreatment, including sexual (2 items), physical (1 item), and emotional abuse (2 items), and severe household dysfunction, including witnessing domestic violence (2 items), having someone in the household suffering from serious mental illness or suicidal ideation (2 items), neglect due to a family member being addicted to drugs or alcohol (2 items), or being incarcerated (1 item), and an unexpected separation from a parent or death of a family member (2 items). Any positive response on an item resulted in a positive coding for the specific domain. Regarding the reliability and validity, while there are no direct assessments of the Child Trust Event Survey CTES 2.0, studies such as those by other (Dube, Williamson, Thompson, Felitti, & Anda, 2004) reported good test-retest reliability of similar type ACE inventories. According to Dube and colleagues, the kappa results of some ACEs related questions were 0.6-0.7 over a year (Dube et al., 2004).

While there have been many ways in which researchers have coded ACEs for analysis, the majority have examined them as a cumulative, summative variable using a sum score of exposure to different ACEs focusing on maltreatment and severe household dysfunction. In fact, the original work used this approach and limited the scale using a threshold of four or more due to the fact of largely diminishing respondents reporting higher numbers (Felitti et al 1998). Other work has generally supported the coding of ACEs as a cumulative measure combining various forms of maltreatment and witnessing intimate partner violence leading to a higher likelihood of mental disorder above both individual exposures (e.g., Afifi et al. 2014) and multiplicative approaches of combinations of exposures (Wiens et al., 2020). The ACEs inventory used in this study is the Childhood Trust Events Survey (CTES 2.0) that is based on the sum of eight different ACEs focusing on maltreatment and household dysfunction to which a participant can be exposed consistent with the work by Felitti et al. (1998). Consistent with this work, the scale will be measured as continuous starting from 0 ACEs but will be limited using a maximum threshold of 4 or more ACEs as the percentage those with higher numbers diminishes. This threshold grouping was based on the finding that being exposed to 4 or more types of ACEs appears to be a point beyond which a significant risk of serious mental health problems is anticipated (Felitti et al., 1998).

3.2.2 COVID-19 Stressors

The proximal stressors associated with COVID-19 were measured in Phase 2 (During COVID-19) and assessed various dimensions of worry or stress. The questions were based on work by Lavoie and Bacon (2020). For the sake of organizing the results, the 12 COVID-19-related stressors that are investigated were grouped based on their topic into 5 groups which are Emotional, Physical, Substance Use, Financial, and Relational Stressors. For emotional stressors, there are

loneliness, frustration, and suspiciousness. For physical stressors, there are physical inactivity (or decreased physical activity) and decreased diet. For substance use, there are increased alcohol consumption and drug use, and for financial stressors there are decreased income, inability to pay for rent and inability to pay for food. For relational stressors, there are serious argument and a physical fight with the people living with the participant. Examples of the questions asked are as follows: "Because of COVID…" I have: "felt lonely and isolated"; "been less physically active"; "my diet has gotten worse"; "I have had serious arguments with the people I live with", "I have had my job hours cut/lost income", "I have been unable to pay my rent/mortgage", and "I have been unable to pay for food". Participants answered each item using 4 response categories including "not at all" (1), "very little" (2), "somewhat" (3), and "to a great extent" (4) (Lavoie & Bacon, 2020). If the participants preferred not to answer, they chose 5 which was considered as missing value and the case was deleted for analysis.

3.2.3 Mental Health Measure

The specific mental health measures pertinent to this study included in the questionnaire used in the COVID-19 sub-study were consistent with the ones collected previously in the NLHS study. Depressive symptomatology was assessed using the Centre for Epidemiological Studies-Depression scale (CESD) by Radloff (Radloff, 1977). This instrument consists of 20 items and has been shown to have excellent validity and reliability (Carleton et al., 2013). It has been widely used in different population groups (including young adults) and has been shown to have high efficiency regardless of age or sex (Lewinsohn, Seeley, Roberts, & Allen, 1997; Shafer, 2006). In the CESD scale, answers are between 1-4, and the possible score for each participant is between 0-60 after subtracting 20 for the total score. Anxiety and hostility were assessed using the 10-item anxiety and 6-item hostility subscales respectively of the Symptom Checklist 90-Revised which

have been demonstrated to be both valid and reliable (SCL-90R) (Derogatis & Unger, 2010; Koeter, 1992). In testing the validity and reliability on cohort of Finnish adolescents (mean age 15.0 years), the authors found that Checklist 90-Revised was not only sensitive in distinguishing psychiatric issues between inpatient and control group, but also sensitive in assessing the difference between inpatients from admission to discharge (Rytilä-Manninen et al., 2016). In the Checklist 90-Revised scale, answers are between 1-4, and the possible scores for participants are between 0-40 for anxiety and 0-24 for hostility. With respect to Perceived Stress, the 14 item Perceived Stress Scale by Cohen was used (Cohen, 1988). In the Perceived Stress Scale, answers are between 0-4, and the possible score for each participant is between 0-56. For General and Emotional Health, the participants were asked to rate it on a scale from 1 to 5 where 1 is excellent and 5 is poor which were reversed so that a higher indicated a poorer self-assessment.

3.2.4 Covariates

In addition to the variables above, age, sex, and education status were included in all analyses as covariates. Age and sex were collected in phase 1 (pre-COVID-19) while education status was collected in both phases 1 and 2 with the latest one used.

3.3 Statistical Analysis

The data analysis proceeded in four steps focusing on case attrition, descriptives, correlations, and finally mixed longitudinal regression main-effects and interaction models. First, an attrition analysis was conducted to examine potential response bias and whether those reporting higher levels of ACEs and mental health problems at phase 1 (pre-COVID-19) were less likely to complete the COVID-19 follow up. Attrition analyses were conducted for all variables as appropriate including all covariates. Second, descriptive statistics are presented for all variables with statistical tests of change in measures collected across both waves as appropriate. For

continuous variables, means and standard deviations are reported, whereas for categorical variables, frequencies and proportions are reported. Third, a correlational analysis was conducted to assess the potential associations between exposure to ACEs and COVID-19-related stressors in relation to mental health outcomes, and check where statistically significant associations between different exposures occur. Finally, longitudinal, mixed effect regression/ANOVA models were used to assess changes in mental health outcomes controlling for sex, age, and education status. This proceeded in a series of analyses to examine whether there was an overall decrease in mental health among young adults that could have been related to the exposure to COVID-19-related stressors. ACEs were included using an ACE by time interaction to assess whether there are any differences in changes in mental health outcomes from pre-COVID-19 to during COVID-19 across different levels of ACEs. The associated proximal COVID-19 stressors were then examined again using a stress by time interaction to assess whether they account for any changes in mental health outcomes. This assessed the independence of the effect of COVID-19-related stressors in relation to ACEs on mental health on changes in health outcomes. A series of 3-way interactions with each COVID-19 stressor by ACEs by time were also tested separately across each mental health outcome to examine whether participants with higher levels of exposure to ACEs have increased vulnerability to changes in mental health outcomes based on higher levels of stressors associated with COVID-19. All analyses were be performed using SAS 9.4 (SAS Institute, Cary, NC) using the significance level set at $p<0.05$ for two-tailed tests. As for power analyses, effect sizes were calculated for the mixed models (Dong, Maynard, & Perez-Johnson, 2008; Tippey & Longnecker, 2016). Power analyses were then performed using G*Power Software (RRID:SCR_013726). In coding, all the measures of mental health outcomes as well as COVID-19-related stressors were recoded as necessary so that higher values indicated declining health.

CHAPTER 4: RESULTS

4.1 Attrition Analysis

First, an attrition analysis was conducted to assess potential sample bias comparing the 171 who completed the follow-up COVID-19 survey to those 77 participants who did not. In table 4.1, the results of the tests that were performed are shown. There were no significant differences across all pre-COVID-19 health outcome measures or ACE profiles. With respect to the covariates, there were no differences in age or sex but those that did not participate in the COVID-19 survey had significantly lower education status. As there were no differences across the key predictor and outcome variables, we proceeded under the assumption that the sample was representative of the original sample, and that there were no steps to be taken to minimize any identified bias.

Based on this final sample size, a post hoc power analysis was calculated to assess the likelihood of avoiding Type II Errors when examining the interaction effects. Effect size, specifically eta-squared (η^2), partial eta-squared (ηp2), and regression coefficients of mixed models were calculated to be 0.235, 0.279, and 0.243 respectfully (Dong et al., 2008; Tippey & Longnecker, 2016), with corresponding statistical power (1-β) calculated as 0.598 (60%), 0.799 (80%), and 0.638 (64%) respectfully.

4.2 Descriptive Statistics

In table 4.2, the descriptive statistics of the participants are reported including sample size, age, sex, education, and mental health outcomes, while COVID-19 related stress measures are reported in table 4.3. As per the sample size, 171 participants have been included in the study as this was the participation number in the COVID-19 supplementary survey which is 69% of the participation in phase 1 (pre-COVID-19). Choosing only those who participated in phase 2 (during COVID-19), we examined participants across both phases (NLHS and COVID19) to assess changes in their

mental health. The mean age of participants was 22.11 (1.47 SD) and there were slightly fewer males (42.7%) than females (57.3%). While half of the participants (50.3%) were either college/university students or graduates, 28.7% had high school diploma or less, and 21.1% had partial college training.

The average score across all mental health measures increased from phase 1 (pre-COVID-19) to phase 2 (During COVID-19) indicating increased problems; however, only anxiety, hostility, and self-rated emotional health had significant increases. Anxiety had the greatest increase with means increasing from 16.80 (SD = 5.57) to 17.81 (SD = 6.01) (with a difference in means of 1.01), and emotional health with means from 2.62 (SD = 1.13) to 3.43 (SD = 1.05) (with a difference in means by 0.81). For hostility, the mean score increased from 9.42 (SD = 2.60) to 10.08 (SD = 3.01) (with a difference in means by 0.66). With respect to COVID-19-related stressors (table 4.3), which used a scale from 1 (not at all) to 4 (to a great extent), loneliness and frustrations have the highest means of 2.7 (SD = 0.96) and 2.6 (SD = 0.97), followed by decreased physical activity (2.4; SD = 1.17) and decreased income (2.4; SD = 1.33), followed by suspiciousness (2.2; SD 0.97) and decreased healthy diet (2.1; SD 1.02).

With respect to the distribution of exposure to ACEs among participants as shown in table 4.4, 22.2% reported being exposed to 4 or more different ACEs while 12.3% reported exposure to 3 ACEs. 23.4% of participants were exposed to 2 ACEs, 25.7% were exposed to one type of ACEs, and only 16.4% were not exposed to any ACEs. The approximate average number of types of ACEs the participants were exposed to is 2 types.

4.3 Correlation Analysis

In table 4.5, the correlations between ACEs and mental health outcomes in phase 1 (pre-COVID-19) are reported. As well, correlations between these baseline variables with during-COVID-19-

related stressors are also examined. Table 4.6 examines all during-COVID-19 mental health outcomes with both ACEs and COVID-19 stress. Zero-order, Pearson correlation coefficients (*r*) and p-values are reported. In the pre-COVID-19 phase, as expected, higher exposure to ACEs was found to be associated with higher levels of all mental health outcomes (depression, anxiety, hostility, perceived stress, general health, and emotional health).

The data for both ACEs and COVID-19-related stressors are the same for both phase 1 and phase 2. Higher exposure to ACEs was found to be associated with higher reported COVID-19-related stressors, specifically loneliness, frustration, increased drug use, inability to pay for food and rent, and serious arguments with roommates. In terms of domains of COVID-19-related stressors (emotional, physical, substance use, financial, and relational) that mental health outcomes are associated with, depression was associated to all stressors in the emotional domain and at least one of each of the rest of the mentioned domains. Anxiety was associated with three domains (emotional, physical, and relational), and perceived stress was associated with two domains (emotional, relational). General health was only associated with increased drug use while hostility was only associated with suspiciousness. For emotional health, it was associated with all three COVID-19-related stressors of the emotional health domain (isolation, frustration, and suspiciousness). Finally, there were no COVID-19 stressors that were found to be associated with all mental health outcomes. Also, physical fights with roommates were not found to be associated with any of the mental health outcomes.

The correlations between ACEs, COVID-19-related proximal stressors, and mental health measures in phase 2 (during COVID-19) are reported in table 4.6. As expected, exposure to ACEs is still associated with all mental health outcomes similar to phase 1 (pre-COVID-19). As per the correlations between mental health outcomes and COVID-19-related stressors, the strength of

association increased for all of them. Also, there are several more significant correlations than in phase 1. Depression is associated with all COVID-19 related stressors with the exception of decreased physical activity and physical fights with roommates. Anxiety is associated with all COVID-19-related emotional and substance use stressors as well as inability to pay for food (financial). Perceived stress is associated with two financial stressors (inability to pay rent and food) as well as the other stressors it was associated with in phase 1 (pre-COVID-19).

It is noteworthy that the number of significant associations for hostility and general health was much higher in phase 2 (during COVID-19). Hostility was associated with all emotional stressors, two financial stressors (inability to pay for rent and food), as well as serious roommate arguments (relational), while general health is associated with all physical stressors, all substance use stressors, two emotional stressors (loneliness and frustration), as well as inability to pay for food (financial) and serious roommate arguments (relational). Self-rated emotional health is found to have statistically significant associations with all the COVID-19-related stressors in phase 2 (during COVID-19) with the exception of decreased physical activity (physical) and physical fight with people living with the participant (relational). Examining COVID-19-related stressors, loneliness, frustration, inability to pay for food, and serious arguments with roommates were associated with all mental health outcomes.

4.4 Mixed Model Regression Analysis

4.4.1 Longitudinal two-way mixed effect models

Longitudinal mixed effects models examined the impact of COVID-19-related stressors on changes in mental health outcomes accounting for exposure to ACEs (table 4.7). These models assessed the independent effect of COVID-19-related stressors and ACEs on changes in mental health outcomes from pre- to during-pandemic. After adjusting for COVID stress and covariates,

higher ACEs were significantly associated with changes in depression and emotional health (Table 4.7). Interestingly, however, the effect after adjusting for COVID-19 stress, identified that those with a lower ACE profile had greater changes in mental health outcomes. For emotional-related COVID stress, higher loneliness was associated with increased depression, hostility, perceived stress, and diminished general and emotional health. To illustrate these interactions, Figure 4.2 illustrates the relationship between increased loneliness on changes in depression. Higher frustration was significantly related to poorer outcomes across all mental health measures (for example, see Figure 4.6) while suspiciousness was related to increased anxiety, hostility, and perceived stress. Among the physical aspects of COVID stress, higher physical inactivity and poor eating were related to increased hostility and decreased general health perceptions. Both alcohol and drug use were related to reductions in general health perceptions. With respect to financial stress, reported decrease in income was related to poorer health outcomes across all measures except anxiety (for example, see Figure 4.4). Higher reported inability to pay rent was associated with hostility, perceived stress, and emotional health while inability to buy food was associated with depression and hostility. Finally, reported higher frequency of having serious arguments with roommates was associated with all health outcomes while physical fights were not associated with any outcome. To summarize, the general patterns showed that emotional, income, and relationship (specifically arguments) stressors had the greatest effect on changes in mental health outcomes after adjusting for ACE exposure and covariates.

4.4.2 Longitudinal three-way mixed effects models

Mixed effects models that examined the impacts of COVID-19-related stressors on mental health outcomes stratified by level of exposure to ACEs (three-way interactions of COVID-19-related stressor by ACE level by time) are reported in table 4.8. These models assess how exposure

to ACEs moderated the effect of COVID-19-related stress on mental health outcomes. Overall, the results indicate that those with higher reported COVD-19 stress combined with a higher ACE profile were more likely to have increased mental health problems over time compared to those with either a high ACE profile or high reported COVID-19 stress but not both, as well as those with low ACEs and low reported COVID-19 stress (Table 4.8). While not all 3-way interactions across COVID-19 stress and mental health outcomes were statistically significant, there were some notable patterns. Specifically, higher reported loneliness and frustration among those with higher ACE profiles were at significantly greater risk for increased levels of depression (Figures 4.9 and 4.10). In addition, loneliness was also associated with increased anxiety (Figure 4.11), hostility (Figure 4.13) and perceived stress while frustration was associated with increased hostility and perceived stress (Figure 4.16). Suspiciousness was significantly associated with both anxiety (Figure 4.12) and perceived stress. Both measures of physical stress, higher physical inactivity, and poor diet, were associated with increased hostility among those with higher ACE profiles (For example, see Figure 4.14). Higher alcohol use was only associated with increased perceived stress (Figure 4.17), while drug use was not associated with any outcome. With respect to financial stressors, only decreased income and difficulty paying for food were associated with increased hostility. Finally, for relationship stresses, serious argument with people living with the participant was only associated with increased anxiety and hostility (Figure 4.15).

4.5 Tables

4.5.1 Attrition and Descriptive Tables

Table 4.1: The Results of The Tests of Attrition for The Mental Health Outcomes, ACEs, and covariates in Phases 1 (Pre-COVID)

Outcome Measures	Responders to COVID Survey		Non-responders to COVID Survey		Mean of Difference	P-value
	N	Mean (SD)	N	Mean (SD)		
Depression	171	16.18 (11.13)	77	14.5 (10.06)	1.69	0.26
Anxiety	170	16.8 (5.57)	75	15.6 (4.93)	1.2	0.11
Hostility	170	9.42 (2.6)	75	9.07 (2.64)	0.35	0.33
Perceived Stress	171	27.05 (5.95)	77	26.21 (5.45)	0.84	0.29
Self-Rated General Health	168	3.4 (0.92	77	3.36 (0.93)	0.04	0.78
Self-Rated Emotional Health	170	3.38 (1.13)	76	3.25 (1.08)	0.13	0.39
Exposure to ACEs	171	1.2 (1.4)	77	2.31 (1.6)	-0.33	0.10
Covariate Measures						
Sex	171	0.43 (0.5)	77	0.55 (0.5)	-0.12	0.08
Age	171	22.11 (1.49)	77	22.16 (1.64)	-0.05	0.81
Education	171	4.2 (1.1)	76	3.78 (1.28)	0.42	0.01

Table 4.2: Descriptive statistics of demographic characteristics and mental health outcomes at Phases 1 (Pre-COVID) and Phase 2 (During-COVID)

	Phase 1 (pre-COVID-19)	Phase 2 (During COVID-19)	p-value
N	171	171	
Sex, (%)			
Male	42.69		
Female	57.31		
Age, years (Mean, SD)	22.11 (1.49)		
Education (%)			
Grade 12 or less	8.77		
High School diploma (or GED)	19.88		
Partial college/training	21.05		
College/university degree	43.86		
Graduate/professional degree	6.43		
Outcome Measures (mean±SD)			
Depression	16.18 (11.13)	17.17 (12.23)	0.200
Anxiety	16.80 (5.57)	17.81 (6.01)	0.011
Hostility	9.42 (2.60)	10.08 (3.01)	0.002
Perceived Stress	27.05 (5.95)	27.42 (6.50)	0.392
Self-Rated General Health	2.60 (0.92)	2.71 (1.03)	0.169
Self-Rated Emotional Health	2.62 (1.13)	3.43 (1.05)	<.001

Data reported as mean (SD) unless otherwise stated. Cleaning for "prefer not to answer" has resulted in slight change in sample size for General Health (168), Anxiety, Hostility, and Emotional Health (170).

Table 4.3: Descriptive statistics of COVID-19 measures at Phase 2 (During-COVID)

	Phase 2 (During COVID-19)	Range of Possible Scores
COVID-19 Measures (mean±SD)		
Emotional		
Loneliness	2.7 (0.96)	1-4*
Frustration	2.6 (0.97)	1-4
Suspiciousness	2.2 (0.97)	1-4
Physical		
Decreased Physical Activity	2.4 (1.17)	1-4
Decreased Diet	2.1 (1.02)	1-4
Substance Use		
Increased Alcohol use	1.7 (0.90)	1-4
Increased Drug use	1.5 (0.83)	1-4
Financial		
Decreased Income	2.4 (1.33)	1-4
Inability to pay rent	1.3 (0.79)	1-4
Inability to pay food	1.3 (0.72)	1-4
Relational		
Serious Argument with People Living with the Participant	1.8 (0.97)	1-4
Physical Fight with People Living with the Participant	1.1 (0.32)	1-4

Data reported as mean (SD) unless otherwise stated. Cleaning for "prefer not to answer" and noting it as missing has resulted in change in sample size for Frustration, Decreased Diet, and Inability to pay food (170), Increased Alcohol use, Decreased Physical Activity, and Serious Argument with People Living with the Participant (169), Decreased Income (167), Physical Fight with People Living with the Participant (166), and Increased Drug use and Inability to pay rent (165). *1 is "not at all" and 4 is "to a great extent."

Table 4.4: Distribution of ACEs

ACEs score, mean (SD)	1.98 (1.39)
ACEs score, n (%)	
0	56 (16.37)
1	88 (25.73)
2	80 (23.39)
3	42 (12.28)
4 or more	76 (22.22)

ACEs = Adverse Childhood Experiences, n = number

4.5.2 Correlation Tables

Table 4.5. The Correlations between ACEs, COVID-19-related Proximal Stressors, and Mental Health Outcomes Pre-COVID-19

			Phase 1 (pre-COVID-19) Mental Health Outcomes					
		ACEs	Depression	Anxiety	Hostility	Perceived Stress	General Health	Emotional Health
COVID-19 Proximal Stressors		ACEs	-	**0.40(<.001)**	**0.25(0.001)**	**0.22(0.004)**	**0.31(<.001)**	**0.41(<.001)**	**0.31(<.0001)**
	Emotional	Loneliness *r(p)*	***0.14(0.06)***	**0.30(<.001)**	***0.14(0.07)***	0.04(0.57)	**0.25(0.001)**	0.08(0.28)	**0.15(0.04)**
		Frustration *r(p)*	**0.18(0.02)**	**0.29(<.001)**	**0.21(0.01)**	0.07(0.36)	**0.27(<.001)**	0.11(0.16)	**0.15(0.05)**
		Suspiciousness *r(p)*	0.12(0.11)	**0.29(<.001)**	**0.19(0.01)**	**0.15(0.04)**	**0.27(<.001)**	0.12(0.13)	**0.21(0.01)**
	Physical	Dec. PA *r(p)*	-0.02(0.83)	0.09(0.23)	0.01(0.94)	-0.04(0.57)	0.01(0.85)	0.01(0.86)	0.03(0.67)
		Dec. Diet *r(p)*	0(0.96)	**0.17(0.03)**	**0.16(0.04)**	0.09(0.25)	***0.14(0.07)***	0.07(0.38)	0.13(0.11)
	Substance Use	Inc. Alcohol *r(p)*	0.05(0.55)	***0.15(0.06)***	0.13(0.1)	-0.06(0.46)	0.1(0.2)	0.1(0.22)	0.1(0.18)
		Inc. Drugs *r(p)*	**0.17(0.03)**	**0.2(0.01)**	0.11(0.16)	-0.05(0.51)	0.1(0.21)	**0.17(0.03)**	0.12(0.13)
	Financial	Decreased Income *r(p)*	0.07(0.34)	0.06(0.43)	0.09(0.27)	-0.1(0.18)	-0.05(0.56)	-0.08(0.32)	-0.03(0.74)
		Inability to pay rent *r(p)*	**0.33(<.001)**	**0.20(0.01)**	0.06(0.44)	0.02(0.77)	0.1(0.2)	0.08(0.29)	0.05(0.55)
		Inability to pay food *r(p)*	**0.33(<.001)**	**0.25(0.001)**	0.11(0.15)	0.01(0.89)	***0.13(0.08)***	0.09(0.26)	***0.13(0.09)***
	Relational	Ser. argument *r(p)*	**0.20(0.01)**	**0.24(0.001)**	**0.15(0.048)**	0.06(0.44)	**0.24(0.002)**	-0.02(0.79)	***0.14(0.08)***
		Physical Fight *r(p)*	0.1(0.2)	0(1)	-0.03(0.71)	0.03(0.71)	-0.01(0.95)	0(0.99)	-0.01(0.94)

Source: NLHS wave. **Bold** results are <0.05 indicating poorer score on health measure. ***Italicized bold*** results are results between 0.05-0.10

Table 4.6. The Correlations between ACEs, COVID-19-related Proximal Stressors, and Mental Health Outcomes During-COVID-19

			Phase 2 (During COVID-19) Mental Health Outcomes					
		ACEs	Depression	Anxiety	Hostility	Perceived Stress	General Health	Emotional Health
COVID-19 Proximal Stressors		ACEs	-	**0.3(<.001)**	**0.34(<.001)**	**0.22(0.004)**	**0.32(<.001)**	**0.26(0.001)**	**0.18(0.02)**
	Emotional	Loneliness *r(p)*	***0.14(0.06)***	**0.42(<.001)**	**0.24(0.002)**	**0.2(0.01)**	**0.38(<.001)**	**0.28(<.001)**	**0.5(<.0001)**
		Frustration *r(p)*	**0.18(0.02)**	**0.41(<.001)**	**0.39(<.001)**	**0.33(<.001)**	**0.46(<.001)**	**0.39(<.001)**	**0.5(<.0001)**
		Suspiciousness *r(p)*	0.12(0.11)	**0.28(<.001)**	**0.35(<.001)**	**0.29(<.001)**	**0.39(<.001)**	0.08(0.29)	**0.32(<.0001)**
	Physical	Dec. PA *r(p)*	-0.02(0.83)	0.05(0.5)	-0.07(0.38)	0.04(0.65)	0.06(0.45)	**0.19(0.01)**	0.11(0.16)
		Dec. Diet *r(p)*	0.00(0.96)	***0.14(0.08)***	0.12(0.13)	***0.14(0.08)***	0.11(0.16)	**0.25(0.002)**	**0.26(0.001)**
	Substance Use	Inc. Alcohol *r(p)*	0.05(0.55)	***0.13(0.09)***	**0.16(0.03)**	***0.15(0.06)***	0.1(0.19)	**0.32(<.001)**	**0.16(0.04)**
		Inc. Drugs *r(p)*	**0.17(0.03)**	**0.18(0.02)**	**0.21(0.01)**	***0.14(0.06)***	**0.19(0.01)**	**0.36(<.001)**	**0.19(0.01)**
	Financial	Decreased Income *r(p)*	0.07(0.34)	**0.17(0.03)**	0.08(0.32)	0.08(0.29)	***0.14(0.07)***	0.11(0.17)	**0.23(0.003)**
		Inability to pay rent *r(p)*	**0.33(<.001)**	**0.22(0.01)**	0.12(0.12)	**0.16(0.04)**	**0.23(0.003)**	0.12(0.12)	**0.16(0.04)**
		Inability to pay food *r(p)*	**0.33(<.001)**	**0.33(<.001)**	**0.18(0.02)**	**0.18(0.02)**	**0.24(0.002)**	**0.17(0.03)**	**0.19(0.01)**
	Relational	Ser. argument *r(p)*	**0.20(0.01)**	**0.37(<.0001)**	**0.29(0.0001)**	**0.34(<.0001)**	**0.37(<.0001)**	**0.19(0.01)**	**0.29(0.0001)**
		Physical Fight *r(p)*	0.10(0.2)	0.06(0.46)	-0.05(0.56)	0.07(0.4)	0.02(0.85)	-0.01(0.93)	0.10(0.19)

Source: NLHS wave. **Bold** results are <0.05 and ***italicized bold*** results are between 0.05-0.10

4.5.3 Two-Way Mixed Effect Table

Table 4.7: Two-way Longitudinal Mixed Effects Models Predicting Changes in Mental Health Outcomes by COVID-19 Proximal Stressors and Exposure to ACEs with Time

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	2.00(0.87)	**23.60(<0.001)**	**7.96(0.01)**	**23.51(<0.001)**	1.13(0.28)	-0.001(0.999)
Loneliness	-1.38(0.49)	-0.71(0.52)	***-1.01(0.06)***	-0.87(0.46)	**-0.45(0.03)**	**-0.70(0.01)**
ACEs	**5.39(<0.001)**	0.59(0.43)	0.55(0.14)	1.29(0.11)	**0.42(0.004)**	**0.67(0.0002)**
Time	-2.51(0.30)	-1.10(0.38)	-0.73(0.26)	***-2.24(0.10)***	-0.37(0.14)	0.13(0.65)
Time* Loneliness	**2.10(0.01)**	0.65(0.12)	**0.51(0.02)**	**1.004(0.03)**	**0.24(0.004)**	**0.40(<.0001)**
ACEs* Time	**-1.11(0.04)**	0.19(0.52)	-0.001(0.99)	-0.06(0.84)	-0.085(0.14)	**-0.21(0.002)**
Intercept	0.62(0.96)	**25.15(<0.001)**	**9.44(0.002)**	**25.39(<0.001)**	1.53(0.14)	-0.14(0.9)
Frustration	-1.56(0.43)	-1.37(0.21)	**-1.64(0.002)**	-1.76(0.13)	**-0.62(0.003)**	**-0.68(0.01)**
ACEs	**5.76(<0.001)**	0.75(0.33)	***0.65(0.08)***	***1.55(0.06)***	**0.44(0.002)**	**0.69(<0.001)**
Time	-2.2(0.34)	***-2.33(0.06)***	**-1.54(0.01)**	**-3.28(0.01)**	**-0.58(0.02)**	0.17(0.54)
Time* Frustration	**2.07(0.01)**	**1.17(0.01)**	**0.86(<.0001)**	**1.47(0.001)**	**0.33(<0.001)**	**0.4(<0.001)**
ACEs* Time	**-1.17(0.03)**	0.14(0.63)	-0.04(0.79)	-0.14(0.66)	***-0.09(0.1)***	**-0.21(0.002)**
Intercept	-12.99(0.27)	**22.22(<0.001)**	5.85(0.05)	**18.97(0.003)**	-0.49(0.64)	**-2.32(0.048)**
Suspiciousness	2.34(0.23)	-1.29(0.23)	-0.56(0.29)	-0.43(0.71)	0.14(0.48)	0.03(0.92)
ACEs	**5.16(<0.001)**	0.56(0.45)	0.48(0.2)	1.21(0.13)	**0.37(0.01)**	**0.6(0.001)**
Time	2.04(0.35)	-1.81(0.1)	-0.45(0.43)	-1.75(0.14)	0.28(0.22)	**0.92(0.001)**
Time* Suspiciousness	0.36(0.65)	**1.09(0.01)**	**0.47(0.02)**	**0.96(0.03)**	-0.02(0.8)	0.1(0.27)
ACEs* Time	-0.92(0.1)	0.22(0.44)	0.03(0.83)	0.01(0.99)	-0.06(0.29)	**-0.17(0.01)**
Intercept	-4.83(0.69)	**21.94(0.001)**	**8.17(0.01)**	**19.6(0.003)**	0.91(0.36)	-1.56(0.19)
Physical Inactivity	0.86(0.6)	0.02(0.99)	**-1.22(0.01)**	0.12(0.9)	**-0.39(0.02)**	-0.06(0.79)
ACEs	**5(<0.001)**	0.49(0.52)	0.52(0.16)	1.26(0.12)	**0.4(0.01)**	**0.59(0.001)**
Time	2.42(0.23)	-0.01(0.99)	-0.62(0.24)	0.28(0.8)	-0.25(0.22)	**1(<0.001)**
Time* Physical Inactivity	0.06(0.92)	0.22(0.52)	**0.51(0.004)**	0.07(0.85)	**0.22(0.002)**	0.06(0.45)
ACEs* Time	-0.86(0.12)	0.24(0.4)	0.02(0.9)	-0.01(0.99)	-0.08(0.18)	**-0.17(0.01)**

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	-4.27(0.72)	**23.41(<0.001)**	**7.7(0.01)**	**21.93(0.001)**	0.71(0.46)	-1.39(0.23)
Poor Diet	0.8(0.65)	-0.77(0.43)	**-1.33(0.01)**	-1.09(0.28)	***-0.37(0.05)***	***-0.15(0.5)***
ACEs	**5.01(0.001)**	0.59(0.45)	***0.66(0.08)***	***1.44(0.08)***	**0.44(0.003)**	**0.6(0.001)**
Time	2.25(0.23)	-0.48(0.62)	-0.42(0.39)	-0.67(0.52)	-0.17(0.39)	**0.95(<0.001)**
Time* Poor Diet	0.18(0.8)	0.53(0.15)	**0.53(0.01)**	0.61(0.13)	**0.22(0.003)**	0.1(0.24)
ACEs* Time	-0.9(0.11)	0.18(0.55)	-0.03(0.83)	-0.09(0.78)	***-0.1(0.08)***	**-0.18(0.01)**
Intercept	-8.5(0.48)	**19.01(0.003)**	**6.13(0.04)**	**20.64(0.001)**	0.79(0.42)	-1.59(0.17)
Inc. Alcohol	1.42(0.51)	0.89(0.45)	-0.67(0.25)	***-0.83(0.5)***	**-0.45(0.04)**	-0.19(0.49)
ACEs	**5.4(<0.001)**	0.52(0.49)	0.5(0.18)	***1.32(0.1)***	**0.39(0.01)**	**0.62(0.001)**
Time	***3.45(0.08)***	1.33(0.19)	0.19(0.72)	-0.2(0.86)	-0.12(0.56)	**1(<0.001)**
Time* Inc. Alcohol	-0.36(0.67)	-0.5(0.27)	0.24(0.3)	***0.33(0.5)***	**0.22(0.02)**	0.1(0.35)
ACEs* Time	***-0.97(0.08)***	0.26(0.38)	0.03(0.82)	-0.01(0.98)	-0.07(0.23)	**-0.17(0.01)**
Intercept	-8.44(0.48)	**19.46(0.002)**	***5.95(0.05)***	**16.48(0.01)**	0.69(0.49)	-1.4(0.23)
Inc. Drugs	1.69(0.47)	1.43(0.27)	-0.22(0.73)	0.85(0.53)	***-0.47(0.06)***	-0.29(0.35)
ACEs	**5.21(<0.001)**	0.4(0.61)	0.44(0.25)	***1.4(0.09)***	**0.41(0.01)**	**0.6(0.001)**
Time	2.57(0.17)	0.81(0.42)	0.17(0.73)	0.58(0.58)	-0.12(0.55)	**0.87(<0.001)**
Time* Inc. Drugs	-0.1(0.92)	-0.3(0.55)	0.19(0.45)	-0.15(0.78)	**0.25(0.01)**	0.19(0.1)
ACEs* Time	-0.84(0.14)	0.31(0.31)	0.07(0.66)	0(0.99)	-0.07(0.21)	**-0.17(0.01)**
Intercept	1.55(0.9)	**20.84(0.001)**	**7.16(0.02)**	**24.83(<0.001)**	0.85(0.4)	-0.73(0.54)
Dec. Income	-2.36(0.11)	0.25(0.76)	**-1.05(0.01)**	**-2.22(0.01)**	**-0.38(0.01)**	**-0.52(0.01)**
ACEs	**5.75(<0.001)**	0.46(0.56)	0.61(0.11)	***1.54(0.06)***	**0.43(0.004)**	**0.66(<0.001)**
Time	0.33(0.86)	0.56(0.57)	-0.27(0.58)	-1.61(0.12)	-0.08(0.7)	**0.64(0.01)**
Time* Dec. Income	**1.21(0.04)**	-0.04(0.9)	**0.39(0.01)**	**0.89(0.01)**	**0.15(0.02)**	**0.23(0.001)**
ACEs* Time	**-1.12(0.048)**	0.28(0.35)	0(0.99)	-0.09(0.77)	-0.09(0.15)	**-0.2(0.003)**

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	-3.7(0.76)	**19.61(0.001)**	***6.04(0.05)***	**21.16(0.001)**	0.09(0.93)	***-1.9(0.1)***
Rent Inability	-1.02(0.69)	-1.2(0.38)	-1.35(0.05)	***-2.53(0.09)***	-0.26(0.33)	-0.62(0.054)
ACEs	**5.85(<0.001)**	1(0.18)	***0.64(0.1)***	**1.71(0.04)**	**0.47(0.002)**	**0.76(<0.001)**
Time	1.93(0.26)	0.26(0.77)	-0.07(0.88)	-0.94(0.33)	0.16(0.38)	**0.94(<0.001)**
Time* Rent Inability	1.12(0.27)	0.54(0.31)	**0.57(0.04)**	**1.27(0.03)**	0.11(0.32)	**0.26(0.04)**
ACEs* Time	**-1.29(0.03)**	0.07(0.82)	-0.03(0.84)	-0.21(0.52)	***-0.1(0.1)***	**-0.23(0.001)**
Intercept	-0.06(1)	**19.78(0.001)**	**6.15(0.04)**	**22.07(0.001)**	0.02(0.99)	-1.8(0.11)
Food Pay Inability	-3.16(0.25)	-1.28(0.38)	**-1.91(0.01)**	-2.27(0.16)	-0.44(0.13)	-0.38(0.28)
ACEs	**5.84(<0.001)**	0.87(0.24)	***0.76(0.05)***	***1.58(0.06)***	**0.46(0.003)**	**0.67(<0.001)**
Time	0.37(0.83)	0.01(0.99)	-0.23(0.62)	-0.86(0.38)	0.06(0.74)	**0.97(<0.001)**
Time* Food Pay Inability	**2.53(0.02)**	0.7(0.21)	**0.78(0.01)**	***1.18(0.06)***	0.18(0.12)	0.19(0.15)
ACEs* Time	**-1.35(0.02)**	0.09(0.76)	-0.07(0.62)	-0.17(0.61)	-0.09(0.12)	**-0.2(0.004)**
Intercept	-9.43(0.43)	**18.3(0.004)**	**6.7(0.03)**	**16.4(0.01)**	0.49(0.63)	**-2.31(0.047)**
Serious argument	-2.54(0.21)	-1.45(0.17)	**-1.79(0.001)**	-0.92(0.44)	**-0.58(0.01)**	-0.36(0.17)
ACEs	**5.69(<0.001)**	0.88(0.23)	***0.73(0.05)***	1.36(0.1)	**0.47(0.001)**	**0.67(<0.001)**
Time	-0.49(0.78)	-0.74(0.41)	***-0.84(0.07)***	-1.2(0.24)	-0.14(0.47)	**0.84(<0.001)**
Time* Serious argument	**2.31(0.004)**	**0.98(0.02)**	**0.92(<0.001)**	**1.03(0.03)**	**0.25(0.003)**	**0.22(0.02)**
ACEs* Time	**-1.3(0.02)**	0.05(0.85)	-0.09(0.53)	-0.13(0.68)	***-0.1(0.08)***	**-0.21(0.003)**
Intercept	1.01(0.94)	**19.23(0.01)**	5.44(0.11)	**20.59(0.01)**	-0.22(0.85)	-1.11(0.42)
Physical Fight	-6.72(0.26)	-0.24(0.94)	-0.7(0.67)	-1.82(0.6)	-0.13(0.84)	-1.02(0.18)
ACEs	**5.42(<0.001)**	0.68(0.36)	0.48(0.2)	1.33(0.1)	**0.41(0.005)**	**0.63(0.001)**
Time	0.1(0.97)	1.2(0.41)	0.15(0.84)	0.02(0.99)	0.25(0.4)	**0.72(0.04)**
Time* Physical Fight	2.6(0.28)	-0.45(0.72)	0.37(0.57)	0.42(0.76)	0.01(0.96)	0.43(0.14)
ACEs* Time	***-1.01(0.07)***	0.2(0.49)	0.04(0.81)	-0.02(0.94)	-0.08(0.19)	**-0.18(0.01)**

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

4.5.4 Three-Way Mixed Effects Tables

Table 4.8: Three-way Longitudinal Mixed Effects Models Predicting Changes in Mental Health Outcomes as a Result of The Interaction between COVID-19 Proximal Stressors and Exposure to ACEs Over Time

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	-7.11(0.61)	***14.76(0.05)***	2.86(0.44)	**16.13(0.04)**	2(0.13)	-0.84(0.58)
Loneliness	1.85(0.6)	2.43(0.21)	0.92(0.33)	1.81(0.38)	**-0.8(0.03)**	-0.4(0.38)
Time	4.78(0.22)	***3.9(0.05)***	***1.82(0.07)***	2.01(0.36)	-0.55(0.17)	0.56(0.23)
ACEs	**9.8(0.02)**	**4.87(0.04)**	**3.17(0.005)**	***4.92(0.05)***	-0.04(0.92)	**1.08(0.04)**
Time*ACEs	**-4.85(0.004)**	**-2.38(0.01)**	**-1.31(0.003)**	**-2.24(0.02)**	0.01(0.96)	**-0.42(0.03)**
Time* Loneliness	-0.65(0.64)	***-1.24(0.09)***	-0.45(0.22)	-0.6(0.45)	**0.31(0.04)**	0.24(0.15)
Loneliness* ACEs	-1.6(0.27)	***-1.56(0.05)***	**-0.96(0.01)**	-1.32(0.12)	0.17(0.26)	-0.15(0.42)
Loneliness* ACEs* Time	**1.36(0.02)**	**0.94(0.002)**	**0.48(0.002)**	**0.79(0.01)**	-0.03(0.57)	0.08(0.24)
Intercept	-8.88(0.53)	**22.5(0.003)**	4.94(0.17)	**17.06(0.03)**	1.49(0.25)	-1.03(0.5)
Frustration	1.87(0.6)	-0.44(0.82)	0.07(0.94)	1.31(0.52)	***-0.61(0.1)***	-0.37(0.41)
Time	4.53(0.23)	-0.76(0.7)	0.71(0.47)	1.14(0.59)	-0.52(0.19)	0.68(0.13)
ACEs	**10.43(0.01)**	2.03(0.38)	**2.98(0.01)**	**5.72(0.02)**	0.45(0.29)	**1.11(0.04)**
Time*ACEs	**-4.63(0.01)**	-0.67(0.44)	**-1.2(0.01)**	**-2.41(0.01)**	-0.12(0.47)	**-0.47(0.02)**
Time* Frustration	-0.49(0.72)	0.57(0.43)	0.01(0.99)	-0.2(0.79)	**0.31(0.03)**	0.21(0.21)
Frustration* ACEs	-1.72(0.24)	-0.47(0.56)	**-0.86(0.03)**	***-1.53(0.07)***	0.004(0.98)	-0.15(0.4)
Frustration* ACEs* Time	**1.27(0.03)**	0.3(0.32)	**0.43(0.004)**	**0.83(0.01)**	0.01(0.85)	0.1(0.16)
Intercept	-17.48(0.2)	13.7(0.06)	2.57(0.47)	11.02(0.14)	-1.52(0.23)	**-3.24(0.03)**
Suspiciousness	4.35(0.24)	2.58(0.2)	0.93(0.34)	3.15(0.14)	0.6(0.12)	0.44(0.36)
Time	5.1(0.15)	1.56(0.38)	0.97(0.29)	1.65(0.4)	***0.7(0.06)***	**1.31(0.003)**
ACEs	**7.2(0.04)**	**4.53(0.02)**	**2.01(0.03)**	**4.85(0.02)**	**0.84(0.02)**	**1.02(0.02)**
Time*ACEs	***-2.33(0.1)***	***-1.34(0.06)***	***-0.63(0.09)***	**-1.55(0.04)**	***-0.26(0.08)***	**-0.35(0.04)**
Time* Suspiciousness	-1.03(0.49)	-0.43(0.57)	-0.17(0.66)	-0.57(0.48)	-0.21(0.17)	-0.07(0.7)
Suspiciousness* ACEs	-0.91(0.52)	**-1.77(0.02)**	***-0.68(0.08)***	***-1.61(0.05)***	-0.21(0.16)	-0.19(0.31)
Suspiciousness* ACEs* Time	0.62(0.27)	**0.7(0.02)**	***0.29(0.05)***	**0.69(0.03)**	0.09(0.15)	0.08(0.26)

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	-0.47(0.97)	**22.95(0.001)**	4.77(0.15)	**22.35(0.002)**	0.82(0.47)	-0.28(0.84)
Physical Inactivity	-1.81(0.53)	-0.71(0.66)	0.21(0.78)	-1.31(0.43)	-0.33(0.28)	***-0.61(0.1)***
Time	1.74(0.56)	0.01(1)	0.82(0.29)	-0.51(0.76)	-0.25(0.42)	0.52(0.16)
ACEs	1.84(0.56)	-0.38(0.83)	**2.24(0.01)**	-0.43(0.81)	0.48(0.15)	-0.07(0.86)
Time*ACEs	-0.51(0.68)	0.24(0.72)	**-0.72(0.03)**	0.39(0.58)	-0.08(0.56)	0.07(0.65)
Time* Physical Inactivity	0.35(0.76)	0.21(0.73)	-0.1(0.74)	0.41(0.53)	***0.22(0.07)***	***0.26(0.07)***
Physical Inactivity* ACEs	1.31(0.26)	0.36(0.58)	**-0.71(0.02)**	0.7(0.3)	-0.03(0.81)	***0.27(0.07)***
Physical Inactivity* ACEs* Time	-0.14(0.76)	0(0.99)	**0.3(0.01)**	-0.16(0.53)	0.0001(0.998)	***-0.1(0.09)***
Intercept	-8.51(0.51)	**22.9(0.001)**	3.24(0.32)	**20.89(0.004)**	0.8(0.48)	-0.51(0.7)
Poor Diet	1.02(0.76)	-1.67(0.36)	0.77(0.37)	-1.33(0.49)	-0.45(0.2)	***-0.73(0.09)***
Time	***5.14(0.08)***	0.28(0.85)	**1.57(0.04)**	0.16(0.92)	-0.19(0.54)	***0.67(0.06)***
ACEs	***5.21(0.09)***	-0.32(0.85)	**2.73(0.001)**	1.21(0.5)	0.37(0.25)	0.04(0.91)
Time*ACEs	***-2.29(0.06)***	-0.18(0.78)	**-0.99(0.002)**	-0.49(0.48)	-0.09(0.48)	-0.05(0.76)
Time* Poor Diet	-1.25(0.35)	0.15(0.82)	-0.45(0.19)	0.2(0.79)	***0.23(0.09)***	0.24(0.15)
Poor Diet* ACEs	-0.1(0.94)	0.41(0.56)	**-0.96(0.004)**	0.11(0.89)	***0.03(0.8)***	0.26(0.11)
Poor Diet* ACEs* Time	0.65(0.2)	0.17(0.53)	**0.44(0.001)**	0.18(0.52)	-0.004(0.93)	-0.06(0.33)
Intercept	-11.72(0.38)	**21.63(0.002)**	6.21(0.07)	***12.86(0.08)***	0.24(0.84)	***-2.44(0.08)***
Inc. Alcohol	4.28(0.3)	-0.71(0.76)	-0.8(0.48)	***4.43(0.06)***	-0.08(0.85)	0.38(0.47)
Time	**6.69(0.02)**	0.6(0.69)	-0.07(0.93)	**3.48(0.03)**	0.15(0.61)	**1.38(<0.001)**
ACEs	**7.59(0.01)**	-0.74(0.67)	0.4(0.63)	**5.36(0.003)**	**0.68(0.03)**	**1.05(0.01)**
Time*ACEs	**-2.6(0.04)**	0.64(0.33)	0.16(0.63)	**-1.85(0.01)**	-0.2(0.11)	**-0.37(0.02)**
Time* Inc. Alcohol	-2.48(0.14)	-0.02(0.98)	0.41(0.37)	**-2.07(0.02)**	0.04(0.82)	-0.15(0.45)
Inc. Alcohol* ACEs	-1.41(0.42)	0.82(0.42)	0.06(0.9)	**-2.59(0.01)**	-0.18(0.31)	-0.28(0.21)
Inc. Alcohol* ACEs* Time	1.04(0.14)	-0.25(0.51)	-0.08(0.68)	**1.18(0.003)**	0.09(0.23)	0.12(0.15)
Intercept	-16.65(0.21)	**16.98(0.02)**	4.95(0.14)	**18.06(0.01)**	-0.33(0.78)	-1.43(0.3)
Inc. Drugs	7.72(0.11)	3.28(0.22)	0.52(0.69)	-0.35(0.9)	0.28(0.57)	-0.27(0.66)
Time	**6.73(0.02)**	1.75(0.27)	0.51(0.52)	0.18(0.92)	0.24(0.44)	**0.95(0.01)**
ACEs	**8.91(0.003)**	1.53(0.35)	0.9(0.27)	0.66(0.7)	**0.87(0.01)**	0.6(0.11)
Time*ACEs	**-2.72(0.02)**	-0.12(0.85)	-0.08(0.79)	0.19(0.78)	***-0.23(0.06)***	-0.21(0.15)
Time* Inc. Drugs	***-3.16(0.1)***	-1(0.33)	-0.06(0.92)	0.15(0.89)	-0.02(0.93)	0.13(0.59)
Inc. Drugs* ACEs	-2.63(0.15)	-0.81(0.43)	-0.33(0.52)	0.52(0.62)	***-0.33(0.09)***	-0.01(0.98)
Inc. Drugs* ACEs* Time	***1.34(0.07)***	0.31(0.44)	0.11(0.59)	-0.13(0.76)	0.11(0.14)	0.03(0.76)

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	2.48(0.85)	**19.43(0.01)**	3.82(0.24)	**21.8(0.002)**	0.81(0.47)	-0.26(0.85)
Dec. Income	-2.47(0.34)	0.89(0.53)	0.37(0.58)	-0.83(0.57)	-0.35(0.19)	**-0.72(0.03)**
Time	1.59(0.55)	1.22(0.39)	0.9(0.2)	-0.05(0.97)	0.002(0.99)	***0.53(0.1)***
ACEs	***5.62(0.05)***	1.21(0.44)	**2.29(0.003)**	***3.18(0.05)***	0.46(0.12)	0.44(0.23)
Time*ACEs	-1.78(0.12)	-0.07(0.91)	**-0.62(0.04)**	-0.91(0.15)	-0.13(0.29)	-0.14(0.31)
Time* Dec. Income	0.65(0.53)	-0.33(0.54)	-0.13(0.62)	0.2(0.73)	0.11(0.29)	**0.28(0.02)**
Dec. Income* ACEs	0.05(0.96)	-0.32(0.58)	**-0.71(0.01)**	-0.69(0.24)	-0.01(0.89)	0.1(0.47)
Dec. Income* ACEs* Time	0.28(0.51)	0.15(0.51)	**0.26(0.02)**	0.34(0.14)	0.02(0.69)	-0.02(0.62)
Intercept	3.85(0.77)	**18.79(0.01)**	5.17(0.12)	**23.89(0.001)**	-0.14(0.9)	-1.45(0.27)
Rent Inability	-5.42(0.24)	-0.05(0.98)	-0.44(0.72)	-3.78(0.16)	-0.03(0.95)	-0.87(0.14)
Time	1.68(0.52)	1.62(0.23)	0.72(0.31)	-0.41(0.78)	0.36(0.19)	**0.94(0.003)**
ACEs	3.26(0.22)	1.68(0.24)	1.17(0.11)	0.97(0.53)	**0.6(0.03)**	***0.61(0.07)***
Time*ACEs	-1.17(0.28)	-0.55(0.32)	-0.39(0.18)	-0.45(0.46)	***-0.19(0.09)***	***-0.24(0.07)***
Time* Rent Inability	1.32(0.48)	-0.51(0.59)	-0.04(0.93)	0.86(0.41)	-0.05(0.79)	0.25(0.26)
Rent Inability* ACEs	1.8(0.25)	-0.47(0.58)	-0.38(0.39)	0.51(0.57)	-0.09(0.57)	0.1(0.61)
Rent Inability* ACEs* Time	-0.08(0.9)	0.43(0.19)	0.25(0.15)	0.17(0.64)	0.06(0.33)	0.003(0.97)
Intercept	11.26(0.39)	**18.12(0.01)**	3.02(0.37)	**25.99(0.001)**	-0.31(0.79)	-0.61(0.66)
Food Pay Inability	***-10.83(0.05)***	0.6(0.84)	0.59(0.69)	-4.55(0.16)	-0.11(0.85)	***-1.21(0.09)***
Time	-1.19(0.69)	1.81(0.23)	1.08(0.17)	-0.66(0.7)	0.33(0.3)	**0.77(0.04)**
ACEs	1.92(0.5)	1.83(0.22)	**2.04(0.01)**	0.41(0.8)	**0.62(0.04)**	0.25(0.49)
Time*ACEs	-0.72(0.53)	-0.65(0.26)	**-0.62(0.04)**	-0.25(0.7)	***-0.2(0.09)***	-0.12(0.39)
Time* Food Pay Inability	***3.78(0.09)***	-0.75(0.51)	-0.28(0.63)	1.02(0.42)	-0.03(0.89)	0.36(0.19)
Food Pay Inability* ACEs	2.88(0.11)	-0.71(0.46)	***-0.95(0.05)***	0.85(0.42)	-0.12(0.52)	0.31(0.18)
Food Pay Inability* ACEs* Time	-0.47(0.52)	0.55(0.14)	**0.4(0.04)**	0.06(0.88)	0.08(0.29)	-0.06(0.49)

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

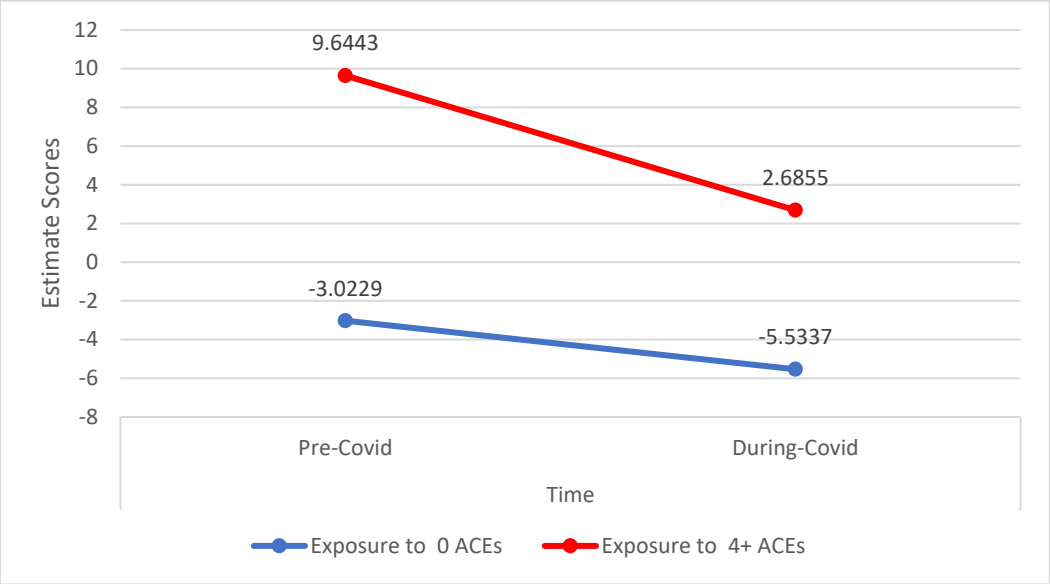
COVID-19 Proximal Stressors &ACEs	Mental Health Outcomes					
	Depression *Estimate (p value)*	**Anxiety** *Estimate (p value)*	**Hostility** *Estimate (p value)*	**Perceived Stress** *Estimate (p value)*	**General Health** *Estimate (p value)*	**Emotional Health** *Estimate (p value)*
Intercept	-4.16(0.75)	**14.19(0.03)**	2.35(0.47)	**17.58(0.01)**	0.43(0.7)	-1.75(0.18)
Serious argument	***-6.37(0.07)***	0.68(0.71)	0.75(0.4)	-1.85(0.37)	-0.59(0.11)	***-0.74(0.1)***
Time	-1.6(0.54)	1.39(0.3)	1.04(0.11)	-1.29(0.39)	-0.06(0.84)	**0.7(0.03)**
ACEs	2.35(0.41)	***2.71(0.07)***	**2.93(<0.001)**	0.54(0.74)	0.47(0.11)	0.34(0.36)
Time*ACEs	-0.74(0.51)	***-1.03(0.07)***	**-1.04(<0.001)**	-0.09(0.89)	-0.14(0.22)	-0.14(0.32)
Time* Serious argument	**2.96(0.03)**	-0.27(0.7)	-0.18(0.61)	1.08(0.17)	0.2(0.16)	0.3(0.08)
Serious argument* ACEs	1.8(0.18)	-1(0.15)	**-1.2(0.001)**	0.44(0.58)	0.002(0.99)	0.18(0.3)
Serious argument* ACEs* Time	-0.3(0.57)	**0.59(0.03)**	**0.52(<0.001)**	-0.03(0.93)	0.02(0.69)	-0.04(0.57)
Intercept	-6.48(0.73)	12.26(0.2)	4.58(0.34)	7.24(0.48)	-1.16(0.5)	-2.86(0.17)
Physical Fight	-0.73(0.95)	6.01(0.37)	0.19(0.96)	9.77(0.18)	0.73(0.58)	0.6(0.71)
Time	1.58(0.77)	3.6(0.2)	0.63(0.67)	4.05(0.19)	0.59(0.31)	**1.36(0.04)**
ACEs	***7.8(0.09)***	3.17(0.2)	0.83(0.51)	**5.94(0.03)**	0.76(0.12)	**1.27(0.03)**
Time*ACEs	-1.57(0.4)	-0.71(0.46)	-0.14(0.78)	-1.54(0.15)	-0.2(0.3)	***-0.42(0.06)***
Time* Physical Fight	1.2(0.81)	-2.72(0.3)	-0.08(0.95)	-3.39(0.24)	-0.31(0.56)	-0.18(0.78)
Physical Fight* ACEs	-2.21(0.59)	-2.31(0.29)	-0.33(0.77)	***-4.28(0.07)***	-0.32(0.46)	-0.6(0.26)
Physical Fight* ACEs* Time	0.52(0.75)	0.84(0.32)	0.17(0.71)	1.41(0.13)	0.12(0.49)	0.23(0.27)

All coefficients are adjusted for sex, age, and education status at baseline (pre COVID-19). **Bold** results are <0.05, ***Italicized bold*** results are between 0.05-0.10

4.6 Figures

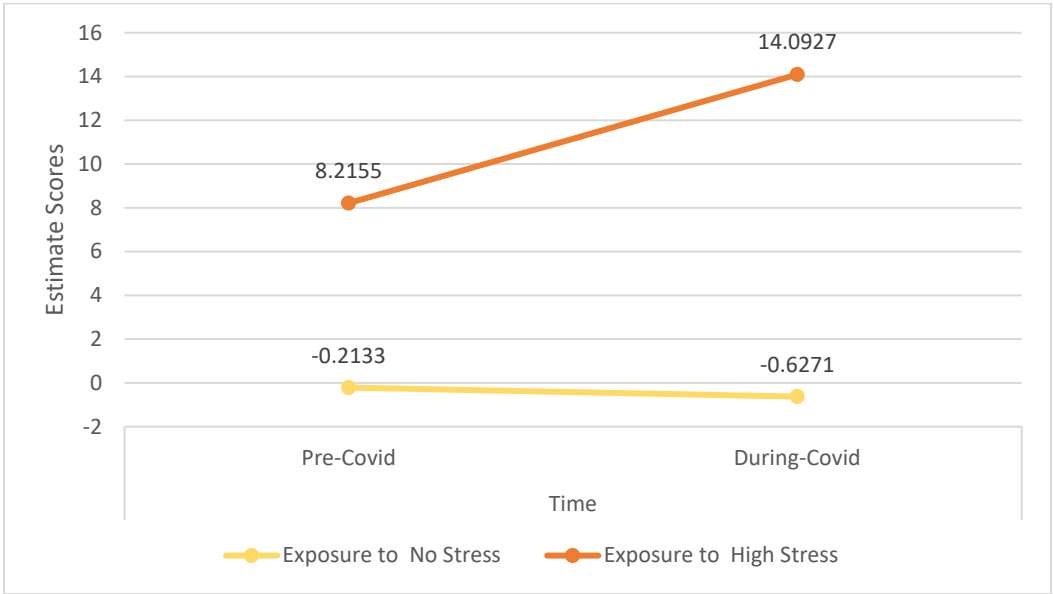
4.2.1 Figures of 2-Way Mixed Tests

Figure 4.1 *Effect of greater exposure to ACEs on Changes in Depressive Symptomatology among Young Adults from Before to During the COVID-19 Pandemic**



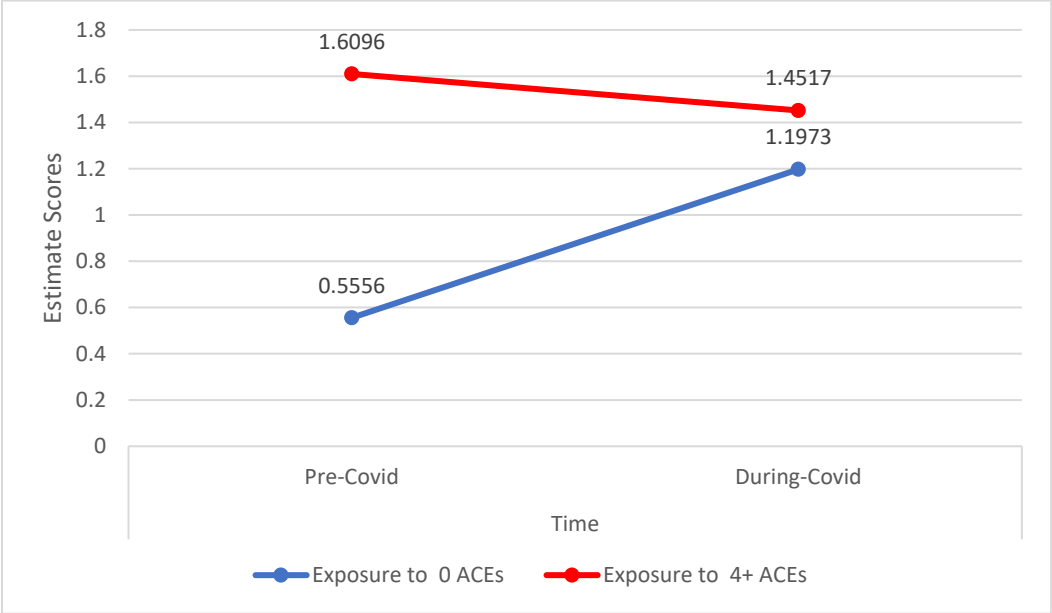
*Adjusting for Loneliness, sex, age, and education

Figure 4.2 *Effect of greater feeling of loneliness on Changes in Depressive Symptomatology among Young Adults from Before to During the COVID-19 Pandemic**



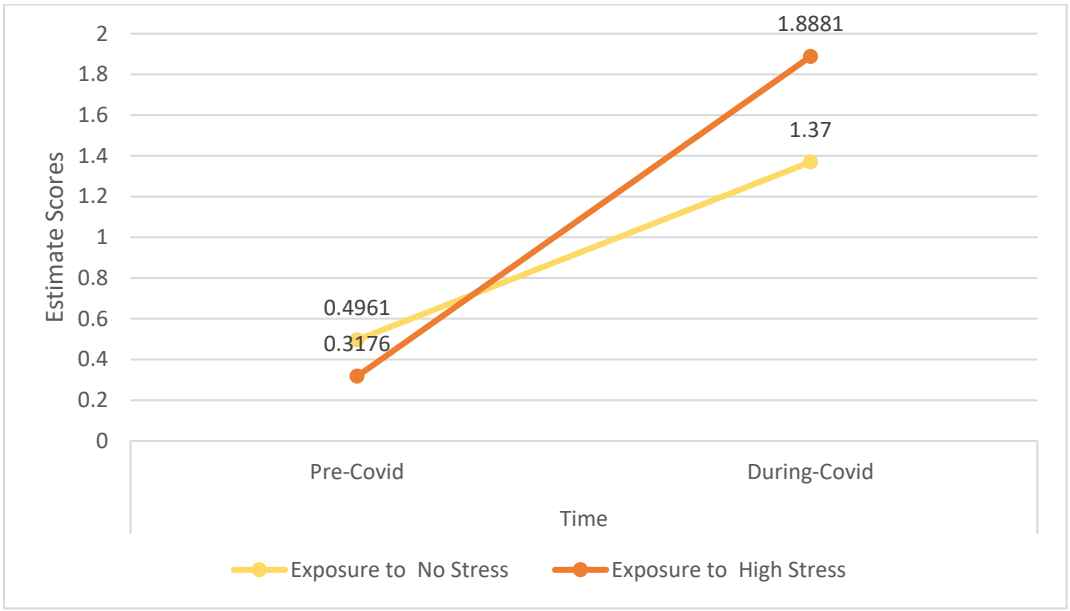
*Adjusting for Exposure to ACEs, sex, age, and education

Figure 4.3 *Effect of greater exposure to ACEs on Changes in overall Emotional Health among Young Adults from Before to During the COVID-19 Pandemic**



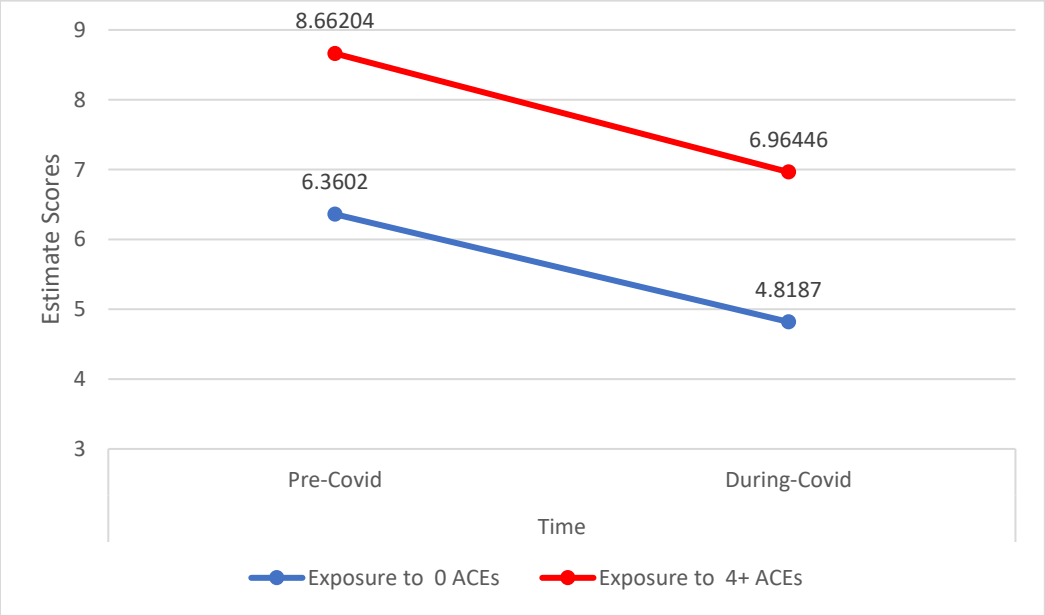
*Adjusting for Decreased Income, sex, age, and education

Figure 4.4 *Effect of greater Decreased Income on Changes in overall Emotional Health among Young Adults from Before to During the COVID-19 Pandemic**



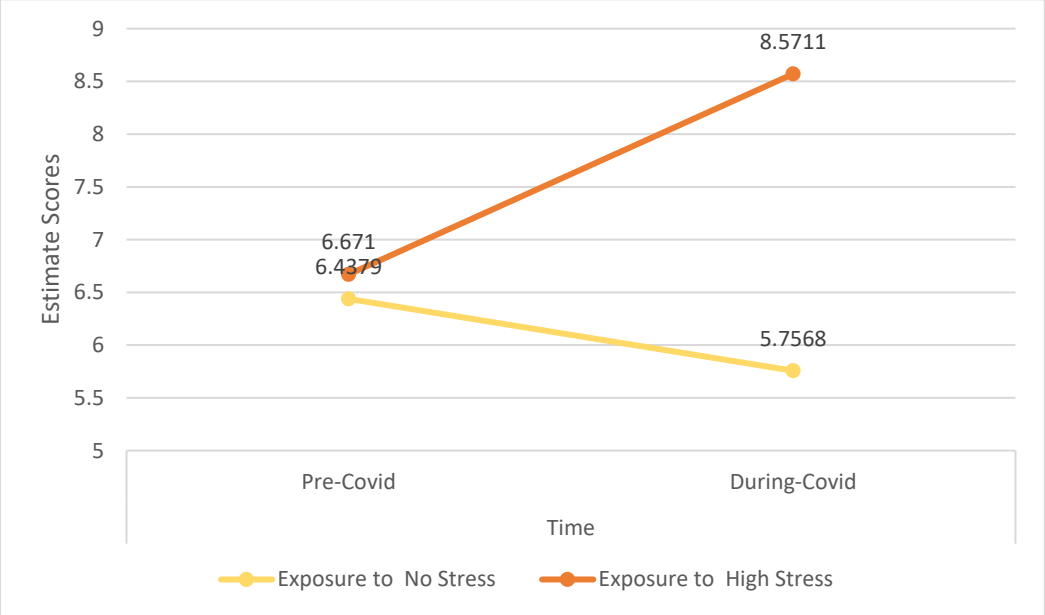
*Adjusting for Exposure to ACEs, sex, age, and education

Figure 4.5 *Effect of greater exposure to ACEs on Changes in Hostility Symptomatology among Young Adults from Before to During the COVID-19 Pandemic**



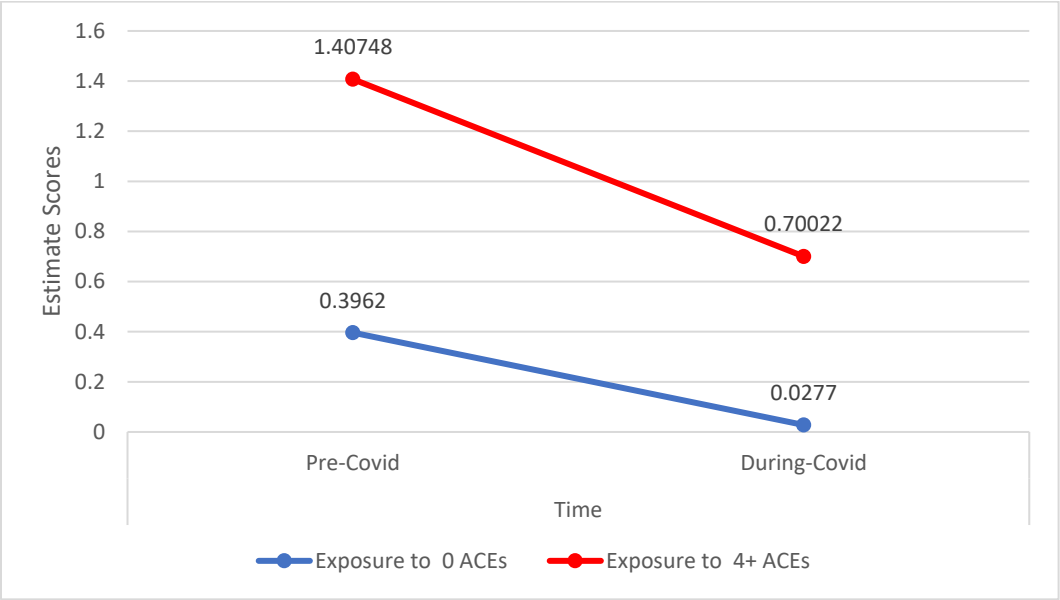
*Adjusting for Frustration, sex, age, and education

Figure 4.6 *Effect of high levels of Frustration on Changes in Hostility Symptomatology among Young Adults from Before to During the COVID-19 Pandemic**



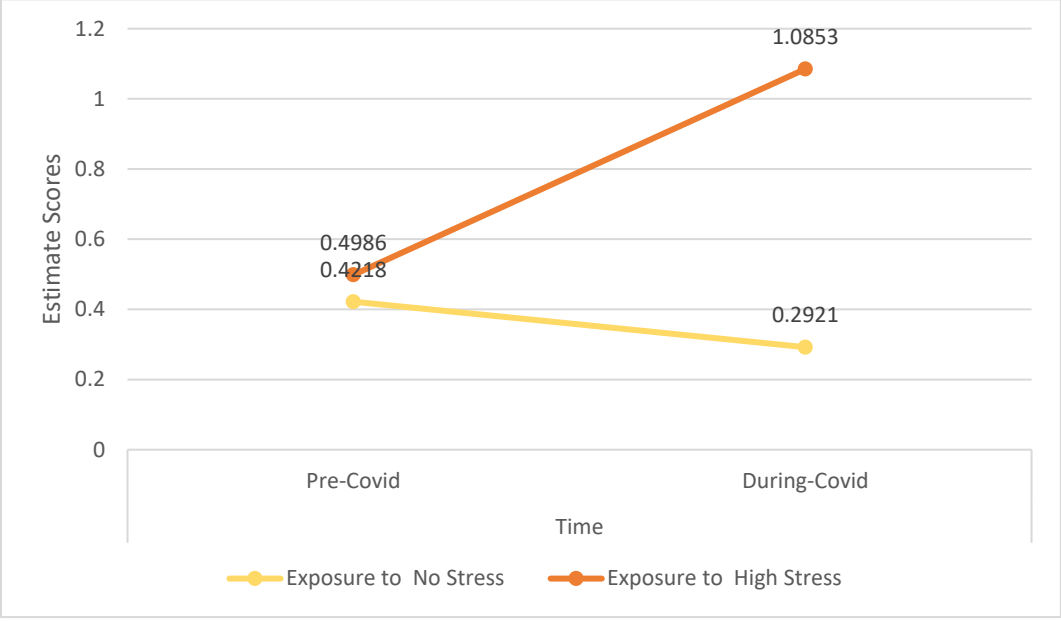
*Adjusting for Exposure to ACEs, sex, age, and education

Figure 4.7 *Effect of greater exposure to ACEs on Changes in overall General Health among Young Adults from Before to During the COVID-19 Pandemic**



*Adjusting for Loneliness, sex, age, and education

Figure 4.8 *Effect of greater feeling of loneliness on Changes in overall General Health among Young Adults from Before to During the COVID-19 Pandemic**



*Adjusting for Exposure to ACEs, sex, age, and education

4.2.2 Figures of 3-Way Mixed Tests

Figure 4.9 *Effect of interaction of greater exposure to ACEs and high levels of Loneliness on Changes in Depressive Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

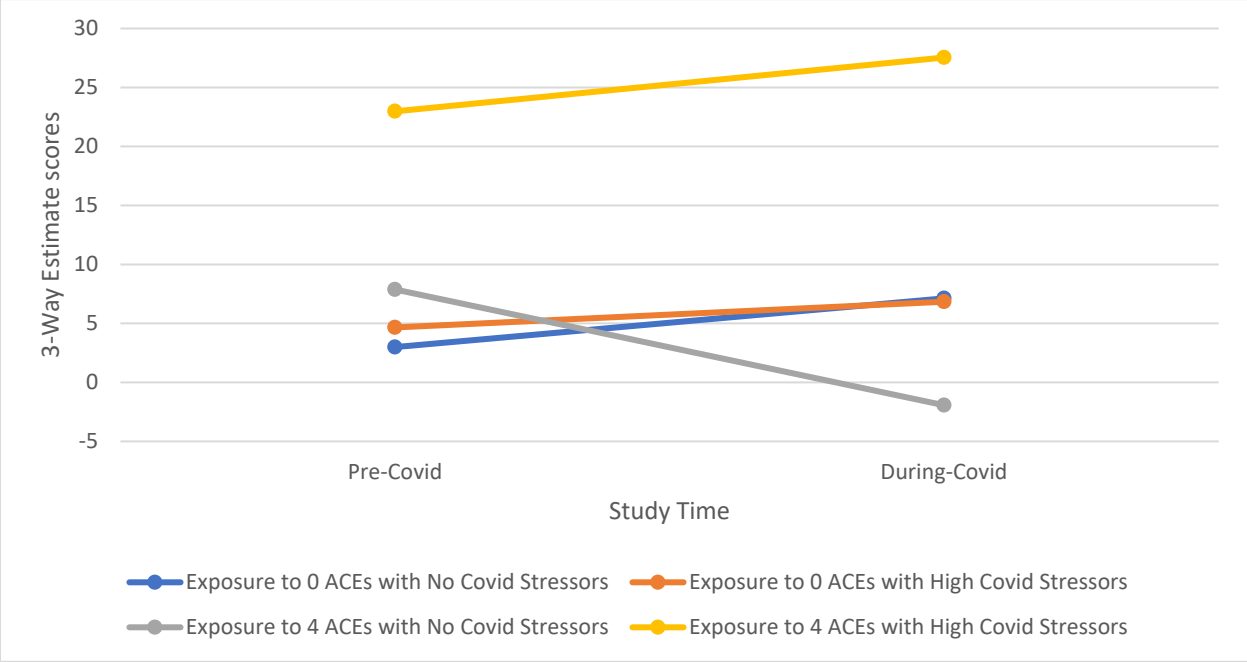


Figure 4.10 *Effect of interaction of greater exposure to ACEs and high levels of Frustration on Changes in Depressive Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

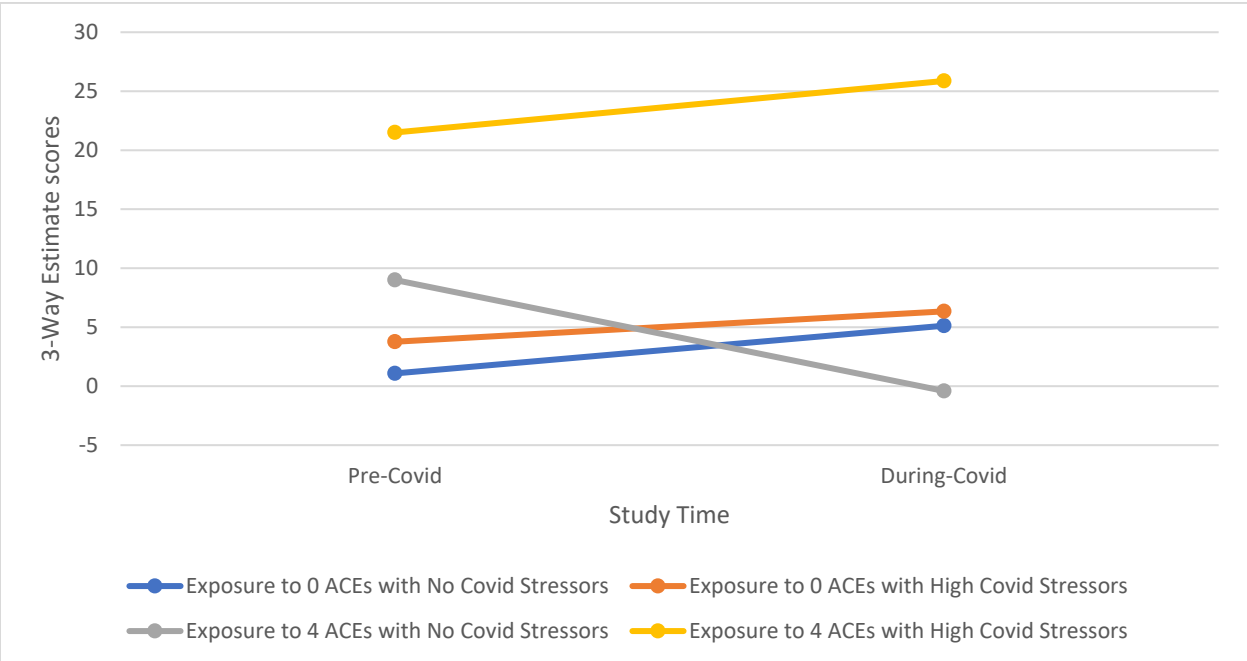


Figure 4.11 *Effect of interaction of greater exposure to ACEs and high levels of Loneliness on Changes in Anxiety Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

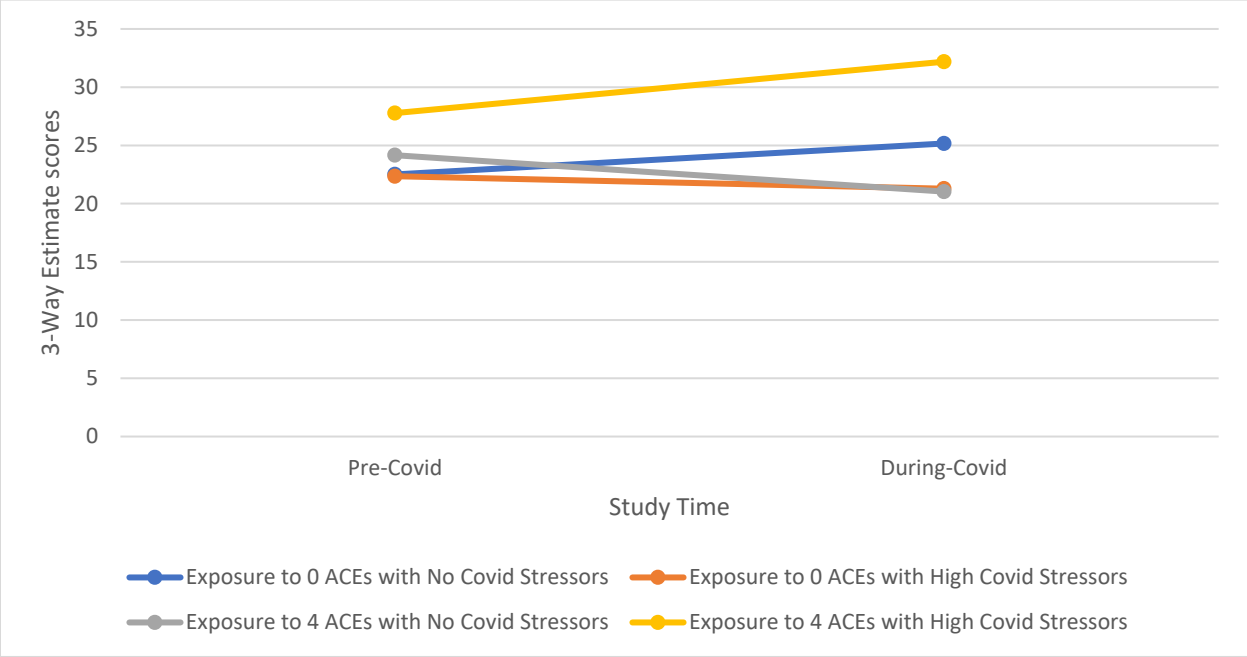


Figure 4.12 *Effect of interaction of greater exposure to ACEs and high levels of Suspiciousness on Changes in Anxiety Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

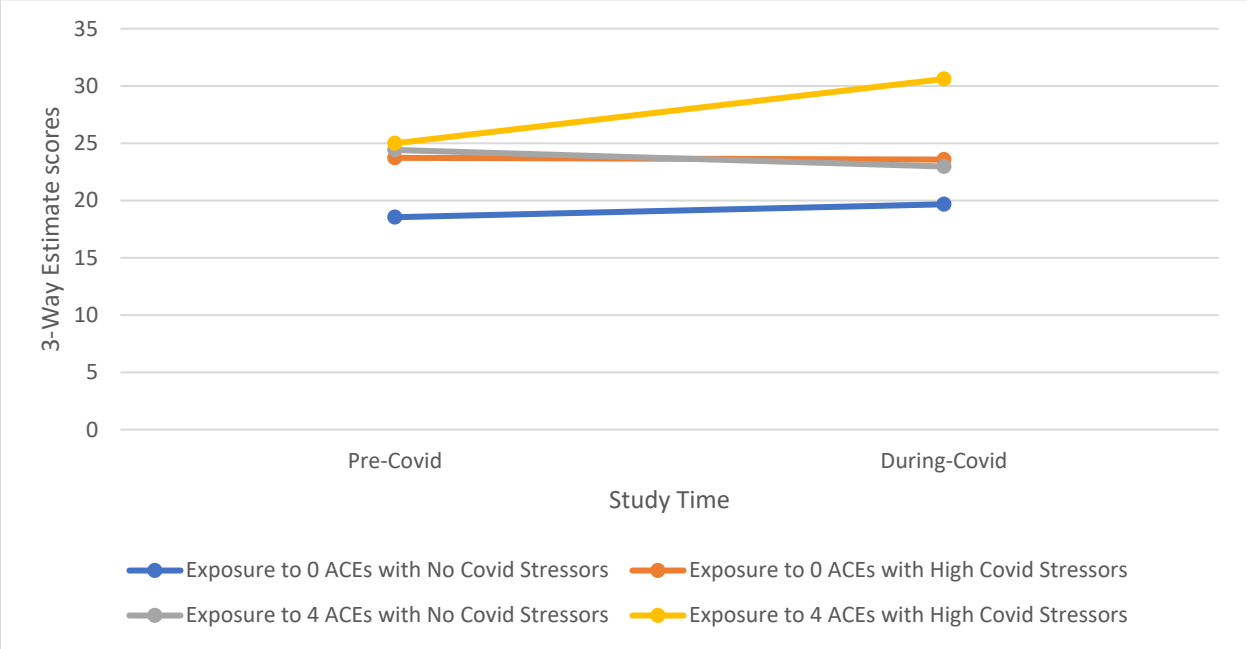


Figure 4.13 *Effect of interaction of greater exposure to ACEs and high levels of Loneliness on Changes in Hostility Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

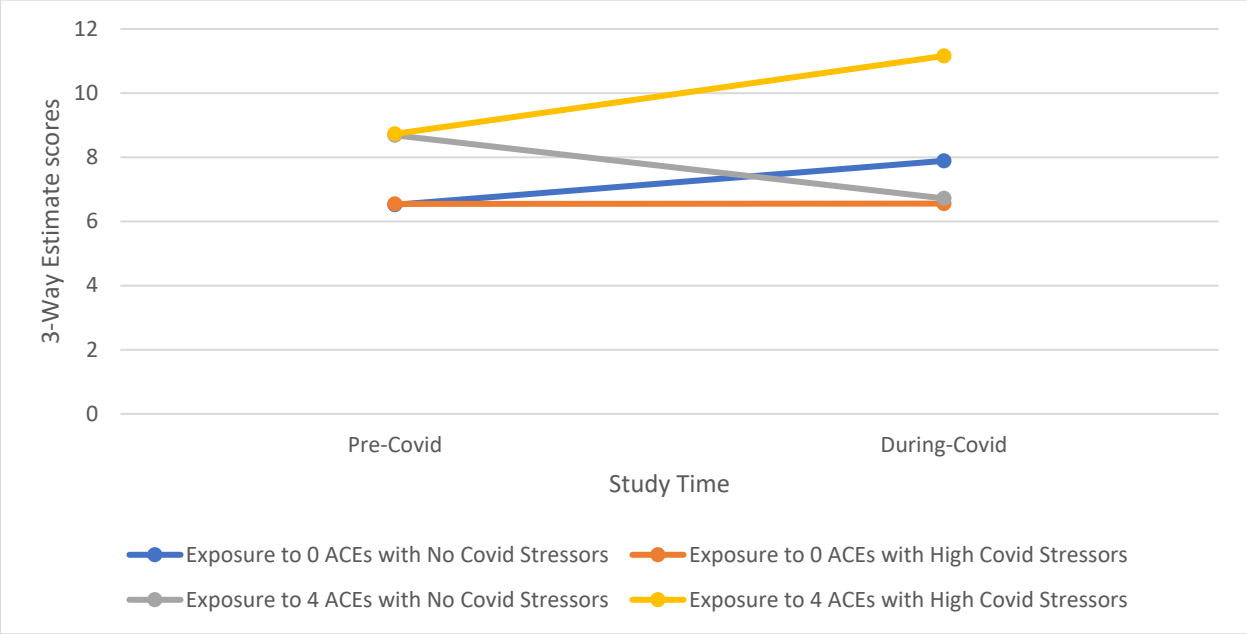


Figure 4.14 *Effect of interaction of greater exposure to ACEs and low levels of Physical Activity on Changes in Hostility Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

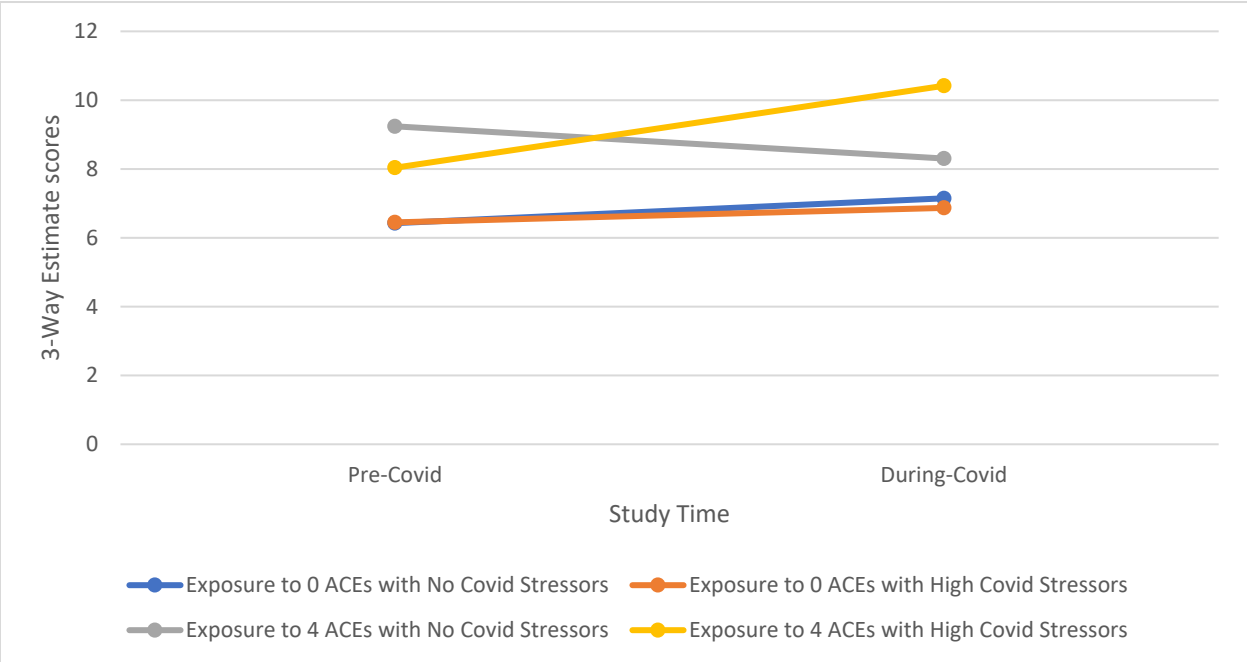


Figure 4.15 *Effect of interaction of greater exposure to ACEs and high levels of Serious Argument with People Living with the Participant on Changes in Hostility Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

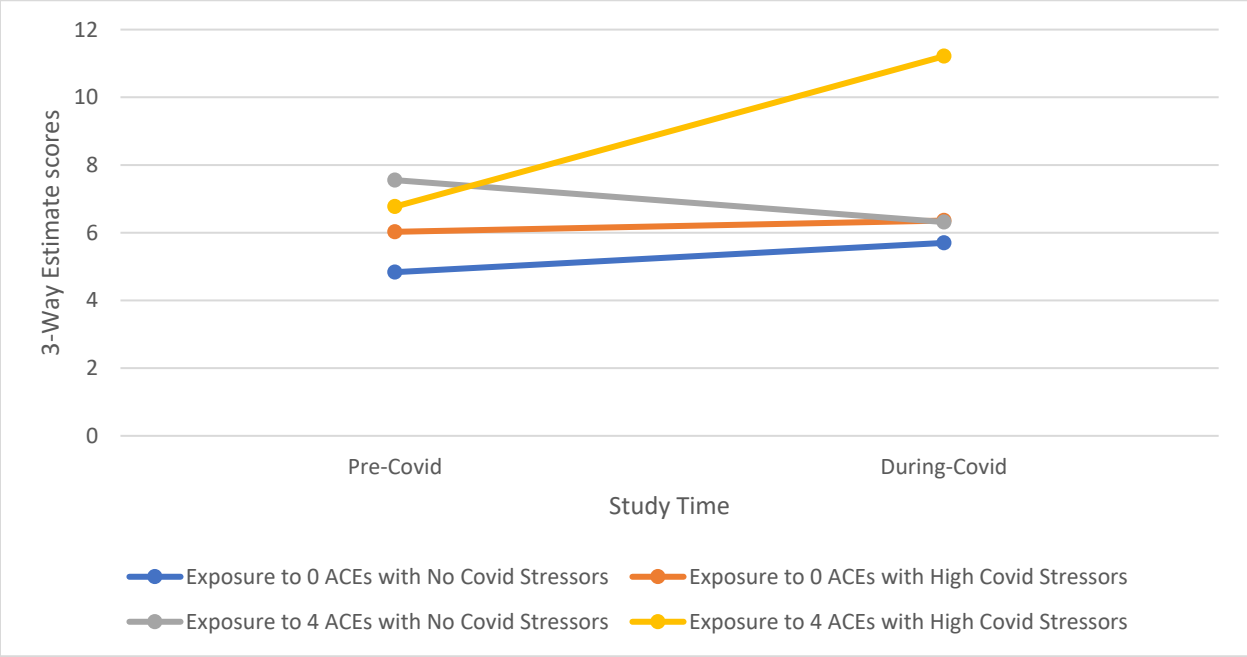


Figure 4.16 *Effect of interaction of greater exposure to ACEs and high levels of Frustration on Changes in Perceived Stress Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*

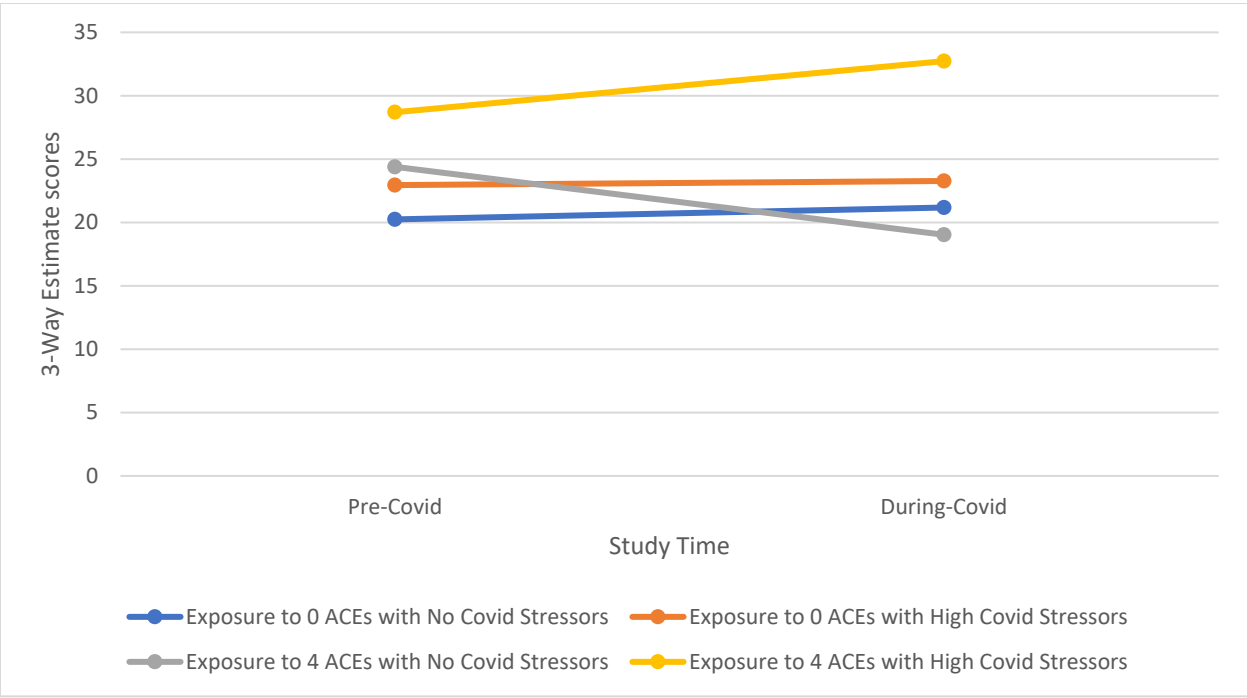
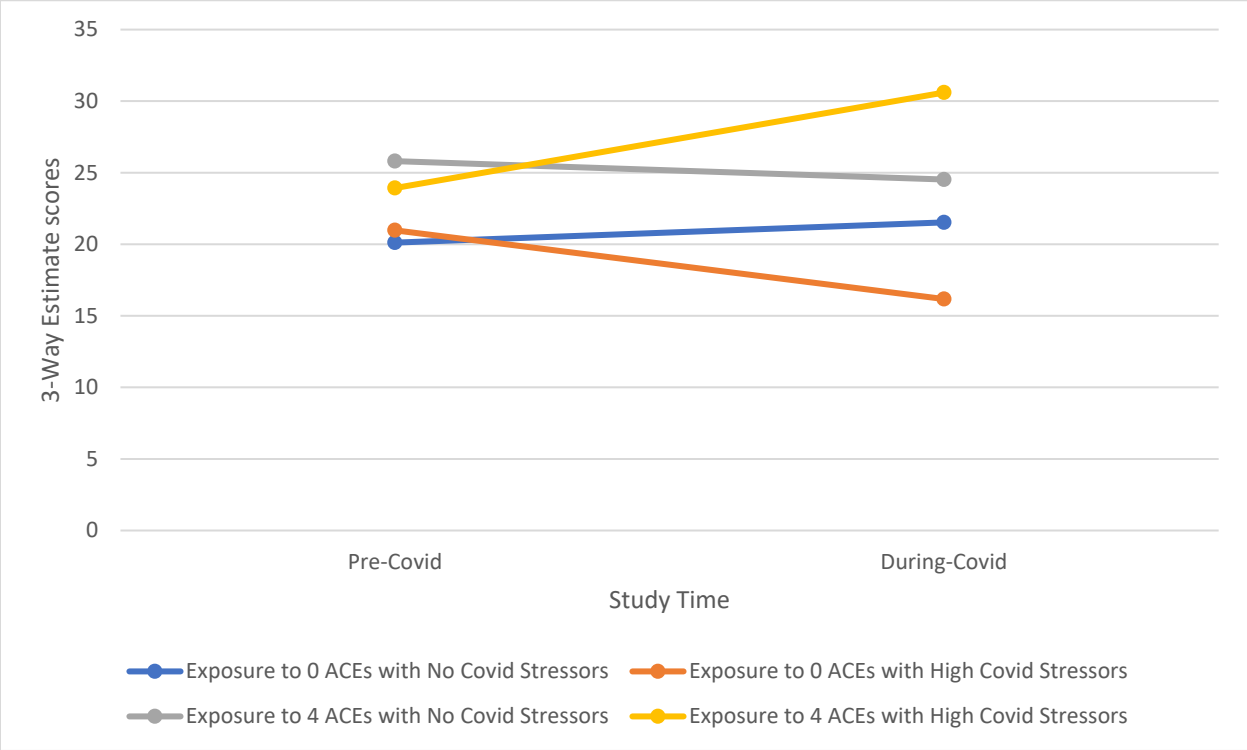


Figure 4.17 *Effect of interaction of greater exposure to ACEs and increased levels of Alcohol Consumption on Changes in Perceived Stress Symptomatology among Young Adults from Before to During the COVID-19 Pandemic*



CHAPTER 5: DISCUSSION

Since the emergence of the novel SARS-Cov-2, the virus responsible for COVID-19, and subsequent policies and governmental actions that accompanied it aiming to stop the rapid spread, the regular everyday life of people changed drastically. With actions such as quarantine and stay-at-home orders, social distancing, and school and workplace shutdowns, there has been a notable impact on the lives of millions of people, up to the point where researchers such as Marques de Miranda and colleagues have considered such pandemic to be akin to a global natural disaster (Marques de Miranda et al., 2020). As such, the pandemic has had a clear impact on both the general public as well as those infected with the virus themselves. The combination of stressors and the sources of these stressors that affect our mental health are immense, but their impact can also vary across cohorts. This thesis focused on young adults as they are in a particularly precarious phase in their life course and how previous exposure to ACEs may condition the effect of COVID-19-related stressors on mental health.

Exposure to ACEs has been linked to many mental health problems (Lee et al., 2020), such as depression, substance use, antisocial behaviors, and/or even personality disorders (Turner et al., 2020). These problems are intensified when one is exposed to a greater number of different ACEs(Clemens et al., 2022; Haydon & Salvatore, 2022; Stinson et al., 2021; Turner et al., 2020). Moreover, the stress associated with the COVID-19 pandemic was also found to be related to higher rates of mental health problems, whether it is the mental health of COVID-19 patients (Wei et al., 2020), or the mental health of the general public (Krishnamoorthy et al., 2020). For confirmed COVID-19 patients, stressors such as uncertainty, isolation, and feeling of helplessness have been experienced and such stressors have been shown to be related to mental problems such as depression, anxiety, posttraumatic stress symptoms, fear, and insomnia (Wei et al., 2020). For

the general public, stress, poor sleep quality, and psychological distress were significantly present (Krishnamoorthy et al., 2020). The stressors related to COVID-19 do impact the mental health of many, yet the relationship between those stressors and exposure to ACEs is not clear. Previous work has found that ACEs have an independent effect even in the presence of recent population-level events (Hein et al., 2020; Karam et al., 2019), but it is unclear as to whether they examined its potential compounding effect with other stressors.

Whether these stressors interact with previous exposure to ACEs was the core question of my thesis. The focus on young adults as the targeted cohort was based on their transitional life course stage which may be especially affected by the COVID-19 pandemic and the governmental responses to mitigating its impact (Bonnie et al., 2015). First, adolescence and emerging adulthood is a critical and sensitive period of development in the prefrontal cortex – the area of the brain responsible for higher-level cognitive functioning (Baltes & Staudinger, 2000; Tanner & Arnett, 2016). The various mitigating strategies such as lockdowns and social isolation may impact this development in their cognitive, emotional, and behavioural growth while in this transitioning period which is sensitive to young adults' environment and experiences (Baltes & Staudinger, 2000; Tanner & Arnett, 2016). Second, young adults make up a large percentage of workers in the tourism, retail, and service sectors – those sectors that were especially hard hit by the pandemic. As such, many young adults are less likely than older adults to have secure, stable, full-time employment with benefits and sick-leave leading to more frequent job loss and reduced hours, increased anxiety and depression (Ganson et al., 2021), and have had less time to build sufficient savings to endure work reductions and unemployment. Finally, they are also more dependent on their social networks to cope with negative emotional responses (Waselewski et al., 2020) which was threatened by lockdowns and the movement to online higher education, job loss, limits on

gatherings, and an inability to initiate and foster lifetime intimate relationships (Hamza et al., 2020). As such, this thesis examined whether greater exposure to COVID-19 associated stressors lead to a greater reduction in mental health among young adults independent of different levels of exposure to ACEs and whether higher levels of ACEs compound the negative effects of COVID-19-related stressors on mental health.

To address the first question, exposure to a higher number of COVID-19-related stressors was associated with increased scores over time across a broad array of mental health outcomes indicating poorer outcomes. In other words, the higher exposure to COVID-19-related proximal stressors, the worse the decline in mental health outcomes independent from the influence of exposure to ACEs and covariates. When looking at figures 4.2, 4.4, 4.6, and 4.8 where the two-way mixed models were adjusted for exposure to ACEs as well as other covariates including sex, age and education, a general trend of worsening in mental health outcomes is noted. For example, when assessing the impact of loneliness on the change of depressive symptomatology while adjusting for exposure to ACEs, it can be seen in Fig. 4.2 that the increase in depressive symptomatology from pre-COVID-19 to during COVID-19 was notably higher for those who reported higher levels of loneliness. The overall patterning of COVID-19 stressors identified that most emotional, financial, and relationship stress, specifically arguments with people who one lives with, were generally associated with a decrease across many mental health outcomes. Interestingly, physical stressors were associated with increased hostility and both physical stressors and substance use were associated with a decline in general health but were not associated with depression, anxiety, perceived stress and emotional health.

In other words, there is a general trend towards reduced mental health across an array of outcomes among young adults who report higher COVID-19 stress compared to those who report

experiencing less COVID-19 stress when adjusting for ACEs. These results are consistent with previous literature that found elevated rates of mental health problems among those experiencing higher COVID-19-related stress in both cross-sectional and longitudinal designs. There are a variety of reasons proposed in the literature that may account for this. First, levels of anxiety were significantly higher if a person knew a family member, a friend, or a relative who was infected by COVID-19 (Cao et al., 2020). Also, medical history and health status can be associated with higher distress (Salari et al., 2020) as COVID-19 may be more concerning among those with chronic health conditions. Also, Cao and colleagues (2020) found that COVID-19-related stressors such as economic restraints and daily life interruptions are positively associated with anxiety symptoms among college students. These findings are in line with the findings in this study that indicated that higher reported stress across a wide array of domains associated with COVID-19 is associated with increased levels of mental health concerns such as depression and anxiety.

The other main finding of this thesis is that exposure to higher levels of ACEs is found to compound the negative effects of COVID-19-related stressors on mental health among young adults indicating that those who experience higher levels of ACEs more vulnerable to stress related with COVID-19. When looking at Figures 4.9 – 4.17, despite the differences in trends between different groups, exposure to both higher number of ACEs and higher reported COVID-19-related stressors have notably worse mental health outcomes in phase 2 (during COVID-19). This suggests that the effect of exposure to a higher number of ACEs compounds the negative effects of exposure to COVID-19-related stressors. That is, those individuals with higher exposure to ACEs appear more vulnerable to the stressors associated with COVID-19 leading to worsening mental health outcomes.

Exposure to ACEs has been shown to have a powerful negative influence on the mental health of those exposed as it is related to many mental health issues such as depression and personality disorders (Turner et al., 2020). Exposure to COVID-19-related stressors is also related to mental health issues such as depression, distress, and anxiety (Salari et al., 2020). In our findings, exposure to ACEs was found to compound the negative effects of exposure to COVID-19-related stressors making those with high exposure to ACEs and high exposure to COVID-19-related stressors the most vulnerable to poorer health outcomes. Moreover, the results suggest that emotional COVID-19-related stressors had the greatest effect on mental health outcomes in relation to ACEs, and hostility appears to be the mental health outcome with the highest number of associations across emotional, physical, financial and relationship COVID-19-related stressors among those with higher levels of ACEs.

Most of these stressors are indirect byproducts of government actions aimed to control the spread of the virus such as social distancing and lockdowns. It is notable that among COVID-19 patients and potential patients, as reported by Wei and colleagues, stressors such as isolation and feeling of helplessness were reported (2020). And while mental health effects have been reported by both patient and nonpatients alike, the number of mental health resources that were available before the pandemic also decreased significantly as a result of lockdown as many existing resources were moved online to virtual and phone appointments. Access to these virtual resources can be problematic based on accessibility to online services. For example, rural areas which, in countries like the Canada and the US, includes up to 63% of the counties (Summers-Gabr, 2020) may have restricted or even nonexistent access to highspeed internet. In the US, about 21.3 million people do not have access to broadband which means that not only will those young adults not have access to education and the ability to socialize in a virtual environment, they will not even

have access to online resources for mental health support if problems arise (Summers-Gabr, 2020). These issues influence stressors such as loneliness and frustration which, as can be seen in table 4.8 and figures 4.9 and 4.10, have notable effect on mental health outcomes such as depression and emotional health.

It is likely that some of these reductions in mental health observed here were already occurring for reasons other than the pandemic as we saw significant overall increases in anxiety, hostility, and perceived general health problems (table 4.2). However, those that reported higher COVID-19-related stress had significantly greater increases than those with lower stress and those with both high ACEs and high COVID-19-related stress had the greatest increases in mental health problems. While acknowledging the potential for pre-existing factors that may account for some gradual increase over time, these results indicate that those with a combination of higher ACEs and higher COVID-19-related stress had the greatest increases across mental health outcomes. For example, the effect of higher stress related to decreased income on changes in overall emotional health seems similar between high and low COVID-19-related stress groups after adjusting for exposure to ACEs (see Fig. 4.4). However, if the pandemic has not introduced those risks, it has, at the least, magnified their impact to a notable degree. For example, the effects of a higher feeling of loneliness on changes in depressive symptoms (Fig. 4.2), the effects of high levels of frustration on changes in hostility (Fig. 4.6), and the effects of a higher feeling of loneliness on changes in overall general (See Fig. 4.8) health on mental health outcomes, after adjusting for exposure to ACEs, show different results. In these examples, those exposed to higher stressors have a notable reduction in their mental health outcomes compared to those exposed to lower stressors. As such, there is a visible relation between the amount of COVID-19-related stressors and mental health outcomes.

One interesting finding of this thesis is that when assessing the values of significant two-way interactions in Tables 4.7, while adjusting for COVID-19-related stress and covariates, all of the significant values for the ACEs by time interaction (2-way interaction) were negative indicating that those with a lower ACEs profile may be more at risk for increases in mental health problems. These findings appear, on the surface, to be nonsensical and opposite to the overwhelming literature examining the relationship between ACEs and mental health outcomes. This raises two issues. First, where the 3-way interactions between ACEs, COVID-19-related stress, and time, one could argue that any interpretation of the 2-way effects are uninterpretable as the relationship between ACEs and time is dependent on the level of COVID-19-relate stress. These effects are adjusted for not only covariates, but also the level of various stressors associated with COVID-19.

The second issue is based on the actual relationship and where the three-way interactions are not significant indicating that we should refer to any significant 2-way interactions. This is generally confined to depression and the two self-rated health measures (general and emotional) as outcome measures. However, when we examine the cross-sectional correlations, all mental health outcomes are positively related to ACEs in both phases indicating greater mental health issues are associated with higher ACEs as expected. And a closer examination of the negative two-way interaction effects does not negate this expected relationship. For example, inspecting figure 4.1 where the 3-way interaction on depression is significant and figure 4.3 where the 3-way interaction on emotional health is nonsignificant illustrates this negative relationship between ACEs and time on changes in the outcomes. In the case of depression where the 3-way interaction is significant, one could argue that interpretation of the 2-way interaction is non-interpretable because it depends on the level of loneliness due to COVID-19. However, if one were to interpret

it, then those with a higher ACE profile started off with significantly higher depressive symptoms in the pre-pandemic wave which was also significantly higher in the during-pandemic phase. But those with a higher ACE profile had a greater reduction in those symptoms compared to those with a lower ACE profile after adjusting for loneliness. Next, in the case of emotional health (figure 4.3), the negative relationship once graphed illustrates that those with lower ACE profiles started off being significantly lower in reporting poor emotional health but caught up to those with higher ACE profiles. That is, those with lower ACE scores report better mental health than those with higher ACE scores in Phase 1 (Pre-COVID-19), but after adjusting for COVID-19 stress, the groups show a convergence to having similar mental health profiles during COVID-19. However, as illustrated in the three-way interaction models (Fig. 4.9-4.17), the group with both high exposure to ACEs and higher reported COVID-19-related stress were at the greatest risk of increased mental health issues compared to those with either a high ACE profile or high reported COVID-19 stress but not both, as well as those with low ACEs and low reported COVID-19 stress.

5.1 Study Strengths and Limitations

This analysis examined changes in mental health outcomes prospectively from before to during COVID-19 pandemic among a sample of young adults. Unlike many studies that are either cross-sectional or longitudinal that began during COVID-19, I was able to assess these changes using baseline data of young adults that was collected prior to the COVID-19 pandemic. This assessment is essential because it establishes the temporality of the data. This allows for assessing the changes that could be attributable to the pandemic, especially the COVID-19-related stressors. Not only that, but it even allows for assessing how stressors can work in tandem with exposure to ACEs and how both can impact the mental health outcomes of the study cohort. Moreover, the study employs a broad array of validated measures of mental health outcomes including depression, anxiety,

hostility, and perceived stress as identified above that were measured both prior to and during COVID-19.

Notwithstanding these strengths, there are some limitations. First, the attrition rate between phases may create a bias in the results. Data collection for the baseline NLHS study was halted in March 2020 due to the pandemic. Out of those 248, only 171 participants (69%) completed phase 2 (during COVID-19) survey. The attrition analysis above identified no significant differences across ACEs or any of the mental health outcomes. Educational status, as one of the covariates, was the only significant factor separating those who participated in the COVID-19 survey and those who did not where those who participated had a higher level of education.

The total sample size available for analysis could have been another potential limitation. The calculated statistical power ranged from 60% to 80% indicating the study may have been slightly underpowered. To compensate for this, those effects that had a statistical probability ranging from 0.05 to 0.10 were also identified in the regression tables. Moreover, a number of significant 3-way interactions between ACEs, COVID-19 stress, and time identified expected patterns across various groups of stressors suggesting the effects are likely quite robust. Another limitation is that CTES 2.0 is not a fully validated measure as it was initially developed as a clinical screen for children and adolescents. However, its items focusing on maltreatment and household dysfunction follow the original CDC- Kaiser study on ACEs (Felitti et al., 1998). Additionally, covariates could have potentially been included in the models. However, due to the sample size, the selection of covariates was minimized to central socio-demographic covariates included in previous work on ACEs. Finally, the COVID-19-related stress measures which were taken from an international study by Lavoie and Bacon (2020) have not been evaluated in relation to their validity and reliability. As COVID-19 research is in its infancy, there has not been time to assess

the psychometrics of measures developed to gauge the impact of the pandemic. These limitations notwithstanding, the ability to examine the effect of ACEs on mental health outcomes in relation to the COVID-19 pandemic in a prospective, natural experimental design is a novel opportunity to provide further evidence on the robust effect of ACEs on longer term health outcomes.

5.2 Final Remarks and Future Work

The fast spread of COVID-19 is one of its features that makes dealing with it very difficult for governments and people. The wide-scale responses aiming to contain the pandemic and mitigate its consequences, such as school and workplace shutdowns and interrupting the social lives of many seem to be, although indirectly, creating an array of stressors associated with mental health outcomes in young adults. Combined with exposure to ACEs, such negative impacts seem to be even greater identifying a target for intervention programs, allocating resources where they are the most beneficial. The findings of this thesis imply that cohorts of young adults, especially those with higher exposure to ACEs, should be considered more thoroughly when the policies to mitigate a pandemic, such as the COVID-19 pandemic, are negatively associated with other health issues, such as mental health issues. The higher vulnerability of young adults with higher exposure to ACEs to mental health issues emphasizes the importance of early identification of such a cohort, as it would help more when accommodations are to be considered for this group. Moreover, it emphasizes the importance of proper access to mental health services and resources. As per directions for future research, examining whether middle-aged and older adults, as well as younger cohorts with higher ACE profiles, would also be more vulnerable to the adverse effects of COVID-19-related stress would identify whether this vulnerability is limited to younger adults or whether it is similar across different age cohorts.

5.3 Conclusion

In conclusion, the findings of this thesis support the two main hypotheses on which the thesis was based. The findings suggest that greater exposure to COVID-19-related stressors is associated with greater reduction in mental health among young adults independent of different levels of exposure to ACEs. Moreover, higher levels of ACEs compound the negative effects of COVID-19-related stressors on mental health among young adults making those who experience higher levels of ACEs more vulnerable to stresses related to COVID-19. These findings are of concern as previous research has shown that both high exposure to ACEs and high exposure to COVID-19-related stressors have notable association with the mental health of individuals (Fuller-Thomson et al., 2016; Karatekin, 2018; Salari et al., 2020). And since young adults are in a life-stage where they may be affected to a greater extent by the pandemic and governmental responses to attempt to mitigate the spread of COVID-19, they may be at greater risk for adverse mental health outcomes compared to other cohorts. As mental health surrounding COVID-19 becomes a larger public health issue both domestically and internationally, these findings identify a particular group who may be at even greater risk resulting from stresses associated with COVID-19 on their mental health.

The findings of this study also emphasize the importance of identifying people with high exposure to ACEs as they may be more vulnerable to mental health problems in the face of stressors across their life course. This suggests that this subgroup may benefit from intervention programs and resources directed at mental health upon times of crisis such as COVID-19 pandemic. Also, the findings highlighted the serious impacts of wide-scale governmental actions and policies that were meant to control the spread of the pandemic. These imposed system-wide responses resulted in a unique set of stressors that appear to be associated, at least partially, with

increases in mental health problems among young adults. In general, the findings of this thesis are in line with the existing literature identifying separately the effects of ACEs and COVID-19 stress on mental health but added to this research by indicating that the combination of high ACEs and COVID-19 stress may identify a group of young adults who are even at greater risk of adverse mental health outcomes.

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APPENDIX

Childhood Trust Events Scale 2.0

The questions below describe some kinds of upsetting experiences. Since we give these questions to everyone, we list a lot of possible events that may have happened at any time in your life. If one or more of these experiences has happened at some time in your life, please circle Y for Yes. If not, circle N for No. When you were a child:

1. Were you ever in a really bad accident, such as a serious car accident?
2. Were you ever in a disaster such as a tornado, hurricane, fire, big earthquake, or flood?
3. Were you ever so badly hurt or sick that you had to have painful or scary medical treatment?
4. Have you ever been threatened or really picked on by a bully (someone outside of your family)?
5. Have you ever had a parent swear at you, insult you, put you down, or say hurtful things such as "You are no good," "You will be sent away because you are bad," or "I wish you were never born"?
6. Were you ever completely separated from your parent(s) for a long time, such as going to a foster home, your parent living far apart from you, or never seeing your parent again?
7. Have you ever had a family member who was put in jail or prison or taken away by the police?
8. Have you ever had a time in your life when you did not have the care you needed, such as not having enough to eat, being left in charge of your younger brothers or sisters for long periods of time, or being left with a grownup who used drugs?
9. Have you ever had a time in your life when you were living in a car, living in a homeless shelter, living in a battered women's shelter, or living on the street?
10. Have you ever had someone living in your home who abused alcohol or used street drugs?
11. Have you ever had someone in your home try to hurt or kill himself/herself, such as cutting himself/herself or taking too many pills or drugs?
12. Have you ever had a family member who was depressed or mentally ill for a long time?

13. Have you ever had a family member or someone else very close to you die unexpectedly?
14. Has someone in your home ever been physically violent toward you, such as whipping, kicking, or hitting hard enough to leave marks?
15. Has an adult ever said they were going to hurt you really badly or kill you, or acted like they were going to hurt you very badly or kill you, even if they didn't actually do it?
16. Have you ever seen or heard family members act like they were going to kill or hurt each other badly, even if they didn't actually do it?
17. Have you ever seen or heard a family member being hit, punched, kicked very hard, or killed?
18. Have you ever seen someone in your neighborhood be beaten up, shot at or killed?
19. Has someone ever robbed or tried to rob (jump) you or your family with a weapon?
20. Has someone ever kidnapped you (taken you away from your home when they shouldn't have) or has someone close to you ever been kidnapped?
21. Have you ever been badly hurt by an animal, such as attacked by a dog?
22. Have you ever had a pet or animal that was hurt or killed on purpose by someone you knew?
23. Have you ever seen a friend killed?
24. Has someone ever touched your private sexual body parts when you did not want them to?
25. Has someone ever made you touch his or her private sexual body parts?
26. Has an adult ever tied you up, gagged you, blindfolded you, or locked you in a closet or a dark scary place?