Physical Activity and Mental Health During the COVID-19 Pandemic

by

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ABSTRACT

The COVID-19 pandemic has affected many aspects of daily life due to social distancing guidelines, including physical exercise. Prior research indicates that physical activity is a potent resilience factor against stress' impact on mental health. Further, research suggests that social integration and participation positively contributes to mental well-being. Yet, one aspect of physical activity that may be particularly impacted by social distancing guidelines is the social context. It is unclear if those who participated in social physical activity prior to the COVID pandemic are more impacted by the restrictions placed on these behaviors. In a sample of 519 adults in the United States, the current longitudinal study examined whether participation in social physical activity, compared to individual physical activity, moderates the influence of pandemic stress on mental health and whether there are gender differences between men and women in these associations. Study results indicated physical activity did benefit mental health during the COVID pandemic. However, greater social physical activity did not buffer against the negative impact of stress. Future research should examine other variables potentially influencing these relationships, and examine them under non-pandemic conditions.

DEDICATION

I dedicate this thesis to any comrades who also seek mental clarity in physical movement and find refuge in the rhythm of their steps on the pavement.

ACKNOWLEDGMENTS

First and foremost, I thank my advisor, Dr. Kristin Mickelson, for her guidance and encouragement throughout this process. I truly appreciate her listening to my ideas, answering my numerous questions and reading through all the drafts of my writing. I thank my committee members, Dr. Deborah Hall and Dr. Lindsey Meân, for all their time and assistance. I also thank the New College of Interdisciplinary Arts and Sciences for funding my thesis study. Finally, I thank my family for their unwavering support of me in my endeavors.

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CHAPTER 1

INTRODUCTION

"*Teach me to dance*", the narrator in Kazantzakis's *Zorba the Greek* requests of his friend after experiencing the epic failure of their work (Kazantzakis, 1952, p. 290). Contrary to how many might expect one to react to such a failure, these men do not become worried, embarrassed, sad or angry. Instead, side by side, they proceed to dance their traditional Greek dance - relieving their spirits through bodily movement. When we experience stress in our own lives, can we "dance" through life's difficulties? Does the physical movement involved in the dance expand our thoughts and emotions and shield us psychologically from the impact of life's adversities on our mental health? Or, do we stand motionless, lacking physical movement and release, and find ourselves ill equipped to deflect life's adversities and the weight on our mental health? And, if we do dance, does our dancing together, side by side, better protect us than dancing alone?

Translating these questions into the scientific realm, I sought in my thesis to examine whether physical activity buffers the relationship between stress and mental health. More specifically, I aimed to understand whether social physical activity, compared to individual physical activity, provides a stronger buffer on stress' deleterious impacts. Medical professionals and health resources frequently inform us of the benefits of physical activity for both physical and mental well-being (CDC, 2020). However, even though many forms of physical activity have social components integrated into them, there are currently no recommendations regarding the social environment of our physical activity. Moreover, we do not know whether the social environment of physical activity

influences stress and mental health equally for everyone; for example, do men or women benefit more from social physical activity?

As I was developing these research questions, the COVID-19 pandemic hit, impacting several key aspects of my thesis. The COVID-19 pandemic is a major global stressor, affecting numerous aspects of people's everyday lives, such as livelihood, daily routine, ability to socialize with others, and of course, health. Additionally, implementation of social distancing/isolation measures has prevented social interactions and posed obstacles to engaging in many forms of physical activity. Given the impact of the pandemic in relation to my original questions, I found it necessary to incorporate current circumstances into my thesis. Thus, my thesis examines the following: 1) the relationship between stress, physical activity and mental health and whether social, compared to solitary, physical activity is more beneficial, 2) potential gender differences in these relationships and 3) the influence of the COVID-19 pandemic on physical activity and mental health.

Stress and Mental Health

The experience of stress is a unifying factor among people; that is, all people experience stress at some point in their life. Yet, despite the commonality of stress, the stress experience can vary greatly between individuals. Stress has been conceptualized from three different perspectives: 1) *environmental*, which centers on external events or experiences that objectively correspond with substantial adaptive demands, 2) *psychological*, which is subjective and centers on the individual's perception of their ability to cope with the demands posed by an experience or event, and 3) *biological*, which centers on activation of physiological systems in response to both physical and

psychological demands (Cohen et al., 1995). Not all stressors are equal in resource demands, and even the same stressor can be experienced differently by different individuals. Even within an individual, the same event can differ in the intensity of demands imposed, depending on the context and timing in which it is occurring. For example, a stressor may be perceived differently depending on whether it occurs in isolation (e.g., a singular stressor, such as an argument with one's spouse) or in combination with others (e.g., argument with one's spouse co-occurring with illness and/or financial problems).

Cohen and colleagues (1995) define stress through an integrated model incorporating all three of these perspectives, where each perspective indicates a stage within the stress process. For example, say an individual loses their job - a potentially stressful event given that the individual is losing their source of livelihood and ability to provide for themselves and their family. The individual may perceive the event as stressful if they believe they lack the ability to cope with the job loss and associated consequences (e.g., they have no money saved; no one to support them while they search for a new job; and/or, they have unavoidable expenses). The individual may then start experiencing physiological symptoms affecting them not only in the short-term during the stressful event, but possibly also long-term, such as by having gastrointestinal disturbances and impacted immune system (Yaribeygi et al., 2017).

The appraisal of an event is a crucial component for determining the occurrence of stress in an individual. Appraisal explains why the same event may be stressful to one and neutral (or possibly even positive) to others (Lazarus & Folkman, 1984). Returning to the previous example of an individual losing their job, that individual may not consider

this event stressful if they have a spouse that can financially provide for them while they are unemployed, or if they were looking to change careers anyway. Lazarus and colleagues (1985) argue the person-environment relationship is essential in conceptualizing stress, saying "*there is simply no way to define an event as a stressor without referring to the properties of the persons that make their well-being in some way vulnerable to that event*" (Lazarus et al.,1985, p.778).

Indeed, stress is the strongest, most consistent predictor of psychological well-being (Kanner et al., 1981; Lu, 1991). Research dating back over 50 years has shown greater amounts of negative life factors, such as work worries, socioeconomic status worries and poor interpersonal affiliations, are associated with poorer mental health outcomes (Langner & Michael, 1963). More recent research indicates similar findings, as stress has been associated with depression (Hammen, 2005), less happiness (Schiffrin & Nelson, 2010) and poorer mental health outcomes (Bovier et al., 2004). Taken all together, this research provides evidence that stress is a critical determinant in an individual's mental health. Given the prevalence of stress in society and in one's life, understanding factors that make us resilient to stress' deleterious outcomes is crucial for providing insight into how to improve people's mental well-being. One potential resilience factor is the role of physical activity in the stress-mental health association.

Physical Activity and Mental Health

Physical activity has been defined broadly as bodily movements that expend energy; it encompasses exercise (i.e., physical activity to incur health benefits) and sport (Hagger & Chatzisarantis, 2005). Research has indicated that physical activity has a beneficial role in mental health (Paluska & Schwenk, 2000), with numerous studies

showing physical activity and exercise can help reduce depressive symptoms and anxiety (e.g., Dinas et al., 2011; Ströhle, 2009; Wipfli et al., 2008). Physical activity, compared to sedentary behavior, has been associated with more positive emotions and psychosocial resources (including self-acceptance, autonomy, personal growth, positive relationships with others, social coherence and social integration) (Hogan et al., 2014). In a study by Wendel-Vos and colleagues (2004), longitudinal analyses indicated that for both men and women, increasing total leisure time physical activity was associated with greater social functioning and, additionally for men, better mental health. Yet, in a cross-sectional study, women who reported greater habitual physical study reported more positive affect, including emotions such as interest, enthusiasm, excitement (Pasco et al., 2011). Additionally, more enjoyable exercise has been associated with increases in positive affect post-exercise (Raedeke, 2007).

One question that arises is whether the mental health benefits of physical activity may be partially related to the social context in which it can occur. Stated differently, the environment in which physical activity takes place, such as whether it is performed individually or socially, may influence the associated mental health outcomes of physical activity. For example, dance is traditionally a social activity. Research has found psychological benefits of group dance in adults (Bräuninger, 2012), elderly populations, and individuals with Parkinson's disease (Lewis et al., 2016). In one study, after just a single group dance session, participants reported better mood, including less tension, depression, confusion, aggression and more energy (Rokka et al., 2010). In a recent study with university students, dancing was found to moderate the relationship between

students' perceived stress and depression and was associated with fewer depression symptoms (Gerber et al., 2014).

Aside from dance, sports are another common form of physical activity with a social component (i.e., teams). Paralleling the previously addressed research, sports participation has been linked to beneficial mental health outcomes. Returning to the study by Gerber and colleagues (2014), they found that participation in ball sports (e.g., basketball, soccer, tennis) was associated with fewer depressive symptoms and moderated the relationship between students' perceived stress and depression. Likewise, in a longitudinal study, adolescents who participated in school sports reported better mental health, lower depression symptoms and less perceived stress five years later (Jewett et al., 2014). Sabiston and colleagues (2016) found that sports participation, specifically in team sports during adolescence, was negatively correlated with depressive symptoms later on in young adulthood. Similarly, Pluhar and colleagues (2019) found among youth who played various sports, those who played team sports (e.g., soccer, hockey, football) reported less anxiety and depression symptoms than those who played individual sports (e.g. swimming, diving, gymnastics, cross country). Additionally, team sport athletes were more likely to play their sport for fun, in comparison to individual sport athletes, who were more likely to play for goal-oriented reasons, such as obtaining a school scholarship, winning a championship, being popular, controlling weight, or pleasing parents (Pluhar et al., 2019).

Yet, one does not need to be a part of a team sport to reap the mental health benefits of social physical activity. More general group exercise has also been found to benefit mental health outcomes. In a study on medical students, group fitness class

participation, in comparison to individual exercise or no exercise, was associated with better stress reduction and mental health outcomes (Yorks et al., 2017). Additional research among younger populations has also found group exercise to be associated with a greater reduction in depression and anxiety symptoms (Doré et al., 2016; Kleppang et al., 2018). These findings are not limited to younger individuals, as similar psychological benefits have been found in older adults. In one study, older adults who engaged in a 12-month program of group exercise reported reduction in anxiety symptoms (Williams & Lord, 1997). Moreover, McAuley and colleagues (2000) found that, in older adults, forms of group exercise in comparison to individual high-intensity exercise were associated with more positive affective changes. Yet, other research has found individual exercise to be as effective as group exercise (Perraton et al., 2010). To conclude, social or group physical activity appears to benefit mental health; however, its effectiveness over and above individual physical activity is less clear for certain aspects of mental health such as depressive symptoms. Thus, the primary aim of this thesis is to examine if social, compared to individual, physical activity is associated with better mental health outcomes in response to stress (*Aim 1*).

Theoretical Rationale

One reason why social physical activity may be better than individual physical activity is related to our need for social connection and belonging (Baumeister & Leary, 1995). Accordingly, research has shown that social integration, or the degree to which someone participates in a wide range of social relationships (Cohen et al., 2000, p.54) can contribute positively to an individual's well-being, including psychological benefits such as having protective effects from depression (Hall-Lande, 2007; Seemen,1996). Research

has also shown that even the mere presence of others can have an effect on an individual, through providing a sense of security (Chou & Nordgren, 2017). Coan and colleagues (2006) found that the presence of others can also influence an individual's response to a threat. In their study, participants holding either a spouse's or a stranger's hand while expecting to experience an electrical shock showed lower neural threat responses in comparison to holding no one's hand (Coan et al., 2006). Furthermore, social participation, or the extent to which an individual engages in various activities with and without others, (Cohen et al., 2000) may contribute to one's social integration and well-being. Participation in social activities has been associated with benefits for mental and physical well-being (Glass et al., 1999; Gilmour, 2012; Phillips, 1967; Rashedi et al., 2014; Young & Glasgow, 1998). Taken together, these findings suggest that being with others and feeling a sense of social connection may change one's perception of a situation and appraise it as less threatening, thereby posing less demands on the individual and making it less taxing on their well-being.

The broaden and build theory (Fredrickson, 1998) adds further explanation for the benefits of social participation for mental health. The theory posits that positive emotions, such as joy, interest, contentment and love, broaden the momentary thought-action repertoire, prompting individuals to let go of their automated behavioral scripts in pursuit of novel paths of thought and action (Fredrickson, 1998), and expand one's attention and cognition. Broadening of one's thought-action repertoire may provide them with novel ways of perceiving the world and an openness to new experiences, which might influence their appraisal of situations and decrease the impact of stress on their mental well-being.

The theory also posits that positive emotions help to build biopsychosocial resources, including physical, intellectual and social resources, such as building up social bonds (Fredrickson, 1998) and fostering psychological resilience against stress (Fredrickson, 2001). For example, a study by Gloria and Steinhart (2016) found that positive emotions were associated with resilience and that resilience moderated the relationship of stress with both trait anxiety and depressive symptoms. This finding echoes the essence of the broaden and build theory, which as Fredrickson states, predicts an "*upward spiral in which positive emotions and the broadened thinking they engender also influence one another reciprocally, leading to appreciable increases in emotional well-being over time. Positive emotions may trigger these upward spirals, in part by building resilience and influencing the way people cope with adversity*" (Fredrickson, 2001, p. 223).

Social participation may be one way to ignite positive emotions and ultimately foster an upward spiraling of emotional well-being. One could argue that everyone has experienced the phenomenon of an uplift in mood from interacting with another person, especially if they particularly like that person. Research backs this well-known experience. Watson (1988) found that social activity (i.e., time spent socializing) was associated with positive affect. Additionally, in a study by Reis and colleagues (2017), positive affect in response to fun experiences was enhanced when others were around, especially friends. Socially experienced fun was also associated with high-arousal positive affect, suggesting that social interaction may be more energizing (Reis et al., 2017). Moreover, and relevant to the current thesis, socially experienced fun is likely to

include participating in physical activity, such as playing a sport, going on a bike ride, hiking or dancing.

Taking a moment to bring together all that I have reviewed thus far, we see that being around others and sharing activities with them may foster positive emotions and aid mood. Additionally, physical activity may foster positive emotions and improve mood. Logically, it should then follow that putting these two components together (i.e., social physical activity) should be associated with more positive affect and better mental health. Moreover, based on the broaden and build theory, positive emotions, such as those that might be gained from physical activity and socializing, may help individuals to build internal and external resources to better deal with stress.

Gender Differences

However, less clear is whether the benefits of social physical activity on the stress-mental health link varies by gender. Some studies have found men to be more physically active than women (Arriaza Jones et al., 1998; Azevedo et al., 2007), whereas others have found women to be more physically active (Craft et al., 2014). Yet, while gender differences in physical activity frequency may be unclear, differences in the reasons for engaging seem to be clearer. Men have reported exercising for enjoyment more than women (Craft et al., 2014), whereas women report exercising more for appearance related reasons, such weight loss and toning (Craft et al., 2014; Smith et al., 1998). These extrinsic motivations for exercising may make it feel more like a chore, instead of an activity done for its own pleasurable experience.

The social component of physical activity can contribute to participation and enjoyment. Yet, gender differences may exist in the benefits of social physical activity.

Research indicates there are gender differences in the types of social interactions preferred by men and women; women appear to prefer interactions with friends that center on conversation, while men prefer engaging in activities with friends (Aukett et al., 1988; Caldwell & Peplau, 1982). In other words, men may experience social fellowship during physical activity, whereas women experience that fellowship through sedentary activities. Thus, the question arises of whether men incur greater mental health benefits from social physical activity than women. To my knowledge, no prior study has examined this question. Therefore, the second aim of this thesis examines gender differences in the relationship of social physical activity on stress and mental health (*Aim 2*).

COVID-19 Pandemic

Finally, as stated earlier, the COVID-19 pandemic has fundamentally altered our social lives. It is the greatest global pandemic faced in the 21st century. Nations went on lockdown starting in late winter/early spring in an attempt to physically and socially distance the public to prevent the spread of the virus and overburdening healthcare systems. People are told by both government and medical authorities to self-isolate, stay home and avoid public gatherings. While medical and essential workers are overburdened, other businesses have shut down and thousands of people have lost their jobs. Many daily and regular interactions and communications between individuals, if even maintained, have now been reduced to virtual methods, limiting many people's feelings of human, physical connection. Moreover, the overwhelming amount of news and uncertainty regarding the virus has flooded our minds with numerous concerns for

our own and loved ones' health, worries about the future, as well as when things will return to normal and what the "new normal" will be.

Suffice it to say, the COVID-19 pandemic is likely, at least to some degree, a significant stressor for everyone. Accordingly, it would not be surprising to see signs of psychological distress and poorer mental health experienced by many. Thus, it is of interest to examine what factors make people resilient to the stress of the pandemic. Paralleling the research previously presented, it may be possible that physical activity buffers individuals from the pandemic's stress. But, what about the social aspect of physical activity? For many, physical activity is intertwined with social interaction, such as attending a dance class or playing tennis with friends. However, social distancing measures have blocked numerous means by which people regularly exercise (e.g., gyms are closed, exercise classes are cancelled, pickleball and tennis courts are closed to the public, and parks and hiking trails are restricted). Consequently, not only are people facing more barriers to engaging in their regular physical activity, many are also losing the associated social interaction with their chosen physical activity. Thus, in light of current circumstances, the third aim of this thesis is to examine how people who specifically engaged in social physical activity before COVID-19, are faring during the pandemic, and whether they are doing better or worse than those who engaged in individual physical activity pre-COVID-19 (*Aim 3*).

CHAPTER 2

CURRENT STUDY

Stress is an influential factor in mental health outcomes and physical activity appears to aid mental health and buffer stress effects. Research has shown that physical activity can influence the relationship between stress and well-being, such that more physical activity is associated with less stress and better mental health outcomes (Gerber et al., 2014; Wunsch et al., 2017). Many forms of physical activity include a social component. As previously discussed, social interactions can buffer stress and positively influence mental health. Based on prior literature, I examined the influence of social physical activity on the stress-mental health relationship in an adult community population to understand whether social physical activity makes individuals resilient to the unfavorable psychological outcomes of stress. In my thesis study, the COVID-19 pandemic serves as a common stressor among participants, seeing that it is a natural phenomenon affecting everyone around the world at this point in time (beginning in early 2020). Resilience, in the face of stress, was addressed through the components of physical activity and social interaction.

Given the prior research and theoretical frameworks discussed above, I proposed two specific hypotheses (see Figure 1). First, physical activity will moderate the stress-mental health relationship. I examined physical activity as moderator (as opposed to mediator) in these relationships based on prior research presented, suggesting a moderating role of physical activity, and also because I aimed to determine whether trait-like physical activity serves as a resilience factor against poor mental health. That is, I sought to understand whether individuals who are habitually active (e.g., " I regularly

play basketball twice a week"), fare better under stress compared to those whose physical activity behaviors are contingent to their current circumstances (e.g., " I was very stressed this week, so I jogged every day – something I do not normally do). As such, in this thesis, physical activity was assessed in terms of the stability and consistency of the behavior (e.g., frequency of physical activity in a *typical* week), in order to better reflect physical activity as a moderator in the stress- mental health relationship, and avoid analyzing any state-like physical activity influenced by the individual's immediate context.

My second hypothesis was that social physical activity will further moderate the influence of physical activity on the stress-mental health relationship. Namely, I predicted social physical activity will be a stronger buffer of the negative influence of stress on mental health outcomes than individual physical activity or no physical activity. Social physical activity is complex entity and in understanding it, there are various factors to be considered, such as the number of people participating in the physical activity together, whether the physical activity is in a formal (e.g., an organized team, a group class) or informal (e.g., walking with a friend) group setting, or the nature of the relationships between the individuals (e.g., friends, trainer and trainee, strangers) participating in the activity. In this thesis, I broadly operationalized social physical activity as engagement in any physical activity with at least one other person. Thus, I examined whether, on a general level, social physical activity further buffered the stress-physical activity- mental health relationships.

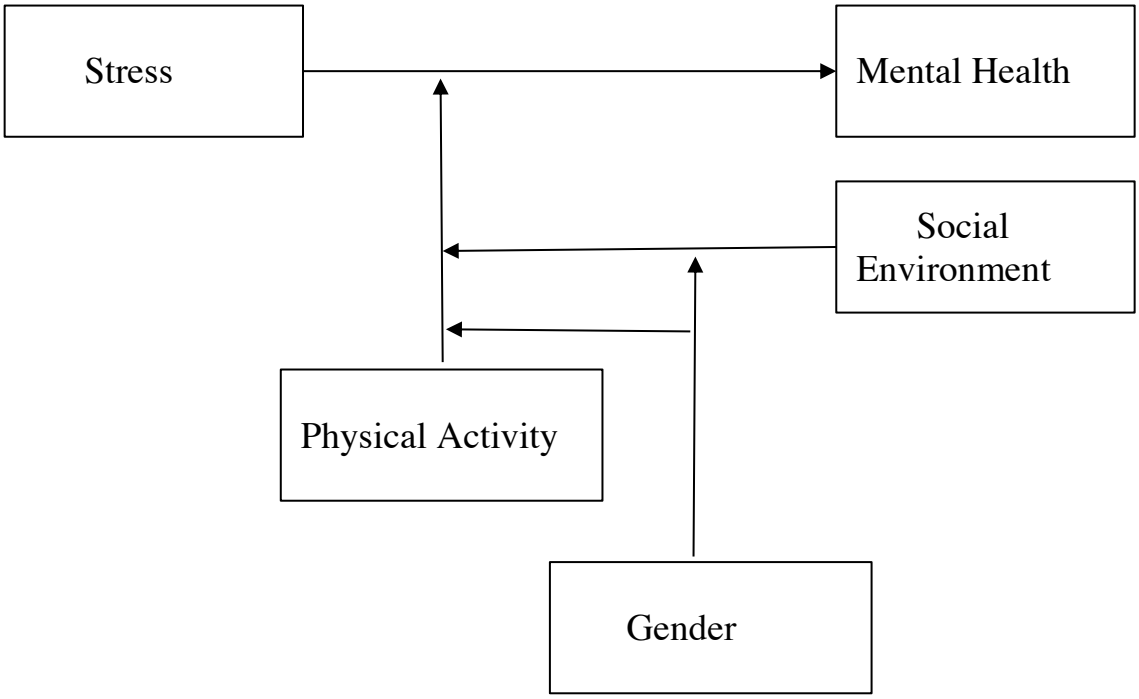
I also explored two research questions. First, I examined whether gender moderates the social physical activity-stress-mental health relationship (*Research*

Question 1). Although the existing research is unclear, I tentatively predicted that men will benefit more from social physical activity than women based on their greater likelihood to engage in social physical activity than women. Second, I explored how individuals who engaged in social physical activity before COVID-19 fare during the stay-at-home orders when social distancing rules applied, and whether there are long-term consequences for them compared to those who engaged in individual physical activity prior to COVID-19 (*Research Question 2*).

To capture the context of COVID-19 as it was initially occurring in the United States, I conducted a baseline study of adults in the United States when lockdowns were in full enforcement throughout most, if not all, of the United States (i.e., end of April 2020). In this baseline study, I assessed stress, physical activity and mental health outcomes approximately one month into the US pandemic. Furthermore, participants were asked to recall and report their physical activity behaviors prior to the start of the lockdown and pandemic, in order to address the third aim of the thesis. A follow-up study was conducted roughly 6 months later to determine longitudinal relationships between social physical activity, stress, and mental health. For the thesis, good mental health was defined as low negative affect, anxiety and depressive symptoms, as well as high positive affect.

Figure 1.

Proposed Relationships of Study Variables



CHAPTER 3

METHOD

Baseline Study (Wave 1)

Participants

Participants initially included a total 600 individuals recruited from Amazon's Mechanical Turk (MTurk) online platform to complete an online survey. Participants were MTurk "workers" and eligibility requirements for the study included being 18 years or older, English speaking and living in the United States. Of the 600 participants who completed the study, 81 participant responses were excluded due to poor data quality (e.g., failed attention checks). The final sample included 519 participants, ranging in age from 18-79 years old (M = 37.55, SD = 11.62). Of these 519 participants, 318 reported being male and 197 reported being female (4 participants did not report gender or reported non-binary gender). On average, male participants were younger (M = 37.08, SD = 11.48) than females (M = 38.18, SD = 11.85).

Procedure

Participants agreed to complete a 15 to 20-minute online Qualtrics survey through the MTurk platform with questions pertaining to physical activity and mental health during the COVID-19 pandemic. This study ran between April 24 and May 1, 2020, which was approximately 1 month into the start of the COVID-19 pandemic in the United States and when the majority of states were on full lockdown. Participants were compensated $1.25 for completing the survey.

Measurements

Socio-demographics. Demographic characteristics believed to be related to one or more of the major study variables were assessed, including age, gender, race/ethnicity, education, employment status, remote work conditions, household income, urbanicity, region, household composition, household size, relationship status, being currently under a stay-at -home order and the length of the stay-at-home order. *Age* range in this sample was between 18 to 79 and was represented as continuous variable. *Race/ethnicity* was a self-report of White, Black or African American, Latinx, Asian, American Indian or Native American, Native Hawaiian or other Pacific Islander. *Gender* consisted of four categories: male, female, nonbinary, other. *Education* consisted of five categories: some high school, high school, some college, college, or an advanced degree. *Household Income* consisted of seven categories: less than $20,000, $20,001 - $40,000, $40,001 - $60,000, $60,001 - $80,000, $80,001 - $100,000, $100,001 - $120,000, or more than $120,000. *Employment status* was categorized as full-time, part-time, self-employed, student, was employed but laid off due to COVID-19 and unemployed. *Remote work* conditions was assessed for participants who reported being employed and was categorized as either working remotely or going in to workplace.

Urbanicity consisted of four categories: city, small town, suburban, rural. *Region* was assessed by asking participants to report their state of residence, which was then recoded into a new variable reflecting geographic region that consisted of 5 categories: Northeast, Southeast, Midwest, Southwest, and West. *Household composition* was categorized as living alone, living with spouse/partner, living with roommate(s), living with parent(s) and living with children. *Household size* was represented as a continuous

variable. *Relationship status* was categorized as either married, cohabitating, separated/divorced, widowed, and single. *Degree of practicing social distancing* was assessed for all participants, and was categorized as yes, somewhat, or no. These demographic variables will be controlled for during analyses due to their potential to confound associations of key variables of interest.

For analytic purposes, the following variables were created for sociodemographic measures. *Gender* was dichotomized into either male and female. Participants who reported non-binary and other gender were not included in gender difference analyses. *Race/Ethnicity* was dichotomized into either white or minority. *Urbanicity* was dichotomized into either rural or urban based criteria by a U.S. Census Bureau reference (Ratcliffe et al., 2016) . *Region* was dichotomized to reflect living in a region containing one of the top 10 states with the current (January 2021 – time frame when data analyses were conducted) greatest cumulative COVID-19 cases (CDC, 2021). A sum score of dichotomous employment status (i.e., employed or unemployed), household income level, and education level was created to reflect *socioeconomic status (SES),* with higher scores indicating greater SES. A sum score of remote work and degree of practicing social distancing was created to reflect *COVID exposure risk*, where higher scores indicated greater risk. *Relationship status* was dichotomized into either in a relationship or not. *Household composition* was dichotomized into either living alone or living with other(s).

COVID- 19 Stress. Stress was assessed through 11 questions asking participants about their thoughts and feelings during this time of the pandemic (see Appendix C,E,F). Example question items included " *Overall, how much has the COVID-19 pandemic*

changed your daily life?", "How stressed do you currently feel with respect to the COVID- 19 pandemic?" and *"How confident do you currently feel in your ability to handle personal problems with respect to the COVID-19 pandemic?".* Responses ranged from 0 = *not at all* to 5 = *a lot* . Exploratory and confirmatory factor analysis were performed to validate the measure and determine scale construction (see Appendix C for further details). Based on the factor analyses, Item 3 (*"How unconcerned are you currently with respect to the COVID-19 pandemic ?")* was excluded from the measure and two factors (perceived coping and distress) were determined. For analyses, items of both factors were combined into a single COVID-19 stress variable. Reverse worded items were recoded and a mean score of the 10 items was created with higher scores indicating greater COVID-19 stress. The measure displayed good internal consistency (baseline: $\alpha = .77$; follow- up: $\alpha = .82$).

Physical Activity. *Physical activity frequency* was measured through a question of "How often do you engage in physical activity or exercise in a typical week? ". Responses ranged from 0 = *never (0 days per week)* to 5 = *daily (7 days per week)*. Participants who reported engaging in physical activity (i.e., those whose responses were not 0), were prompted to report the social and environmental context of their physical activity behaviors.

The *social environment of physical activity* was measured using an adaptation of the Godin *Leisure Time Exercise Questionnaire* (Godin, 2011), which was changed to: 1) include more currently popular forms of physical activity and 2) ask about the environmental context the activity occurs in (i.e., indoors or outdoors and alone or with others). Participants self-reported the number of times in a typical week they engaged in

light (minimal effort – e.g., yoga, golf, tai chi), moderate (not exhausting – e.g., baseball, tennis, fast walking) and strenuous physical activities (heart beats rapidly – e.g., running, soccer, hockey), either alone, with another person, or with a group, and whether the activity was done indoors or outdoors (see Appendix E, F). Participants completed both physical activity measures twice: 1) regarding their current physical activity behaviors (i.e., during the lockdown period) and 2) one month prior (i.e., before the lockdown).

Mean scores for each of the three social physical activity environments (i.e., alone, with someone and with a group) were created, with higher scores indicating greater amounts of physical activity in the associated social environment. A mean score for all social physical activity combined (i.e., with someone and with a group), as well as a mean score for total physical activity combined (i.e., individual, with someone and with a group) were also created, with higher scores indicating greater amounts of physical activity. If participants reported never engaging in physical activity during a typical week, they were not prompted to answer questions about the social environment of physical activity. For analytic purposes though, these participants were given mean score values of zero for social physical activity and for total physical activity.

Mental Health Measures. Mental health was assessed with positive and negative affect, anxiety and depression symptoms.

Positive and Negative Affect. Positive and negative affect was measured using the *Positive and Negative Affect Schedule* (Watson et al., 1988). Participants were asked to report the extent to which they felt 20 different emotions, such as interested, distressed, and excited, over the past week. Responses ranged from 1 = *very slightly or not at all* to 5

= *extremely*. A mean score of the 10 positive affect items was created, with higher scores indicating greater positive affect, and a mean score of the 10 negative affect items was created, with high scores indicating greater negative affect. Internal consistency was strong for both positive affect (baseline: α = .89; follow- up: α = .92) and negative affect (baseline: α = .95; follow- up: α = .94).

Anxiety. Anxiety was measured using the *Beck Anxiety Inventory* (Beck et al., 1988), which asked participants to report the extent to which they have been bothered by 21 common anxiety symptoms during the past month. Example symptoms included numbness or tingling, feeling hot, and unable to relax. Responses ranged from 0 = *not at all*" to 3 = *severely - it bothered me a lot*. A mean score of the 21 items was created, with higher scores indicating greater anxiety. Internal consistency was strong (baseline: α = .97; follow- up: α = .97).

Depression. Depression was measured using the *Center for Epidemiologic Studies- Depression Scale* (CES-D) (Radloff, 1977). Participants were asked to indicate the extent to which they felt 20 different ways during the past week. Example items included "I was bothered by things that usually don't bother me" and "I did not feel like eating; my appetite was poor ". Responses range from 0 = *rarely or none of the time (less than 1 day)* to 3 = *most or all of the time (5-7 days)*. Positively worded items were reversed scored and a sum score was calculated, with higher sum scores indicating greater depression symptomatology. Internal consistency was strong (baseline: α = .93; follow- up: α = .94).

Physical Health. Physical health was assessed with one question- ag. Responses ranged from 1 = *poor* to 5 = *excellent*. Greater scores indicated better physical health.

Follow-Up Study (Wave 2)

Method

Participants & Procedure

The follow-up study consisted of a 15 to 20-minute online Qualtrics survey through the MTurk platform. The follow- up survey was made available only to the 502 participants from the baseline study who reported willingness to participate in a follow-up. The study ran from October 14th – November 25th 2020, which was approximately 8 months into the COVID – 19 pandemic. Participants were compensated $1.25 for completing the survey. In total, 159 individuals completed the follow- up survey. Fifteen participants' data were excluded due to prior exclusion from the baseline study, while an additional eighteen participants' data were excluded for poor quality (e.g., multiple failed attention checks). Thus, the final sample consisted of 126 participants, ranging in age from 22 – 79 years old (M = 41.31, SD = 13. 56). Of the final sample, 53 participants were female and 73 were male.

Measurements

Measurements of stress, positive and negative affect, anxiety, and depression were identical to those used in the baseline study. Measurements of physical activity were also identical to baseline study's, with the exception that participants were asked about their current physical activity behaviors in the past two weeks, as well as about if their physical activity behaviors had changed since April (e.g., if they returned to their original pre-COVID participation and activities). Additional measures included in the follow-up survey are as follow:

Athletic Identity. Athletic identity was assessed using the 7-item version of the Athletic Identity Measurement Scale (Brewer & Cornelius, 2001). Participants were asked to report the extent to which they agreed on seven statements pertaining to athletic identity. Example items included " I consider myself an athlete", " I have many goals related to sport", and "Most of my friends are athletes". Responses ranged from 1 = *strongly disagree* to 7 = *strongly agree.* A mean score of the seven items was created, with higher scores indicating stronger athletic identity. Internal consistency for the measure was strong ($\alpha = .96$).

Overview of Analyses

Prior to the main analyses, I examined the data to determine if the assumptions for linear regression were met. Additionally, I determined whether any potential socio-demographics or covariates needed to be controlled for in the main analyses. Next, moderation analysis using PROCESS v34 in SPSS were conducted in order to address Hypothesis 1 and 2, determining if physical activity moderates the stress-mental health relationship and if social physical activity further moderates that relationship. For Research Question 1, men and women were analyzed separately and slopes were compared to determine the possibility of gender differences in these relationships. For Research Question 2, I created a variable indicating whether individuals' social physical activity changed from pre-COVID-19 to during COVID-19. I then conducted a MANCOVA to determine whether those individuals who engaged in social physical activity prior to COVID but stopped during COVID show worse outcomes than those who engaged in individual physical activity pre-COVID and those who maintained their social physical activity during COVID.

CHAPTER 4

RESULTS

Attrition Analyses

Attrition analyses were performed to determine whether attrited participants differed in demographic or main study variables, compared to those who completed Wave 2 of the study. Of the 519 participants who completed the first wave, 144 participants also completed the second wave. Eighteen of the participants who completed Wave 2 were not used in main analyses due to failed data quality checks. However, for attrition analyses, these participants were included. As displayed in Table 2, participants (both male and female) who attrited were significantly younger than those who completed Wave 2. Among males, there were significant differences in race, education, employment status, region and relationship status, between those who attrited and those who completed Wave 2. Among females, there was only a difference of household income between those who attirited and those who completed Wave 2.

Attrited participants also significantly differed in main study variables. Attrited participants reported engaging in significantly more social physical activity (PA) *times/week* and total PA *times/week*, both pre-COVID and at Wave 1. These significant differences were found for both males and females. Significant differences were also found for mental health measures, as attrited men and women had significantly greater negative affect, depression and anxiety at Wave 1 than those who completed Wave 2. Additionally, males who completed Wave 2 had significantly better self-reported physical health at Wave 1, in comparison to those who attrited.

Table 3.

Complete Participant Descriptive Statistics

	Total (N = 519)		Males (N = 318)		Females (N= 197)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Pre-COVID PA *(days/week)*	2.06	1.04	2.13	0.97	1.95	1.14
Pre-COVID Social PA *(times/week)*	1.26	1.69	1.43a**	1.77	1.01b**	1.53
Pre-COVID Total PA *(times/week)*	1.57	1.57	1.73a**	1.65	1.33b**	1.43
W1 PA *(days/week)*	1.86	1.14	1.86	1.06	1.86	1.26
W1 Social PA *(times/week)*	1.14	1.92	1.27a**	1.76	0.84b**	1.54
W1 Total PA *(times/week)*	1.42	1.80	1.51a*	1.68	1.20b*	1.52
W1 Stress	2.38	0.78	2.34	0.72	2.42	0.86
W1 Positive Affect	31.76	8.42	33.19a***	8.10	29.57b***	8.51
W1 Negative Affect	24.10	10.84	24.74	11.22	22.97	10.23
W1 Depression	21.48	13.32	21.86	13.39	20.61	13.27
W1 Anxiety	0.89	0.83	0.99a***	0.88	0.72b***	0.72
W1 Physical Health	3.86	0.95	4.00a***	0.92	3.66b***	0.94
	Total (N = 126)		Males (N = 73)		Females (N = 53)	
W2 PA *(days/week)*	2.03	1.23	2.08	1.19	1.96	1.30
W2 Social PA *(times/week)*	0.50	1.02	0.47	1.04	0.54	1.00
W2 Total PA *(times/week)*	1.01	1.02	1.06	1.12	0.95	0.86
W2 Stress	2.03	0.91	1.99	0.81	2.08	1.03
W2 Positive Affect	32.75	9.66	34.10	9.89	30.89	9.11
W2 Negative Affect	17.32	8.84	17.89	9.76	16.53	7.38
W2 Depression	13.98	12.75	14.45	13.37	13.34	11.93
W2 Anxiety	0.44	0.63	0.44	0.64	0.43	0.63
W2 Physical Health	3.69	1.03	3.73	1.00	3.64	1.08

* p <.05, **p <.01,***p < .001; a denotes the larger mean, b denotes the smaller mean.
PA = Physical Activity

Table 4.

Attrited and Completed Wave 2 Participant Descriptive Statistics

	Total Attrited (N = 375)		Total Completed W2 (N = 144)		Males Attrited (N = 238)		Males Completed W2 (N = 80)		Females Attrited (N = 134)		Females Completed W2 (N = 63)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Pre-COVID PA *(Days/Week)*	2.08	1.00	2.02	1.14	2.16	0.96	2.05	0.99	1.94	1.05	1.98	1.31
Pre-COVID Social PA *(Times/Week)*	1.50a***	1.79	0.64b***	1.20	1.65a***	1.82	0.76b***	1.43	1.27a***	1.72	0.47b***	0.80
Pre-COVID PA *(Times/Week)*	1.76a***	1.67	1.08b***	1.16	1.91a***	1.71	1.19b***	1.33	1.52a**	1.59	0.93b**	0.92
W1 PA (*Days/Week*)	1.83	1.07	1.93	1.30	1.87	1.01	1.81	1.20	1.76	1.16	2.08	1.42
W1 Social PA *(Times/Week)*	1.35a***	1.80	0.46b***	1.15	1.52a***	1.85	0.53b***	1.22	1.08a***	1.68	0.35b***	1.04
W1 PA (*Times/Week)*	1.58a***	1.73	0.89b***	1.15	1.71a***	1.77	0.94b***	1.20	1.38a***	1.66	0.80b**	1.09
W1 Stress	2.41	0.72	2.29	0.91	2.38	0.67	2.22	0.83	2.45	0.80	2.35	0.98
W1 Positive Affect	32.24a*	8.11	30.53b*	9.13	33.34	7.73	32.74	9.13	30.37	8.47	27.87	8.42
W1 Negative Affect	25.80a***	10.70	19.60b***	9.93	26.47a***	10.94	19.60b***	10.50	24.63a***	10.29	19.43b***	9.23
W1 Depression	23.31a***	13.05	16.64b***	12.88	23.87a***	12.97	15.90b***	12.91	22.21a*	13.28	17.22b*	12.70
W1 Anxiety	1.04a***	0.83	0.49b***	0.69	1.14a***	0.86	0.54b***	0.78	0.87a***	0.76	0.39b***	0.51
W1 Physical Health	2.08b*	0.909	2.31a*	1.033	1.94b*	0.867	2.19a*	1.032	2.31	0.928	2.41	0.978

* p <.05, **p <.01, ***p < .001; a denotes the larger mean, b denotes the smaller mean

PA = Physical Activity

Table 5.

Correlations of Main Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Pre-COVID PA *(Days/Week)*		.24**	.35**	.68**	.13	.26**	.08	.14*	.06	.03	.04	.64**	.07	.36**	-.08	.35*	-.07	-.09	-.01
2. Pre-COVID Social PA *(Times/Week)*	.14*		.94**	.16*	.79**	.80**	.06	.25**	.35**	.31**	.48**	.25	.33*	.40**	.14	.44**	.22	.07	.26
3. Pre-COVID PA *(Times/Week)*	.23**	.94**		.28**	.76**	.85**	.04	.17*	.33**	.31**	.45**	.40**	.36**	.53**	.09	.40**	.18	.09	.21
4. W1 PA *(Days/Week)*	.59**	.18**	.24**		.11	.31**	.05	.09	.03	.02	.03	.70**	.03	.33*	-.08	.23	-.17	-.14	-.08
5. W1 Social PA *(Times/Week)*	.14*	.84**	.82**	.20**		.92**	.06	.26**	.42**	.38**	.54**	.08	.18	.30*	.03	.38**	.20	.12	.19
6. W1 PA *(Times/Week)*	.20**	.82**	.84**	.31**	.96**		.03	.18*	.34**	.35**	.46**	.32*	.12	.38**	.03	.34*	.08	.08	.04
7. W1 Stress	-.07	.34**	.30**	-.02	.29**	.26**		-.12	.49**	.56**	.32**	-.01	.08	-.05	.79**	-.06	.27	.43**	.24
8. W1 Positive Affect	.24**	.33**	.28**	.32**	.32**	.28**	-.05		.22**	-.02	.32**	.29*	.43**	.47**	-.06	.79**	.16	-.06	.29*
9. W1 Negative Affect	.01	.53**	.47**	.03	.58**	.49**	.62**	.19**		.79**	.81**	-.18	.24	.05	.45**	.08	.70**	.71**	.78**
10. W1 Depression	-.02	.53**	.46**	.02	.55**	.48**	.65**	.07	.86**		.73**	-.05	.16	.09	.55**	-.07	.68**	.83**	.67**
11. W1 Anxiety	.06	.60**	.52**	.12*	.63**	.55**	.56**	.31**	.87**	.87**		-.09	.36**	.24	.44**	.12	.79**	.66**	.81**
12. W2 PA *(Days/Week)*	.58**	.14	.24*	.60**	.12	.22	-.14	.20	-.16	-.34**	-.09		.21	.57**	-.07	.38**	-.17	-.18	-.08
13. W2 Social PA *(Times/Week)*	.23	.39**	.33**	.09	.61**	.49**	.18	.33**	.53**	.38**	.64**	.01		.79**	.15	.39**	.34*	.14	.41**
14. W2 PA *(Times/Week)*	.35**	.38**	.48**	.24*	.46**	.47**	.15	.27*	.44**	.28*	.45**	.30*	.83**		.03	.46**	.26	.10	.26
15. W2 Stress	-.13	.14	.15	-.12	.08	.04	.74**	-.29*	.48**	.59**	.44**	-.20	.15	.13		-.02	.37**	.45**	.32*
16. W2 Positive Affect	.33**	.34**	.26*	.24*	.33**	.18	-.32**	.71**	-.16	-.38**	-.03	.26*	.36**	.21	-.34**		.02	-.21	.21
17. W2 Negative Affect	-.18	.26*	.20	-.13	.37**	.20	.45**	-.19	.71**	.72**	.65**	-.22	.46**	.32**	.54**	-.18		.78**	.77**
18. W2 Depression	-.24*	.22	.18	-.15	.22	.18	.53**	-.35**	.65**	.82**	.56**	-.40**	.32**	.16	.60**	-.44**	.81**		.66**
19. W2 Anxiety	-.04	.38**	.36**	-.04	.39**	.30*	.43**	.06	.75**	.72**	.79**	-.18	.56**	.43**	.51**	-.11	.77**	.72**	

**p <.01, * p < .05

Note: Correlations for males on bottom left. Correlations for females on top right.

PA = Physical Activity

Table 6.
Males - Correlations of Main Study Variables and Demographics

	Age	Race	Region	Urbanicity	SES	COVID Exposure Risk	Household Composition	Household Size	Relationship Status	W1 Physical Health	W2 Physical Health	Althetic Identity
Pre-COVID PA *(Days/Week)*	-.08	.03	.12*	-.03	.05	-.06	.10	.13*	.08	.32**	.51**	.27*
Pre-COVID Social PA (*Times/Week)*	-.10	.27**	.11	-.04	.19**	.04	.21**	.30**	.29**	.18**	.20	.41**
Pre-COVID PA *(Times/Week)*	-.07	.22**	.14*	-.09	.14*	.02	.19**	.26**	.23**	.20**	.27*	.43**
W1 PA (*Days/Week*)	-.08	.07	.13*	.01	.13*	-.10	.12*	.14*	.14*	.33**	.38**	.30**
W1 Social PA *(Times/Week)*	-.10	.34**	.11	-.12*	.16**	.03	.22**	.33**	.31**	.22**	.28*	.28*
W1 PA (*Times/Week)*	-.07	.27**	.11	-.13*	.14*	.01	.19**	.28**	.26**	.22**	.30*	.24*
W1 Stress	-.18**	.25**	.01	.03	-.03	-.09	.10	.20**	.16**	-.06	-.22	-.01
W1 Positive Affect	-.03	.21**	.13*	-.05	.19**	-.08	.20**	.15**	.25**	.44**	.52**	.27*
W1 Negative Affect	-.24**	.40**	.04	-.11*	.01	.01	.13*	.31**	.27**	.16**	.02	.31**
W1 Depression	-.20**	.38**	.02	-.08	-.02	.02	.12*	.28**	.25**	.07	-.26*	.17
W1 Anxiety	-.21**	.42**	.07	-.12*	.05	.00	.19**	.36**	.34**	.24**	.07	.40**
W2 PA (*Days/Week*)	-.12	.09	.10	.22	.26*	-.09	-.05	-.04	-.04	.46**	.52**	.29*
W2 Social PA *(Times/ Week)*	-.12	.34**	.13	.01	.27*	-.10	.18	.20	.29*	.36**	.36**	.40**
W2 Total PA (*Times/ Week)*	-.14	.16	.15	.00	.09	-.10	.03	.09	.11	.43**	.44**	.51**
W2 Stress	-.15	-.03	-.14	-.06	-.24*	-.07	-.27*	-.11	-.14	-.29*	-.38**	.05
W2 Positive Affect	-.10	.15	.21	-.02	.33**	-.03	.26*	.16	.19	.50**	.57**	.32**
W2 Negative Affect	-.18	.09	-.16	-.02	.01	-.07	-.05	.18	.05	-.15	-.20	.33**
W2 Depression	-.10	.10	-.18	-.08	-.16	-.05	-.10	.08	.00	-.34**	-.42**	.13
W2 Anxiety	-.24*	.21	-.04	-.07	-.09	-.07	.06	.24*	.14	-.01	-.12	.41**

**p <.01, * p < .05
PA = Physical Activity

Table 7.
Fenales - Correlations of Main Study Variables and Demographics

	Age	Race	Region	Urbanicity	SES	COVID Exposure Risk	Household Composition	Household Size	Relationship Status	W1 Physical Health	W2 Physical Health	Athletic Identity
Pre-COVID PA *(Days/Week)*	-.09	.00	.03	.04	.06	-.07	.05	.07	-.09	.15*	.31*	.36**
Pre-COVID Social PA *(Times/Week)*	-.14	.13	-.05	.06	-.05	.21**	.09	.19**	.16*	.18*	.16	.48**
Pre-COVID PA *(Times/Week)*	-.12	.11	-.02	.05	-.03	.20**	.06	.14*	.08	.14*	.12	.49**
W1 PA (*Days/Week*)	.04	-.07	.02	.12	.07	.06	.03	.00	-.07	.16*	.27*	.19
W1 Social PA *(Times/Week)*	-.06	.15*	-.02	.04	-.02	.21**	.06	.16*	.19**	.20**	.04	.26
W1 PA (*Times/Week)*	-.05	.12	-.03	.02	.02	.16*	.03	.11	.09	.16*	.07	.29*
W1 Stress	-.18*	.02	-.06	.06	.03	-.09	.11	-.01	.12	-.04	-.07	.16
W1 Positive Affect	.01	.07	-.09	.13	.17*	.05	.04	.14*	.17*	.37**	.30*	.54**
W1 Negative Affect	-.24**	.19**	-.09	.06	.06	.09	.08	.21**	.24**	.18*	.03	.38**
W1 Depression	-.22**	.14*	-.12	-.02	.01	.02	.03	.10	.12	-.02	-.06	.21
W1 Anxiety	-.21**	.18*	-.10	.06	.11	.12	-.02	.22**	.19**	.19**	.15	.36**
W2 PA (*Days/Week*)	.01	-.01	.03	.16	.16	.02	-.01	.01	-.05	.29*	.28*	.32*
W2 Social PA *(Times/ Week)*	-.19	-.02	-.05	-.11	.30*	.02	.24	.30*	.34*	.30*	.08	.51**
W2 PA (*Times/Week)*	-.10	-.07	.05	.01	.23	.20	.05	.18	.22	.34*	.22	.47**
W2 Stress	-.30*	-.05	.00	.09	.18	-.30*	-.19	-.14	.02	.03	-.01	.18
W2 Positive Affect	-.13	-.03	.02	.03	.13	.00	.17	.12	.14	.37**	.38**	.60**
W2 Negative Affect	-.21	-.09	-.06	-.17	.15	-.17	.01	.06	.10	.03	.02	.31*
W2 Depression	-.11	.14	-.05	.01	.13	-.19	-.11	-.02	-.01	-.20	-.25	.06
W2 Anxiety	-.25	-.14	.03	-.06	.24	-.10	.08	.24	.11	.16	.10	.43**

**p <.01, * p < .05
PA = Physical Activity

OLS Hierarchical Regression for Covariates and Main Effects

Bivariate correlations of most sociodemographic variables and mental health outcome measures were generally small, with just a few having moderate correlations (see Tables 6 and 7). Thus, to further examine whether any sociodemographic and or other variables (i.e., physical health, stress and PA) explained significant variance in each mental health outcome, hierarchical linear regressions were performed. That is, any variables thought to potentially confound the relationships between main study variables were included in these hierarchical regressions, in order to determine which variables would then be included as covariates in main study analyses.

Wave 1 Cross-Sectional

Variables reflecting age, race (dichotomous), region (dichotomous), urbanicity (dichotomous), household composition (dichotomous), household size, socioeconomic status, COVID exposure risk, relationship status (dichotomous), and Wave 1 current physical health were entered in at Step 1. A variable reflecting Wave 1 COVID -19 stress was entered at Step 2, and variables reflecting Wave 1 PA *days/week* and Wave 1 PA *times/week* were entered at Step 3 of the regression. To clarify the difference between these two PA variables, PA *days/week* was one's frequency of *days* participating in physical activity in typical week, whereas PA *times/week* was the mean score of the total number of *times* per week one participated in physical activity, across all social environments.

Demographic variables significantly explaining variance of each mental health outcome are listed in Tables 8, 9 and 10. For the total sample (males and females), as

predicted, significant main effects of stress were found for all mental health outcomes - positive affect (β = -.10, $p < .05$), negative affect (β = .52, $p < .001$), depression (β = .56 , $p < .001$), and anxiety (β = .40, $p < .001$). Additionally, as predicted, there was a significant main effect of PA *days/week* on negative affect (β = -.11, $p < .05$), depression (β = -.07, $p < .05$) and anxiety (β = -.08, $p < .05$). Similarly as predicted, significant main effects of PA *times/week* were found for all mental health outcomes - positive affect (β = .14, $p < .05$), negative affect (β = .30, $p < .001$), depression (β = .32, $p < .001$), and anxiety (β = .39, $p < .001$) (see Table 8).

Table 8.

Total Sample Wave 1 Cross-Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictor	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.23		.22		.17		.26	
	Age		.08		-.18**		-.17**		-.13*
	Race		.13*		.24		.23**		.26**
	Region		.02		-.03		-.06		-.02
	Urban-icity		.04		.00		-.01		.00
	Household composition		.02		-.13*		-.11		-.16*
	Household size		.00		.18**		.15*		.23**
	SES		.08		-.07		-.07		-.04
	COVID exposure risk		-.01		.05		.02		.05
	Relationship status		.10*		.23**		.20**		.24**
	W1 Physical health		.39**		.04		-.08		.10*
Step 2		.01*		.24**		.29**		.14**	
	W1 Stress		-.10*		.52**		.56**		.40**
Step 3		.02**		.07**		.08**		.12**	
	W1 PA (days/week)		.06		-.11*		-.07*		-.08*
	W1 PA (times/week)		.14*		.30**		.32**		.39**

*$p < .05$,
**$p < .001$
PA = Physical Activity

Next, I tested whether gender interacted with each main effect. Wave 1 stress (mean centered), gender and an interaction term calculated from these two variables were entered as predictors of each mental health outcome. Variables of age, race, household composition, household size, relationship status, and Wave 1 physical health were

entered as covariates in the model. The same analysis was performed using Wave 1 PA *days/week (*mean centered) and also Wave 1 PA *times/week* (mean centered) as the focal predictor instead of stress. A significant interaction of stress and gender emerged for negative affect (b = -2.76**,** SE = 0.94*,* t(504) = -2.95, $p < .01$, $\Delta R^2 = .01$), depression (b = -2.30**,** SE = 1.16*,* t(504) = -1.99, $p < .05$, $\Delta R^2 = .004$) and anxiety (b = -.32**,** SE = 0.07*,* t(504) = -4.28, $p < .001$, $\Delta R^2 = .02$). Simple slopes analyses indicated that more stress significantly predicted greater negative affect, depression and anxiety for both males (negative affect: b = 8.33**,** SE = 0.66*,* t(504) = 12.59, $p < .001$; depression: b = 10.62**,** SE = 0.82*,* t(504) = 12.96, $p < .001$; anxiety: b = .57**,** SE = 0.05*,* t(504) = 10.90, $p < .001$) and females (negative affect: b = 5.57**,** SE = 0.68*,* t(504) =8.23, $p < .001$; depression: b = 8.32**,** SE = 0.84*,* t(504) = 9.91, $p < .001$; anxiety: b = *.25***,** SE = 0.05*,* t(504) = 4.73, $p < .001$), with these relationship being stronger for males. No significant interactions of gender and PA *days/week* nor gender and PA *times/week* were found for any of the mental health outcomes.

Figure 2.

Wave 1 Cross-sectional: Gender and Stress on Negative Affect

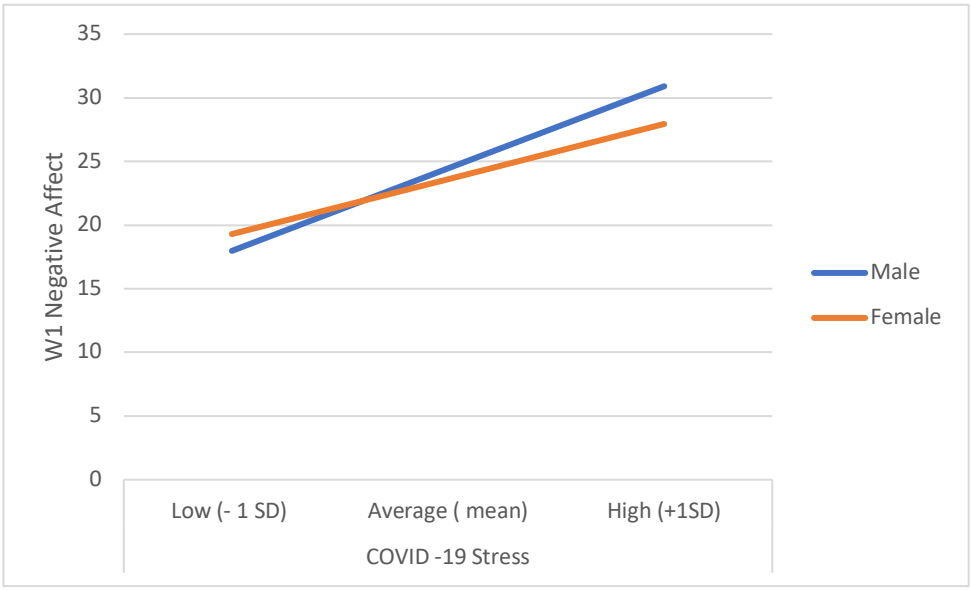


Figure 3.

Wave 1 Cross-sectional: Gender and Stress on Depression

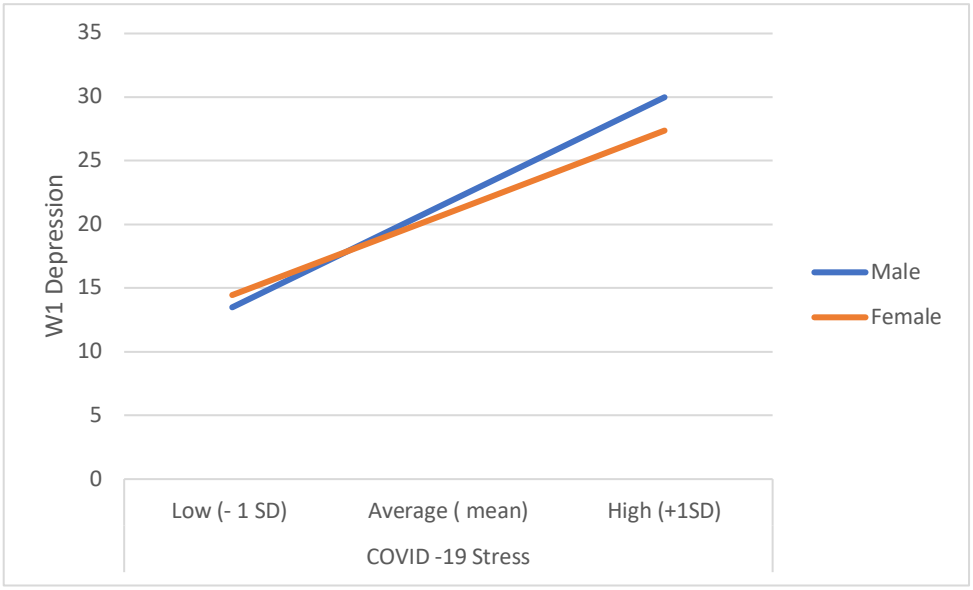
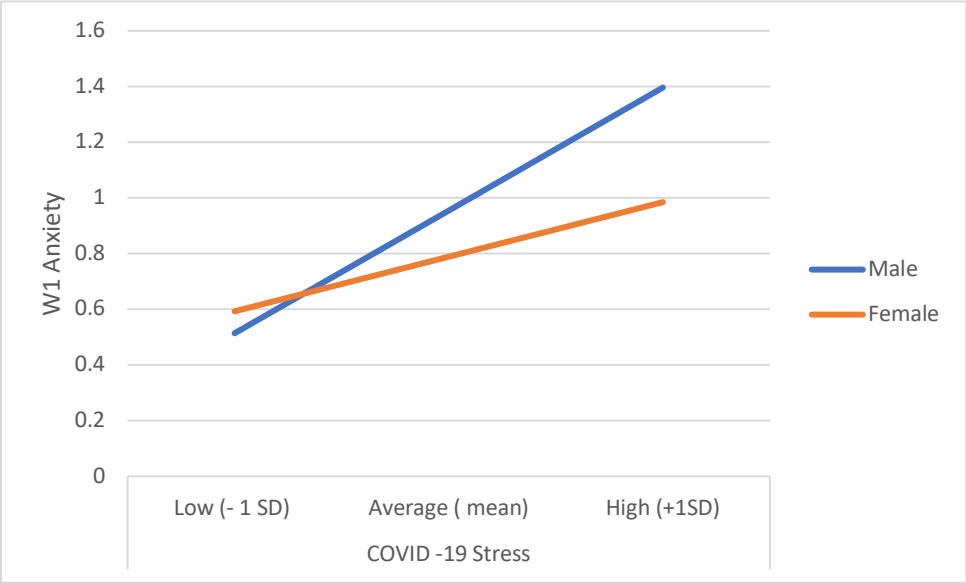


Figure 4.

Wave 1 Cross-sectional: Gender and Stress on Anxiety



I then examined the main effects of stress separately for males and females. For males, there was a significant main effect of stress found for negative affect (b = 8.41, SE = .67, $t(294)$ = 12.53, p < .001), depression (b = 10.56, SE = .81, $t(294)$ = 13.09, p < .001) and anxiety (b = .56, SE = .05, $t(294)$ = 10.52 p < .001) (see Table 9). For females, a significant main effect of stress was again found for negative affect (b = 5.61, SE = .72, $t(183)$ = 7.82, p < .001), depression (b = 8.25, SE = .94, $t(183)$ = 8.82, p < .001) and anxiety (b = 2.60, SE = .06, $t(183)$ = 4.73, p < .001) (see Table 10).

Table 9.

Males Wave 1 Cross-Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.26		.26		.23		.32	
	Age		.05		-.17*		-.14*		-.12*
	Race		.13*		.26***		.27*		.27**
	Region		.08		.00		-.02		.02
	Urbanicity		.00		-.06		-.03		-.06
	Household composition		.10		-.167*		-.17*		-.15*
	Household size		-.10		.23*		.23*		.25**
	SES		.07		-.10		-.12*		-.10
	COVID exposure risk		-.03		.03		.03		.03
	Relationship status		.14*		.23*		.22*		.27**
	W1 Physical health		.38**		.05		-.03		.12*
Step 2		.01		.26**		.28**		.19**	
	W1 Stress		-.08		.54**		.57**		.46**
Step 3		.03*		.07**		.07**		.08**	
	W1 PA (days/week)		.13*		-.12*		-.09*		-.06
	W1 PA (times/week)		.12*		.30**		.30**		.33**

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

PA = Physical Activity

Table 10.

Females Wave 1 Cross-Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictors	Δ R^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.18		.18		.12		.20	
	Age		.12		-.21*		-.24*		-.18*
	Race		.05		.16**		.14		.16*
	Region		-.06		-.05		-.10		-.05
	Urbanicity		.09		.08		.01		.06
	Household composition		-.07		-.11		-.07		-.21*
	Household size		.09		.13		.06		.22*
	SES		.06		-.01		-.05		.05
	COVID exposure risk		.03		.09		.03		.12
	Relationship status		.10		.26*		.18*		.22*
	W1 Physical Health		.33**		.03		-.14		.04
Step 2		.01		.21**		.26		.09**	
	W1 Stress		-.11		.47**		.54**		.31**
Step 3		.01		.06**		.10		.15**	
	W1 PA (days/week)		.00		-.07		-.07		-.11
	W1 PA (times/week)		.12		.27**		.34**		.42**

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

PA = Physical Activity

Wave 2 Cross-Sectional

Variables reflecting age, race (dichotomous), region (dichotomous), urbanicity (dichotomous), household composition (dichotomous), household size, socioeconomic status, COVID exposure risk, relationship status (dichotomous), athletic identity (which

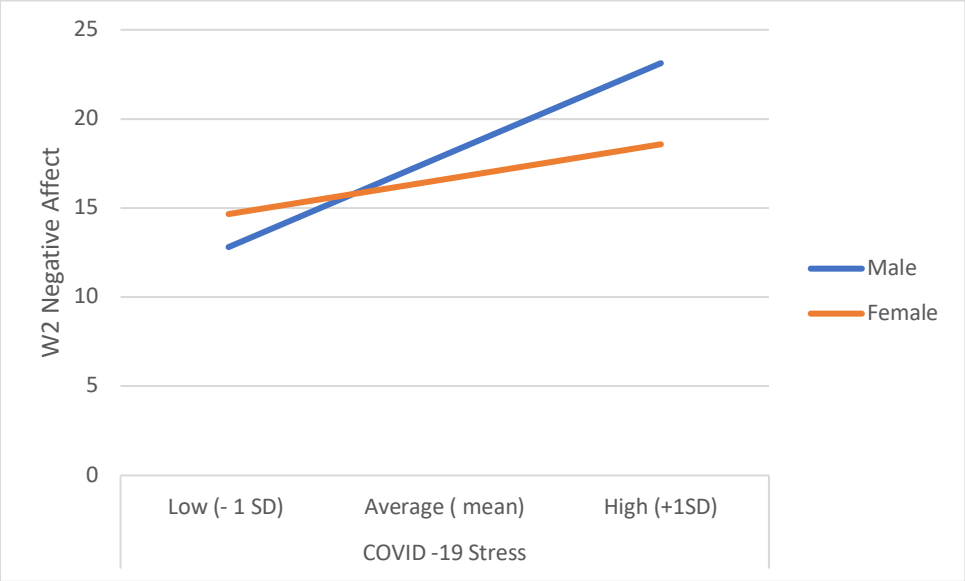
was only captured at Wave 2) and Wave 2 physical health were entered in at Step 1 of the regression. A variable reflecting Wave 2 COVID -19 stress was entered at Step 2, and variables reflecting Wave 2 PA *days/week* and Wave 2 PA *times/week* were entered at Step 3 of the regression. Demographic variables significantly explaining variance of each mental health outcome are listed in Tables 11, 12, and 13. For the total sample (males and females), a significant main effect of stress was found for negative affect ($\beta = .36$, $p < .001$), depression ($\beta = .43$, $p < .001$) and anxiety ($\beta = .33$, $p < .001$). A significant main effect of PA *days/week* and *times/week* was found for negative affect (PA *days/week* $\beta = -.31$, $p < .001$; PA *times/week* $\beta = .31$, $p < .001$), depression (PA *days/week* $\beta = -.29$, $p < .05$; PA *times/week* $\beta = .26$, $p < .05$), and anxiety (PA *days/week* $\beta = -.26$, $p < .05$; PA *times/week* $\beta = .29$, $p < .05$) (see Table 11).

Next, I examined whether gender interacted with each main effect. Wave 2 Stress (mean centered), gender and an interaction term calculated from these two variables were entered as predictors of each mental health outcome. Variables of household composition, athletic identity, Wave 2 physical health, household size (for negative affect and anxiety analyses), SES (for anxiety analyses only) and relationship status (for anxiety analyses only) were included as covariates in the model. The same analysis was also performed using Wave 2 PA *days/week (*mean centered) and Wave 2 PA *times/week* (mean centered) as the focal predictors instead of stress. A significant interaction of gender and stress was only found for negative affect ($b = -3.54$**,** $SE = 1.48$, $t(504) = -2.39$, $p < .05$, $\Delta R^2 = .03$). Simple slopes analyses indicated that more stress predicted greater negative affect for both males ($b = 5.70$**,** $SE = 1.15$, $t(504) = -4.97$, $p < .001$) and

females (b = 2.16**,** SE = 1.00, $t(504) = 2.17$, $p < .05$) (see Figure 5), with the relationship being stronger for males. Significant interactions of gender and stress were not found for the other mental health outcomes, nor were any significant interactions of gender and PA *days/week* or gender and PA *times/week* found for any of the mental health outcomes.

Figure 5.

Wave 2 Cross-sectional: Gender and Stress on Negative Affect



I then examined the main effect of stress on negative affect separately for males and females. Examining males, a significant main effect of stress was found for negative affect (b = 5.40, SE = 1.47, $t(59) = -3.68$ $p < .001$) (see Table 12). Examining females, a significant main effect of stress was not found for negative affect (see Table 13).

Table 11.

Total Sample Wave 2 Cross- Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.36		.25		.28		.32	
	Age		.14		-.11		-.10		-.11
	Race		-.02		-.04		.11		-.04
	Region		.07		-.07		-.08		.04
	Urban-icity		.01		-.03		-.02		.00
	Household composition		.13		-.33*		-.32**		-.35*
	Household size		-.05		.22		.20		.33*
	SES		.14		-.09		-.12		-.19*
	COVID exposure risk		.05		-.12		-.13		-.08
	Relationship status		-.05		.17		.15		.24*
	Athletic Identity		.31*		.42**		.27*		.50**
	W2 Physical Health		.35**		-.28*		-.45**		-.24*
Step 2		.01		.09**		.14**		.08**	
	W2 Stress		-.12		.36**		.43**		.33**
Step 3		.00		.10**		.07**		.08**	
	W2 PA (days/week)		.04		-.31**		-.29*		-.26*
	W2 PA (times/week)		.03		.31**		.26*		.29*

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

PA = Physical Activity

Table 12.

Males Wave 2 Cross- Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.34		.33		.39		.40	
	Age		.16		-.07		-.12		-.10
	Race		.078		-.006		.09		.06
	Region		.00		-.10		-.09		.01
	Urban-icity		-.06		.052		-.01		.03
	Household composition		.23		-.33		-.29		-.34*
	Household size		-.12		.28		.26		.31*
	SES		.30		-.13		-.27*		-.365
	COVID exposure risk		-.035		-.134		-.12		-.08
	Relationship status		-.20		.12		.19		.31
	Athletic Identity		.11		.46*		.29*		.48**
	W2 Physical Health		.46**		-.35*		-.49**		-.30*
Step 2		.004		.12**		.11**		.10*	
	W2 Stress		-.083		.45**		.43**		.40*
Step 3		.01		.08*		.08*		.09*	
	W2 PA (days/week)		-.15		-.28*		-.31*		-.15
	W2 PA (times/week)		-.06		.25*		.22		.37*

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

PA = Physical Activity

Table 13.

Females Wave 2 Cross -Sectional Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		Positive Affect		Negative Affect		Depression		Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.42		.21		.23		.32	
	Age		.11		-.14		-.01		-.05
	Race		-.04		-.08		.20		-.10
	Region		.09		-.01		.05		.13
	Urbanicity		.07		-.14		.01		.02
	Household composition		-.05		-.24		-.41		-.32
	Household size		.11		.05		.19		.36
	SES		-.08		-.01		.14		.06
	COVID exposure risk		-.01		.15		-.22		-.10
	Relationship status		.11		.22		.21		.18
	Athletic Identity		.59**		.34*		.18		.47*
	W2 Physical Health		.19		-.16		-.38*		-.15
Step 2		.01		.05		.12*		.04	
	W2 Stress		-.14		.29		.42*		.23
Step 3		.03		.13*		.06		.06	
	W2 PA (days/week)		.09		-.45*		-.29		-.33
	W2 PA (times/week)		.15		.48*		.33		.18

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

PA = Physical Activity

Longitudinal

Variables reflecting age, race, region, urbanicity, household composition, household size, socioeconomic status, COVID exposure risk, relationship status, athletic identity, Wave 2 physical health and corresponding Wave 1 mental health outcome were all entered in at Step 1. A variable reflecting Wave 1 COVID -19 stress was entered at Step 2, and variables reflecting Wave 1 PA *days/week*, and Wave 1 PA *times/week* were entered at Step 3 of the regression. Demographic variables significantly explaining variance of each mental health outcome are listed in Tales 14, 15 and 16. For the total sample, no significant main effects of stress, PA *days/week* nor PA *times/week* were found for any of the mental health outcomes (see Table 14).

Table 14.

Total Sample Longitudinal Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		W2 Positive Affect		W2 Negative Affect		W2 Depression		W2 Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.61		.58		.73		.69	
	Age		.00		.02		.08		-.01
	Race		.00		-.07		.08		-.04
	Region		.04		-.05		-.03		.01
	Urbanicity		.00		-.06		-.04		.01
	Household composition		.09		-.17		-.11		-.17
	Household size		-.04		.08		.07		.20*
	SES		.06		.11		.03		-.08
	COVID exposure risk		.04		.00		-.01		-.01
	Relationship status		-.08		.02		.01		.02
	Athletic Identity		.14		.19*		.07		.24**
	W2 Physical Health		.17*		-.18*		-. 24*		-.18*
	W1 Pos. Affect		.60**	W1 Neg. Affect	.67**	W1 Dep.	.76**	W1 Anx.	.70**
Step 2		.00		.00		.01		.00	
	W2 Stress		-.02		-.08		-.10		-.07
Step 3		.00		.01		.00		.00	
	W1 PA (days/week)		-.07		-.13		-.05		-.08
	W1 PA (times/week)		.05		.10		.06		.03

*$p < .05$,
**$p < .001$
PA = Physical Activity

Table 15.

Males - Longitudinal Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		W2 Positive Affect		W2 Negative Affect			W2 Depression			W2 Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β		ΔR^2	β		ΔR^2	β
Step 1		.58		.66			.75			.71	
	Age		.09		.07			.09			-.04
	Race		.09		-.11			.02			-.02
	Region		-.06		-.05			-.06			-.02
	Urbani-city		-.05		.04			.01			.06
	Household composition		.17		-.13			-.03			-.14
	Household size		-.07		.06			.00			.13
	SES		.20		.19			.07			-.16
	COVID exposure risk		.08		.03			.01			-.01
	Relation-ship status		-.21		.00			.02			.10
	Athletic Identity		.08		.26*			.12			.26*
	W2 Physical Health		.27*		-.27**			-.25**			-.24**
	W1 Pos. Affect		.52**	W1 Neg. Affect	.73**	W1 Dep.		.77**	W1 Anx.		.67**
Step 2		.00		.00			.00			.01	
	W1 Stress		-.02		.01			-.07			-.12
Step 3		.02		.02			.01			.02	
	W1 PA (days/week)		-.13		-.13			.02			-.12
	W1 PA (times/week)		-.05		.15			.13			.20*

*$p < .05$
**$p < .001$
PA = Physical Activity

Table 16.

Females - Longitudinal Hierarchical Multiple Regression with Sociodemographics, Stress and Physical Activity Predicting Mental Health

		W2 Positive Affect		W2 Negative Affect		W2 Depression		W2 Anxiety	
	Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1		.71		.57		.78		.73	
	Age		-.03		-.04		.11		.12
	Race		-.08		-.12		.14		.03
	Region		.14		-.05		.02		.12
	Urbanicity		.07		-.22		-.13		-.02
	Household composition		-.02		-.10		-.20		-.20
	Household size		.01		-.06		.10		.29
	SES		-.10		-.04		-.02		.00
	COVID exposure risk		-.12		-.01		-.05		-.07
	Relationship status		.08		.02		.01		-.02
	Athletic Identity		.20		.10		.04		.27*
	W2 Physical Health		.10		.05		-.22*		-.13
	W1 Pos. Affect		.69*	W1 Neg. Affect	.71**	W1 Dep.	.83**	W1 Anx.	.75**
Step 2		.00		.01		.01		.00	
	W1 Stress		-.03		-.18		-.13		-.05
Step 3		.03		.01		.01		.01	
	W1 PA (days/week)		-.01		-.10		-.10		-.10
	W1 PA (times/week)		.20		.10		.01		-.06

*$p < .05$
**$p < .001$
PA = Physical Activity

Hypothesis 1: Two-way Interactions of Stress and Physical Activity (PA) on Mental Health Outcomes

Wave 1 Cross-sectional

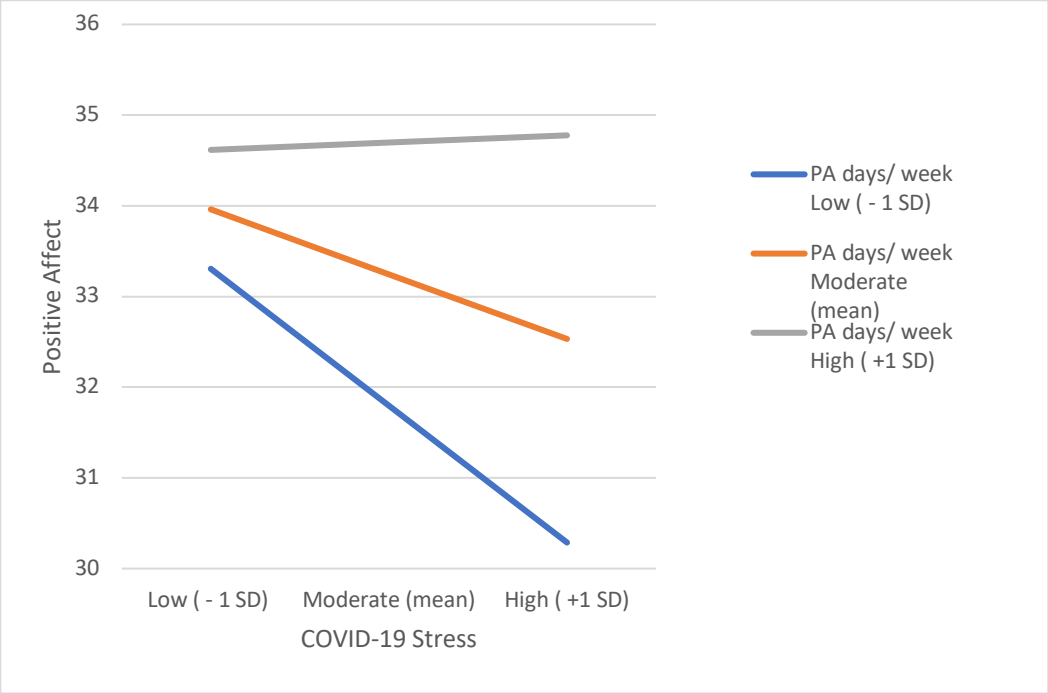
To investigate whether the relationship between Wave 1 COVID-19 stress and Wave 1 mental health outcomes (positive affect, negative affect, depression, and anxiety) varied as a function of PA, Wave 1 stress (mean centered), Wave 1 PA (mean centered) and an interaction term calculated from these mean-centered variables were entered as predictors of each mental health outcome. For each outcome variable, these analyses were performed twice - once using the PA *days/ week* variable and the other using the PA *times/week* variable.[1]

Examining males separately, covariates of age, race, household composition, household size, relationship status and Wave 1 physical health and SES (only for depression analyses) were included. A significant interaction of stress and PA *days/week* emerged for positive affect (b = 1.05**,** SE = 0.51*,* $t(307) = 2.04$, $p < .05$, $\Delta R^2 = .01$). Simple slope analysis indicated that at low PA *days/week*, stress significantly negatively corresponded with positive affect (b = -2.11**,** SE = 0.83*,* $t(307) = -2.55$, $p < .05$) (see Figure 6). At moderate and high PA *days/week* though*,* stress did not significantly correspond with positive affect.

[1] For the total sample, covariate variables of age, race, household composition, household size, relationship status, and Wave 1 physical health were entered. No significant interactions were found between stress and PA *days/ week* for any of the mental health outcomes, while significant interactions of PA *times/week* and stress were found for positive affect (b = 1.06**,** SE = .35*,* $t(506) = 3.00$ $p < .01$ *)* and anxiety (b = 0.09**,** SE = .03*,* $t(506) = 3.29$ $p < .01$).

Figure 6.

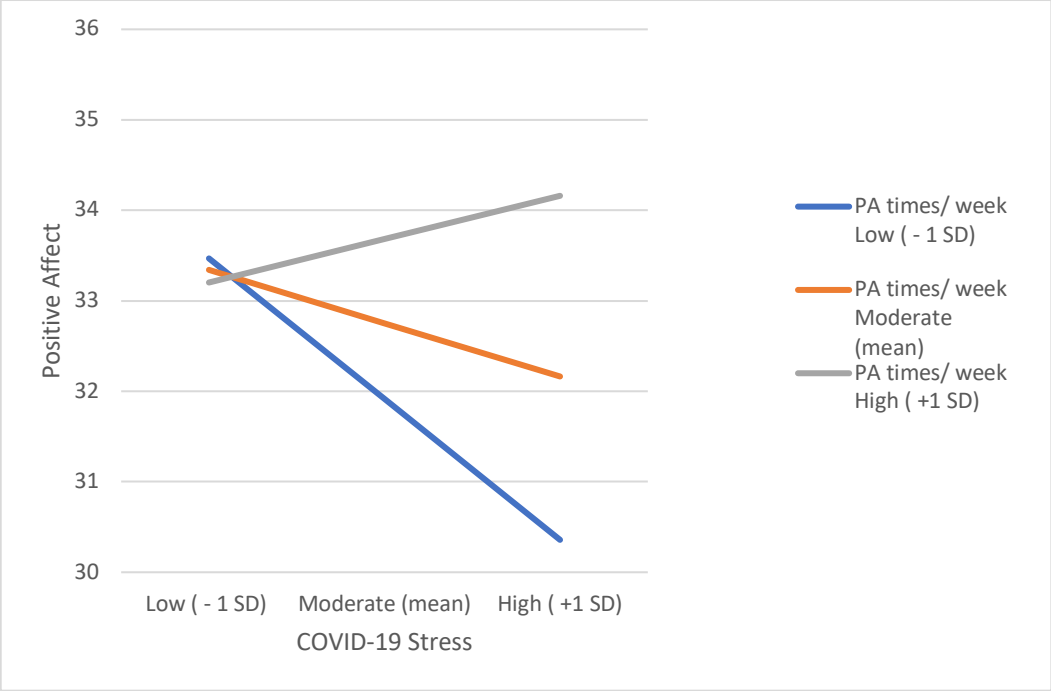
Males: Wave 1 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Days/Week on Positive Affect



Similar results were found using PA *times/week*. A significant interaction of stress and PA *times/week* also emerged for positive affect (b = 0.88**,** SE = 0.41*,* $t(297) = 2.13$, $p < .05$, $\Delta R^2 = .01$). Simple slope analysis indicated that at low PA *times/week*, more stress significantly corresponded with less positive affect (b = -1.52**,** SE = -2.16*,* $t(297) = -2.95$, $p < .01$) (see Figure 7). At moderate and high levels of PA *times/week* though, stress did not significantly correspond with positive affect. As for the rest of the mental health outcomes, no significant interactions were observed.

Figure 7.

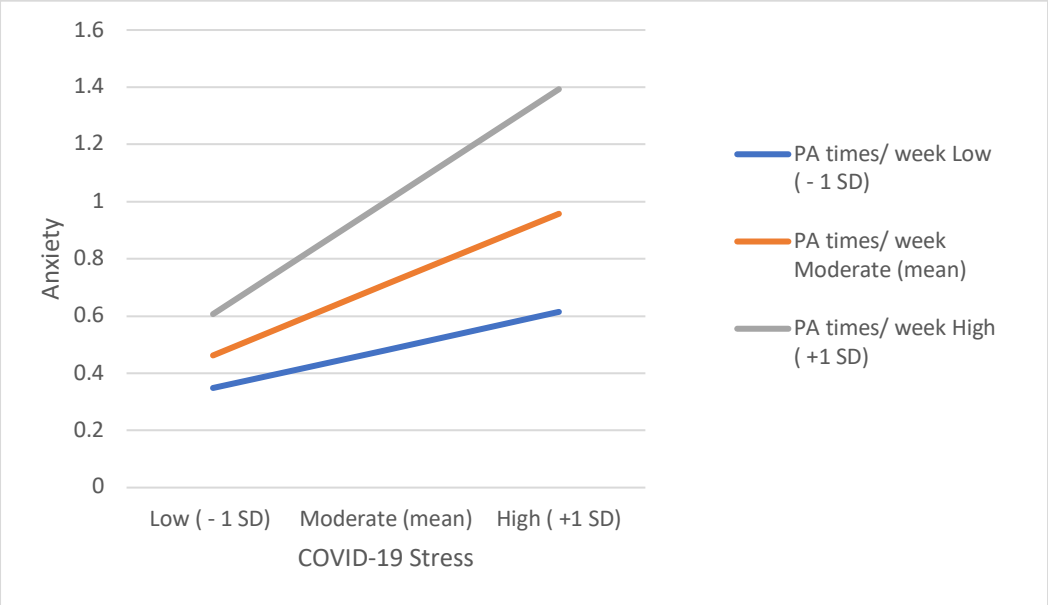
Males: Wave 1 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Times/Week on Positive Affect



Examining females separately, covariates of age, race, relationship status, Wave 1 physical health (for positive affect analyses only), household composition, household size (for anxiety analyses only) were included. A significant interaction of stress and PA *times/week* emerged for anxiety, (b = .11 SE = .05, t(187) = 2.22, $p < .05$, ΔR^2 = .02). Simple slopes indicated that at low (b = 0.15, SE = 0.06, $t(187) = 2.49$, $p < .01$,), average (b = 0.29, SE = 0.05, t(187) = 5.50, $p < .001$) and high (b = 0.45, SE = 0.11, $t(187) = 4.24$, $p < .001$) PA *times/week*, more stress corresponded to more anxiety (see Figure 8). No significant interactions were observed for the other mental health outcomes.

Figure 8.

Females: Wave 1 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Times/Week on Anxiety



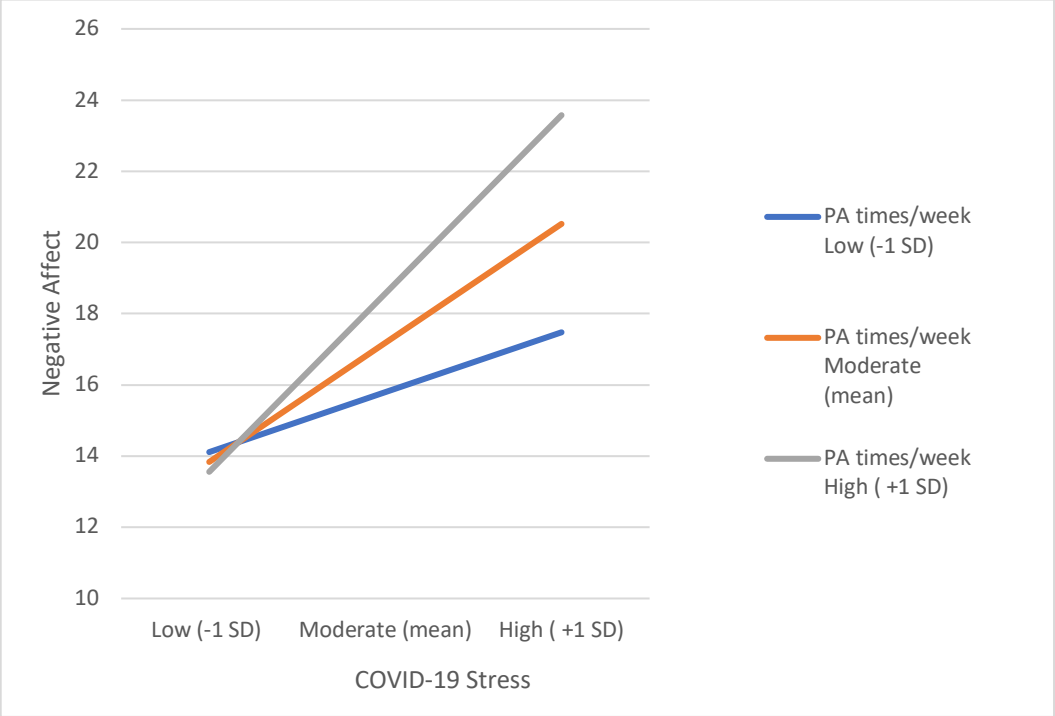
Wave 2 Cross-sectional

To investigate whether the relationship between Wave 2 COVID-19 stress and Wave 2 mental health outcomes (Positive Affect, Negative Affect, Depression, and Anxiety) varied as a function of PA, Wave 2 Stress (mean centered),Wave 2 PA (mean centered) and an interaction term calculated from these mean-centered variables were entered as predictors of each mental health outcome. Again, these analyses were performed twice - once using PA *days/ week* and the other using *PA times/week*. For the total sample, household composition, athletic identity, Wave 2 physical health, household size (for negative affect and anxiety analyses), SES (for anxiety analyses only) and relationship status (for anxiety analyses only) were included as covariates.

A significant interaction of stress and PA *times/week* was found for negative affect (b = 1.80**,** SE = .85*,* $t(117) = 2.11$, $p < .05$, $\Delta R^2 = .02$). Simple slopes analyses indicated that at average (b = 3.68**,** SE = 0.77*,* $t(117) = 4.78$, $p < .001$,) and high (b = 1.22**,** SE = 4.52*,* $t(117) = 4.52$, $p < .001$) PA *times/week* , more stress significantly corresponded with more negative affect (see Figure 9). At low PA *times/week* however, stress did not significantly correspond to negative affect.

Figure 9.

Total Sample Wave 2 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Times/Week on Negative Affect

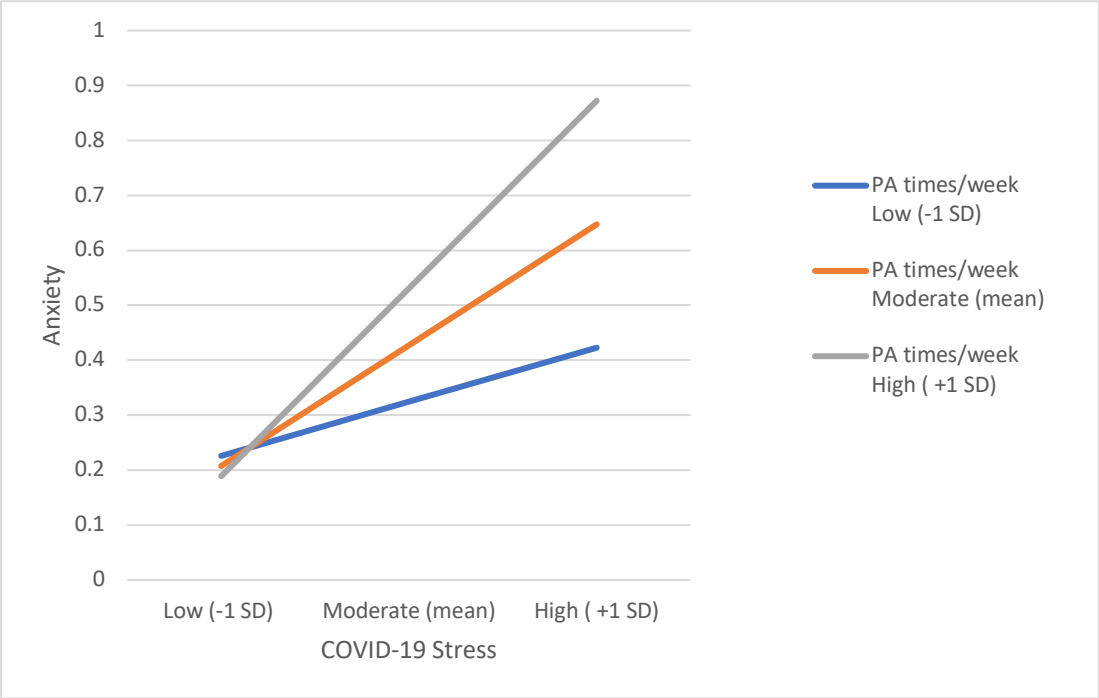


A significant interaction of stress and PA *times/week* was found for anxiety (b = 0.13**,** SE = 0.06*,* $t(115) = 2.27$, $p < .05$,$\Delta R^2 = .02$). At average (b = 0.24**,** SE = 0.05*,* $t(115) = 4.59$, $p < .001$) and high (b = 0.38**,** SE = 0.08*,* $t(115) = 4.48$, $p < .001$) PA

times/week, more stress significantly corresponded with more anxiety (see Figure 10). At low PA *times/week* however, stress did not significantly correspond with anxiety. Furthermore, as for the other mental health outcomes, no significant interactions were observed.

Figure 10.

Total Sample Wave 2 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Times/Week on Anxiety

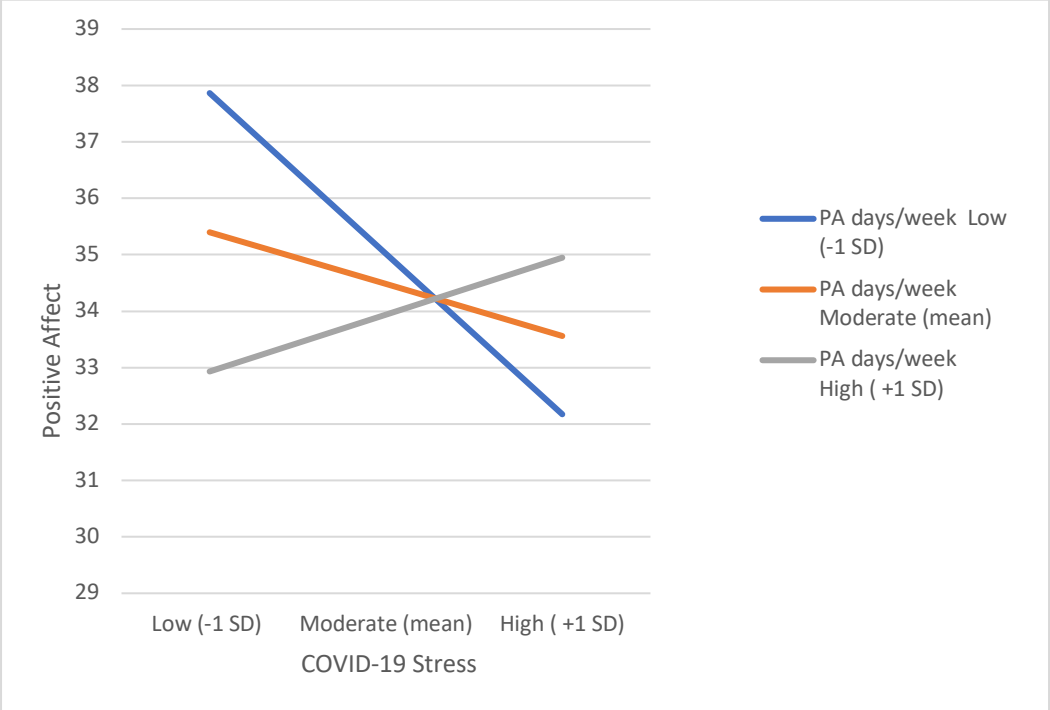


Examining males separately, covariates of athletic identity, Wave 2 physical health, SES (included for positive affect, depression and anxiety), household composition (included for anxiety only) and household size (included for anxiety only) were included. A significant interaction of stress and PA *days/week* was observed (b = 2.01, SE = 0.94, $t(66) = 2.15$ p <.05, ΔR^2 = .04). Simple slopes indicated that at low PA

days/week, more stress significantly corresponded to less positive affect (b = -3.53**,** SE = 1.53*,* $t(66)$ = -2.30, p <.05) (see Figure 11). At moderate and high PA *days/week* however, stress did not significantly correspond to positive affect. No significant interactions were observed for the other mental health outcomes.

Figure 11.

Males Wave 2 Cross-Sectional Two-Way Interaction of Stress and Physical Activity Days/Week on Positive Affect



Examining females separately, covariates of athletic identity (for positive affect and anxiety), Wave 2 physical health (for depression only) were included. No significant interactions were observed for any of the mental health outcomes.

Longitudinal

To examine whether the relationship between Wave 1 COVID-19 stress and Wave 2 mental health outcomes (Positive Affect, Negative Affect, Depression, and Anxiety) varied as a function of PA, Wave 1 stress (mean centered) and Wave 1 PA (mean centered) and an interaction term calculated from these mean-centered variables were entered as predictors of each mental health outcome. Again, these analyses were performed twice - once using PA *days/ week* and the other using PA *times/week*. Examining the total sample, covariates of household size (for anxiety only), athletic identity (for negative affect and anxiety), Wave 2 physical health and Wave 1 corresponding mental health outcome were included. No significant interactions were found. Examining males separately, covariates of athletic identity (for negative affect and anxiety), Wave 2 physical health and corresponding Wave 1 mental health outcome were included. Again, no significant interactions were found. Examining females separately, covariates of athletic identity (for anxiety only), Wave 2 physical health (for depression only) and Wave 1 corresponding mental health outcome were included. Similarly, no significant interactions were found.

Hypothesis 2: Three-way Interactions of Stress, PA, and Social Environment on Mental Health Outcomes

To examine whether the relationship between COVID-19 stress, PA, and mental health outcomes (Positive Affect, Negative Affect, Depression, and Anxiety) varied as a function of the social environmental of PA (social PA), stress (mean centered), PA (mean

centered), social PA (mean centered) and the four possible interaction terms calculated from these mean-centered variables were entered as predictors of each mental health outcome. Again, these analyses were performed twice - once using PA *days/ week* and the other using PA *times/week*. Covariates included in each set of analyses matched those in the corresponding hypothesis 1 analyses.

Wave 1 Cross-Sectional

Examining males separately, a significant three-way interaction of stress, PA *days/week* and social PA (*number of times/week*) was found for depression (b = 1.26**,** SE = 0.56*,* $t(285) = 2.24$, $p < .05$, $\Delta R^2 = .01$). Simple slopes analyses indicated that among those with low PA *days/week* and for those who were low (b = 8.58, SE = 1.15*,* $t(285) = 7.28$, $p < .001$) or average (b = 5.87, SE = 0.85*,* $t(285) = 10.39$, $p < .001$) on social PA, greater stress significantly predicted greater depression (see Figure 12). However, for those at low PA *days/ week* but high in social PA, stress did not predict depression. Among those at average PA *days/week*, and for those who were at low (b = 8.79, SE = 0.85*,* $t(285) = 10.39$, $p < .001$), average (b = 7.77, SE = 1.01*,* $t(285) = 7.71$, $p < .001$) or high (b = 6.36, SE = 2.11*,* $t(285) = 3.02$, $p < .01$) levels of social PA, greater stress significantly predicted greater depression (see Figure 13). Similarly, among those with high PA *days/week* and for those who were at low (b = 8.99, SE = 1.17*,* $t(285) = 7.70$, $p < .001$), average (b = 9.68, SE = 1.00*,* $t(285) = 9.65$, $p < .001$) or high (b = 10.64, SE = 1.51*,* $t(285) = 7.03$, $p < .001$) on social PA, greater stress significantly predicted greater depression (see Figure 14).

Figure 12.

Wave 1 Cross-Sectional. Males - Low Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression

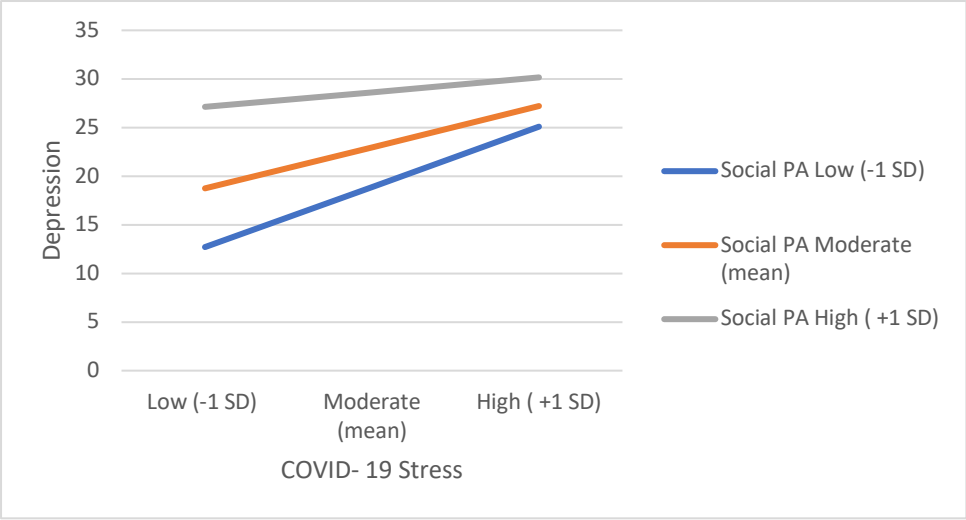


Figure 13.

Wave 1 Cross-Sectional. Males - Moderate Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression

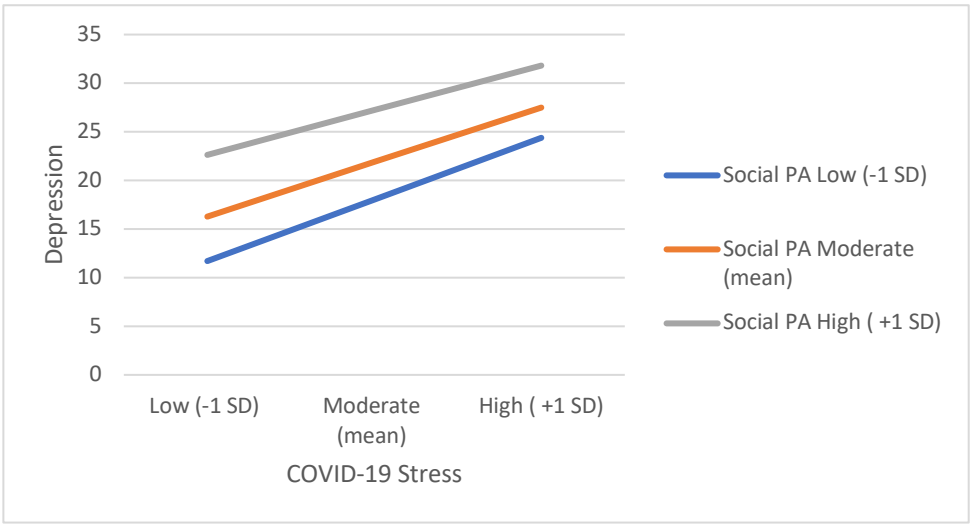
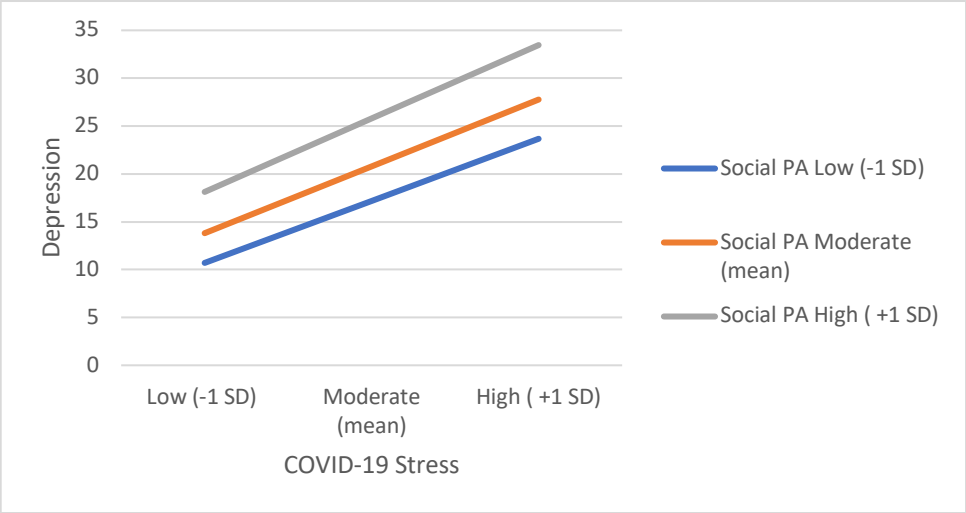


Figure 14.

Wave 1 Cross-Sectional. Males - High Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression

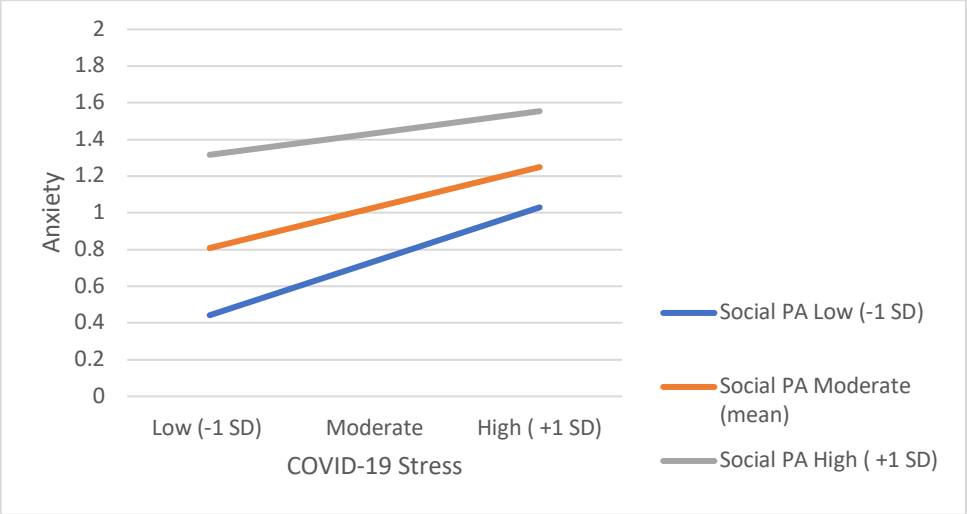


A significant interaction of stress, PA *days/week* and social PA was found for anxiety as well, (b = .08**,** SE = 0.04, $t(286) = 2.16$, $p < .05$, $\Delta R^2 = .01$). Simple slope analyses for this interaction paralleled results found for depression. Among those low in PA *days/week* and for those who were low (b = 0.41, SE = 0.07, $t(286) = 5.60$, $p < .001$) or average (b = 0.31, SE = 0.10, $t(286) = 3.02$, $p < .01$) on social PA, greater stress significantly predicted greater anxiety (see Figure 15). However, for those low in PA *days/week* but high in social PA, stress did not significantly predict anxiety. Among those at average PA *days/week* , and for those who were at low (b = 0.41, SE = 0.05, $t(286) = 7.68$, $p < .001$), average (b = 0.41, SE = 0.06, $t(286) = 6.44$, $p < .001$) or high (b = 0.42, SE = 0.13, $t(286) = 3.09$, $p < .01$) social PA, greater stress significantly predicted greater anxiety (see Figure 16). Similarly, among those with high PA *days/week* and for those

who were at low (b = 0.41, SE = 0.07, $t(286)$ = 5.58, p <.001), average (b = 0.52, SE = 0.06, $t(286)$ = 8.20, p <.001) or high (b = 0.67, SE = 0.10, $t(286)$ = 6.98, p <.001) social PA, greater stress significantly predicted greater anxiety (see Figure 17). [2]

Figure 15.

Wave 1 Cross-Sectional. Males - Low Physical Activity Frequency (days/week): Stress and Social Physical Activity on Anxiety



[2] Examining the total sample, a significant interaction of stress, PA *days/week* and social PA was also found for depression (b = 1.18, SE = .48, $t(482)$ = 2.47 p < .05).

Figure 16.

Wave 1 Cross-Sectional. Males - Moderate Physical Activity Frequency (days/week): Stress and Social Physical Activity on Anxiety

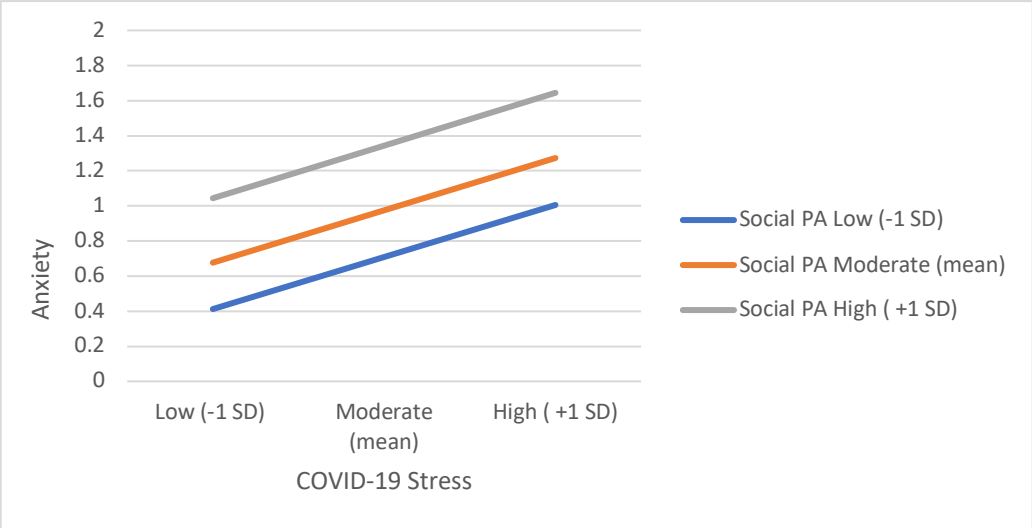
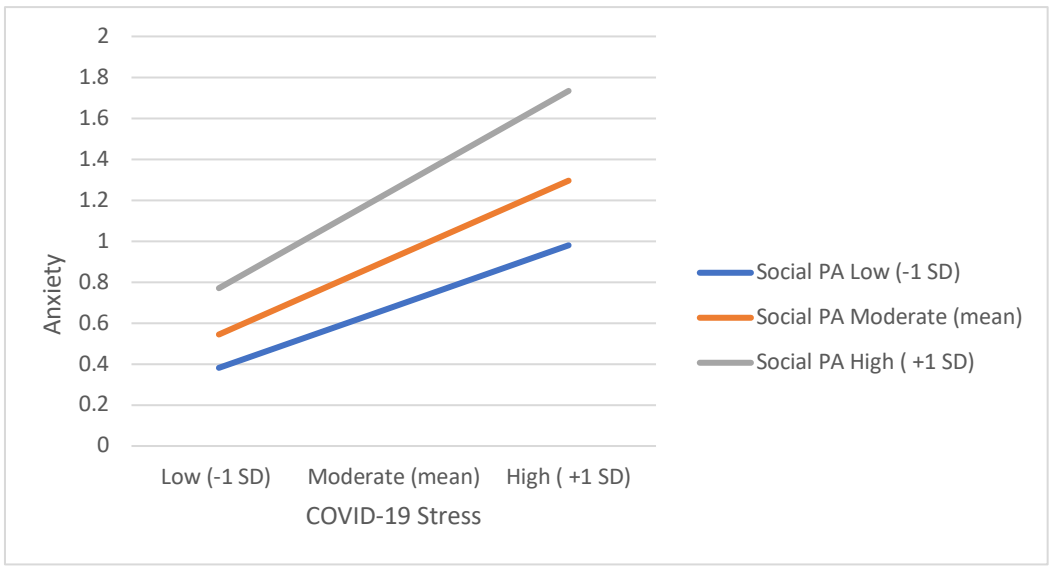


Figure 17.

Wave 1 Cross-Sectional. Males - High Physical Activity Frequency (days/week): Stress and Social Physical Activity on Anxiety



Wave 2 Cross-Sectional

No significant three-way interactions were found for any of the mental health outcomes.

Longitudinal

Examining the total sample, a significant interaction of Wave 1 stress, Wave 1 PA *days/week* and Wave 1 social PA was found for Wave 2 depression (b = -2.50**,** SE = 0.98*,* $t(112) = -2.56$, $p < .05$, $\Delta R^2 = .01$). Simple slope analyses indicated that among those with low PA *days/week* but high social PA, more stress significantly predicted more depression at Wave 2 (b = 9.56 SE = 4.16*,* $t(112) = 2.30$, $p < .05$) (see Figure 18). However, for those with low PA *days/week* and low social PA or for those with low PA *days/week* and average social PA, stress did not significantly predict depression. In contrast, among those at the average PA *days/week* but low social PA, the stress – depression relationship was buffered, such that as stress increased, Wave 2 depression decreased (b = -1.91**,** SE = 0.98*,* $t(112) = -2.02$, $p < .05$) (see Figure 19). For those with average PA *days/week* and average social PA or for those with average PA *days/week* and high social PA, stress did not significantly predict depression. Similarly, at high PA *days/week*, for those low (b = -2.25**,** SE = 1.08*,* $t(112) = -2.09$, $p < .05$) and average (b = -2.08**,** SE = 1.04*,* $t(112) = -2.00$, $p < .05$) in social PA, the stress – depression relationship was buffered such that as stress increased, W2 depression decreased. (see Figure 20). For those with high PA *days/week* and high social PA though, stress did not significantly predict depression. Furthermore, no significant three-way interactions were found for

any of the other mental health outcomes, nor for any analyses examining males and females separately.

Figure 18.

Longitudinal. Total Sample - Low Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression

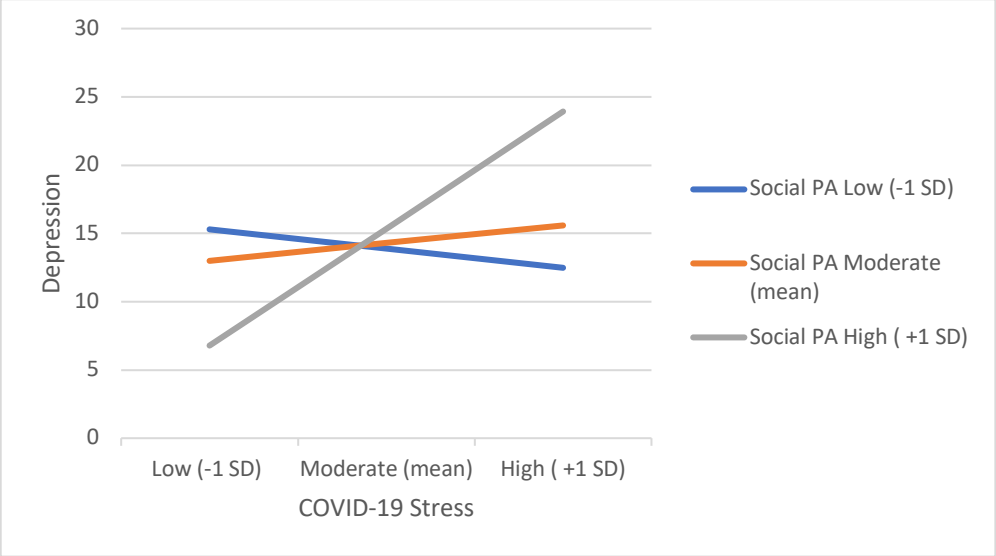


Figure 19.

Longitudinal. Total Sample - Moderate Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression

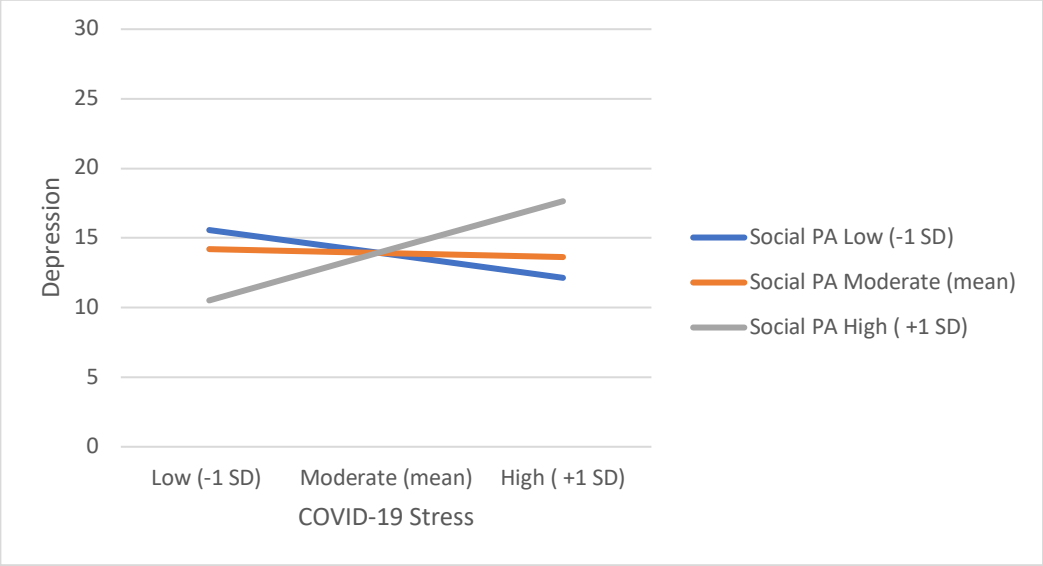
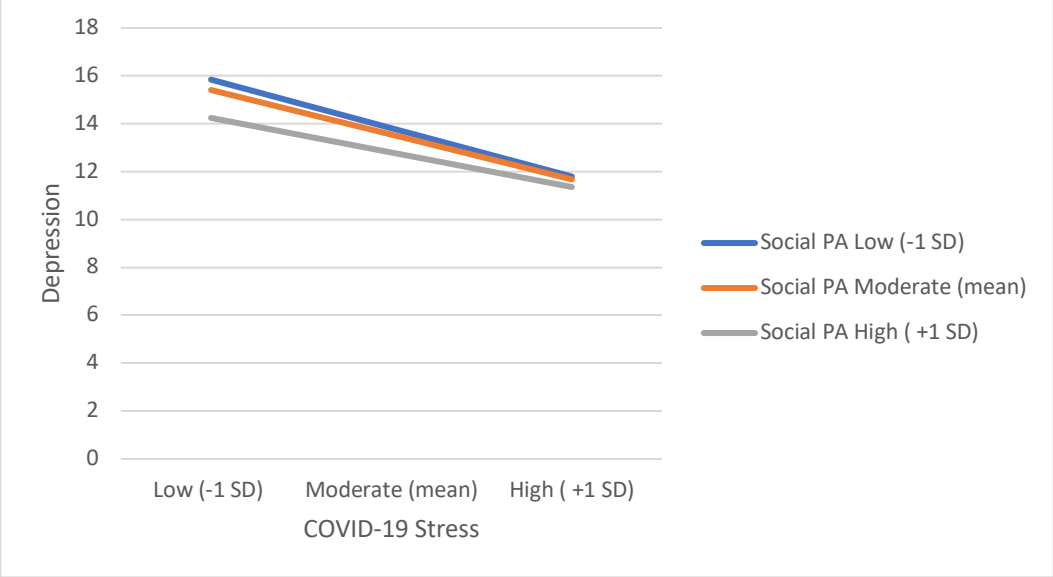


Figure 20.

Longitudinal. Total Sample - High Physical Activity Frequency (days/week): Stress and Social Physical Activity on Depression



Research Question 2

To investigate how individuals who engaged in social physical activity prior to COVID -19 fare during the pandemic and whether there are long-term consequences for them compared to those who engaged in individual physical activity prior to COVID-19 the following analyses were performed. First, a difference score was calculated by subtracting participants' Wave 1 social PA (*number of times/week*) from their pre-COVID social PA (*number of times/week*). This difference score was used to create a categorical variable reflecting whether participants decreased, had no change or increased their social PA. A MANCOVA was then performed with this categorical variable of change in social PA entered as the predictor and Wave 1 positive affect, negative affect, depression, anxiety and stress entered as the outcome variables. Covariates of age, race, household composition, household size, SES, relationship status, Wave 1 physical health and Wave 1 total physical activity (*times/week*) were included, as these variables had been previously determined to explain significant variance in the various mental health outcomes.

On a multivariate level, change in social PA from pre-COVID to Wave 1 significantly influenced mental health (Pillai's Trace = .06, F (10, 960) = 2.70, p <.01, partial η^2 = .03). More specifically, it predicted differences in the following mental health outcomes at Wave 1: anxiety (F (2, 483) = 5.52, p < .01, partial η^2 = .02) and stress (F (2, 483) = 6.43, p < .01, partial η^2 = .03). Pairwise comparisons showed that those with no change their social PA from pre-COVID to Wave 1 had less anxiety (p < .05) and stress

($p < .05$) than those who decreased their social PA. Similarly, those who had no change in their social PA from pre-COVID to Wave 1 had less anxiety ($p < .01$) and stress ($p < .01$) than those who increased their social PA.

Figure 21.

Change in Social Physical Activity (Pre-COVID - Wave 1) on Wave 1 Anxiety.

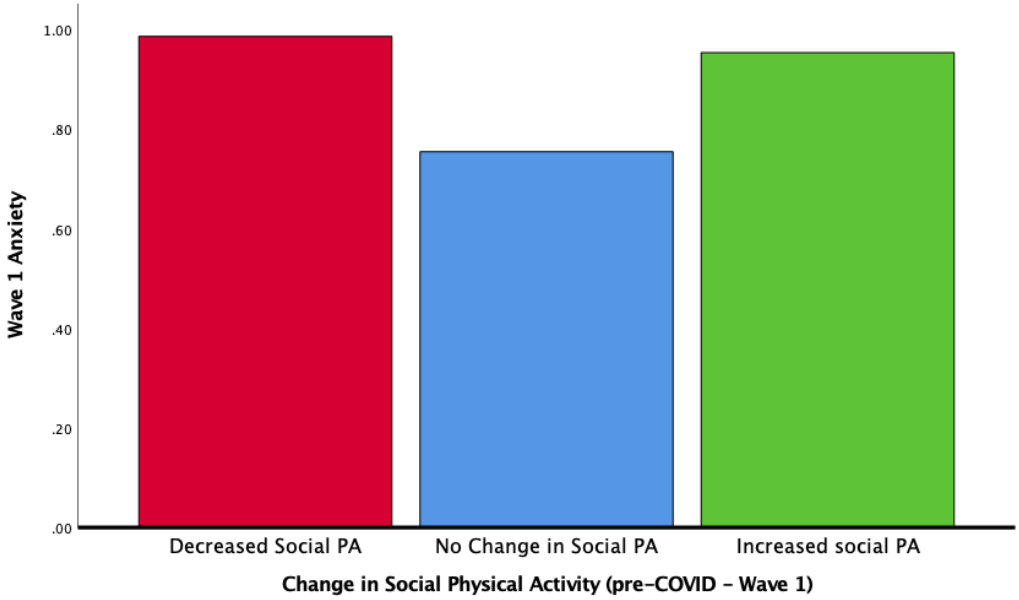
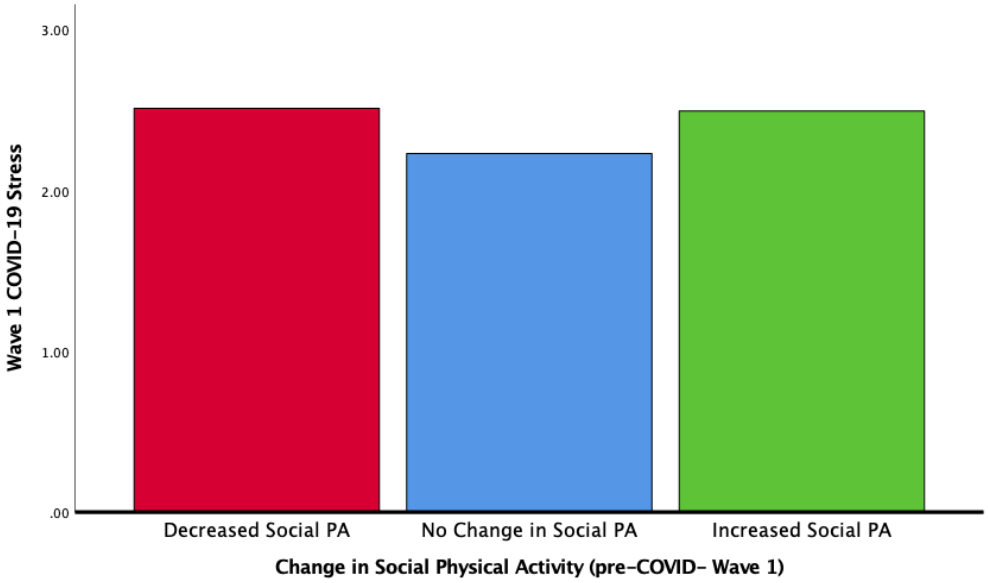


Figure 22.

Change in Social Physical Activity (Pre-COVID - Wave 1) on Wave 1 Stress



To examine long term consequences, the change in social PA from pre-COVID to Wave 2, was determined. A MANCOVA was then performed with this categorical variable of change in social PA entered as the predictor and Wave 2 positive affect, negative affect, depression, anxiety and stress entered as the outcome variables. Covariates of household composition, household size, athletic identity, Wave 2 physical health and Wave 2 total physical activity (times/week) were included, as these variables had been previously determined to explain significant variance in the various mental health outcomes.

On a multivariate level, change in social PA from pre-COVID to Wave 2 did not significantly influence mental health. On univariate levels, change in social PA from pre-

COVID to Wave 2 did not significantly influence any of the individual mental health outcomes.

CHAPTER 5

DISCUSSION

The impact of physical activity on mental health is well documented and its buffering role in stress and mental health has been established. Less clear is the role of social physical activity in this association. Furthermore, with the COVID-19 pandemic, individuals exercise routines were likely impacted – especially those that participated in social physical activity. But, would this disruption have an impact on their mental health? The current thesis had three objectives: 1) to determine the influence of the COVID-19 pandemic on physical activity and mental health, 2) to examine the relationship between stress, physical activity and mental health and whether social, compared to individual, physical activity is more beneficial and 3) to determine if there are gender differences in these relationships.

Gender Differences in Physical Activity & Mental Health

The first hypothesis that physical activity would buffer the negative impact of COVID -19 pandemic stress on mental health was partially supported for males, as more physically active men had greater positive affect (an indication of better mental health) regardless of stress level. This finding was observed cross-sectionally at both Wave 1 (~ 1 month into the pandemic) and Wave 2 (~ 8 months into the pandemic). However, it was not observed longitudinally, thereby precluding any case for causation. Given prior research indicating that males engage in exercise for enjoyment more than females do (Craft et al., 2014), it was anticipated that more physically active males would also have more positive affect.

Support of the first hypothesis was not found for females. In fact, results were the opposite of what was expected. Cross-sectionally at Wave 1, for more physically active females, stress was associated with greater anxiety. Research has indicated that females, more than males, report exercising for extrinsic and appearance related reasons (Craft et al., 2014; Smith et al., 1998). As such, a weak intrinsic motivation may have partially contributed to the negative feelings that were associated for more physically active females.

While this finding was only observed for females at Wave 1 (and not at Wave 2 cross-sectionally nor longitudinally) it merits further examination, as similar findings were observed when examining the total sample (male and females) at Wave 2 cross-sectionally. Cross-sectionally at Wave 2, physical activity appears to exacerbate the negative impact of stress on mental health. That is, stress was associated with greater negative affect and anxiety for those who were more physically active. Again, because these findings were not observed longitudinally, no case for causation can be made. Yet, the question arises of why these unexpected results occurred.

One potential reason may be that those who were already experiencing high levels of stress and poorer mental health during that given time frame (i.e., at Wave 1 and Wave 2) may have also been more physically active in an attempt to cope with stress and ameliorate their mental health. Prior research has indicated physical exercise to be a commonly employed coping strategy for stress (Cairney et al., 2014; Garber, 2017; Kim & McKenzie, 2014). Perhaps then, these cross-sectional results (both at Wave 1 for females and at Wave 2 for the total sample), simply displayed individuals during the

process of coping with their stress. If so, we may have expected to see some fruition of this coping strategy in results of the longitudinal analyses. However, it should be noted that the Wave 2 sample size was relatively small, given the type of analyses performed. Based on G Power analyses, the sample size needed for an effect size $f^2 = .15$ and power = .80 is 77 participants. In the separate male and female analyses both at Wave 2 cross-sectionally and longitudinally, the sample sizes fell below this requirement. Thus, a larger sample size may have been beneficial for determining the long-term influence of using physical activity as a coping strategy.

Another reason potentially contributing to these unanticipated findings could be related to the volume and intensity of the physical activity performed. Some studies have indicated a J and/or U-shaped dose-response relationship of physical activity and mental health (Kim et al., 2012; Kim et al., 2020), such that there is a threshold on the volume and intensity of physical activity that is optimal for mental health. In relation to this current study's results, it is possible that by attempting to use physical activity as a coping strategy, individuals may be participating in physical activity at volumes/intensities that may actually be more taxing on their mental well-being.

Social Physical Activity & Mental Health

The second hypothesis of this thesis study was that *social* physical activity will further buffer the negative impact of stress on mental health. Overall, support for this hypothesis was not found. For males cross-sectionally at Wave 1, social physical activity exacerbated the stress - depression and stress - anxiety relationship. Regardless of how active males were (i.e., how often they generally engaged in physical activity), greater

participation in social physical activity did not attenuate stress' negative influence on mental health. However, these results were only observed at Wave 1 and for males. Again, the small sample sizes at Wave 2 may have affected the findings. G power analyses with an effect size $f^2 = .15$ and power = .80, indicated needing roughly 105 participants (with some slight variations in needed sample size depending on the outcome variable). Yet, when analyzing males and females separately, such a sample size was not available.

In examining the total sample longitudinally, significant findings were again opposite to the hypothesis. Among the least physically active participants, those who participated most often in social physical activity also had the most depression at Wave 2. Among those averagely or highly physically active (i.e., those who engaged in total physical activity either at or above the mean frequency), those either at or below average on social physical activity actually had less depression at Wave 2. Overall, this finding suggested that greater physical activity did in fact benefit mental health long-term by buffering stress's role on predicting depression. Contrary to expectations though, physical activity more frequently within a social environment did not offer greater benefit for mental health during this time of the COVID-19 pandemic and in some cases it predicted worse depression outcomes.

One reason why these results occurred could simply be that people who prefer solitary physical activity may be faring better throughout the duration of this pandemic and with its associated social distancing regulations. It could be related to the individual's personality. That is, perhaps more extroverted individuals are drawn to

participate in more social physical activity and the general decrease or absence of in-person socialization during this pandemic has negatively impacted their mental health, more so than for introverted individuals. Prior research has indicated that athletes are more extroverted than non-athletes, and that team sport athletes are more extroverted than individual sport athletes (Allen et al., 2020 ; Eagleton et al., 2007; Mckelvie et al., 2003). Moreover, a study with Canadian adults found that those higher in extroversion and neuroticism had greater stress during the pandemic and greater increase in stress compared to before the pandemic (Liu et al., 2021). Taken together, it is plausible that more extroverted individuals are experiencing greater stress and poorer mental health during the pandemic and then engaging in more social physical activity in an attempt to cope. While this thesis study did not examine personality, doing so may have aided in gaining a clearer understanding how social physical activity affected individuals' mental health during the pandemic.

Additionally, all modes of social physical activity were jointly examined in these analyses. That is, no differentiation was made if the social interaction was in-person or virtual (in real time or on demand). However, especially early into the pandemic when most cities were in full lockdown, virtual social physical activity emerged as fairly commonplace practice. For example, personal trainers would have video-call workout sessions with their trainees and exercise classes (e.g., yoga, Pilates, cycling, dance) were held synchronously online. While these activities include social interaction, the nature of virtual social interaction is very different from an in-person interaction. Perhaps one needs the "real deal", in-person interaction to fulfill their social connection needs and

ultimately reap mental health benefits of social physical activity. To my knowledge, it is yet to be examined if virtual social physical activity differentially influences mental health, compared to in-person social physical activity. However, research has found that social bonding between friends is greatest during in-person interaction, compared to other digital forms of interaction (Sherman et al., 2013). As such, examining the difference between in-person and virtual social physical activity may have important implications for well-being and may shed light on the un-hypothesized current findings.

Changing Social Physical Activity Behaviors During COVID-19

The second research question examined how individuals who participated in social physical activity prior to COVID-19 fare during the pandemic, compared to those who participated in individual physical activity prior to COVID-19. Examining changes to social physical activity from before COVID-19 to Wave 1, those with no change in their social physical activity fared the best at Wave 1. Interestingly, those who increased their social physical activity had slightly worse mental health, with greater anxiety and stress. However, this finding was consistent with previously mentioned results regarding social physical activity and mental health outcomes. Lastly, those who decreased their social physical activity fared worst of all groups, having the most anxiety and stress at Wave 1. Similarly, in a series of post hoc analyses not included here (see Appendix D), people who engaged in more individual physical activity pre-COVID had less depression and anxiety at Wave 1, compared to those who participated in more social physical activity pre-COVID. Together, these findings suggested that about one month into the pandemic, those whose lifestyle was most impacted seemed to fare worse in their mental

well-being and those who more often engaged in solitary physical activity pre-COVID fared better.

When examining long term consequences, changes in social physical activity from before COVID to Wave 2 did not influence Wave 2 mental health outcomes. However, in a series of post hoc analyses not included here (see Appendix D), those who participated in more social (versus individual) physical activity pre-COVID had more positive affect at Wave 2, potentially indicating better adjustment during the pandemic for those with greater social physical activity pre-COVID. Overall though, this finding was difficult to theoretically interpret, so further discussion on it is refrained. Replication of this study would be necessary to determine whether the finding is spurious or not, and ultimately attempt to make sense of it. Unfortunately, an exact replication of this study is difficult due to the uniqueness of the COVID-19 circumstances at each study wave.

Limitations and Future Directions

Overall, there were several limitations to this thesis study. As previously mentioned, the smaller sample size collected at Wave 2 reduced the power, which may have impacted the findings. An additional limitation of this study is the generalizability of the results, on account of two reasons. Firstly, the study was conducted solely with participants from the US. However, it is well known that the pandemic has affected each country differently. Some countries have been more affected than others, with greater amounts of cases, more lockdowns, greater restrictions. Thus, the nature of the study's findings may have been very different if it were conducted in another country. Secondly, the stress measure used in this study was specific to the COVID-19

pandemic. In consequence, the findings may be limited to the unique context of this pandemic. Future research should replicate this study after the pandemic is officially over (when things have returned to "normal") and use a general stress measure to determine if similar results and relationships are observed.

Other future directions include examining the motivation for engaging in physical activity, specifically social physical activity, to determine whether and how it is used as a coping strategy. It may be for some that social physical activity is a large way in which they receive social support, and so they participate in more social physical activity to receive more social support, particularly when in face of stress. The relationship between personality and social physical activity could also be examined to determine potential personality influences on the use of social physical activity as a coping strategy. Additionally, future directions could explore the nuances of social physical activity and their potential influence in the stress- mental health relationship. For example, perhaps the quality of the group setting of the physical activity is important (e.g., formal or informal, among friends or strangers, competitive environment or not). Relatedly, future research could examine whether in-person versus virtual social physical activity differentially influence mental health, which to my knowledge has not been previously examined. Furthermore, comparing the intensity of physical activity and whether it plays a role on the stress - mental health relationship in this context may be beneficial. Finally, while this thesis study tested the role of physical activity and its social environment as moderators of the stress- mental health relationship, it is possible

that some of these variables act instead in a mediational pathway. Future research should examine this possibility.

CHAPTER 6

CONCLUSION

In its rawest form, this thesis began with two questions - whether "dancing" through life's adversities shields us from their negative impact on our mental health, and whether dancing alongside others protects us even better. Under the context of the COVID- 19 pandemic, I sought to examine the influence of physical activity and its social environment on the stress- mental health relationship, whether it differed by gender and how the unique social distancing conditions of the COVID-19 pandemic further influenced adjustment to the difficult times. Overall, main findings suggested that physical activity does indeed influence mental health and that males may benefit more than women. Moreover, and contrary to my predictions, I observed that social physical activity actually exacerbated the relationship between stress and poor mental health. Additionally, those who changed their social physical activity from before COVID, seemed to fare worse 1 month into the pandemic. All these results, however, are confined to the context of the COVID -19 pandemic and specifically within the US. Future research should expand on this study, determining if the nature of these relationships remains identical under non-pandemic conditions and whether any additional factors in these relationships should be considered. In sum, this thesis provides a foundation upon which future research can be laid in effort to answer the initial, fundamental questions posed.

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APPENDIX A

TABLE 1

Wave 1 Complete Participant Demographics

	Total Participants (N = 519)	Females (N = 197)	Males (N = 318)
	M (SD)	*M (SD)*	*M (SD)*
Age	37.55 (11.62)	38.18 (11.85)	37.08 (11.48)
Race/Ethnicity (%)			
White	63.1	75.1	55.3
Black or African American	7.5	6.1	8.5
Latinx	23.9	13.7	30.5
Asian	3.9	3.6	4.1
American Indian or Native Alaskan	1.2	1.5	0.9
Native Hawaiian or other Pacific Islander	0.4	0.0	0.6
Education (%)			
High School/ GED	6.6	7.6	6.0
Some College	18.7	19.8	18.0
College	52.1	54.8	50.2
Advanced Degree	22.6	17.8	25.9
Employment Status (%)			
Full-time	73.2	65.0	79.2
Part-time	5.6	7.1	4.4
Self-employed	8.3	10.7	6.6
Student	1.0	1.5	0.6
Was employed but laid off due to COVID-19	5.6	7.1	4.7
Unemployed	6.4	8.6	4.4
If employed, working remotely			
Yes	77.5	80.7	75.4
No	22.5	19.3	24.6
Household Income (%)			
Less than $20,000	10.2	10.7	9.4
$20,001 - $40,000	19.7	21.4	18.6
$40,001 - $60,000	26.6	25.5	27.7
$60,001 - $80,000	20.7	19.4	21.4
$80,001 - $100,000	9.2	11.2	8.2
$100,001 - $120,000	5.8	4.1	6.9
More than $120,000	7.7	7.7	7.9
Neighborhood (%)			

	City	46.6	35.0	53.5
	Small Town	13.3	14.2	12.9
	Suburban	27.2	33.5	23.3
	Rural	12.9	17.3	10.4
Region (%)				
	Northeast	16.5	17.3	16.4
	Southeast	27.0	27.6	26.5
	Midwest	13.9	14.3	13.2
	Southwest	14.1	14.3	14.2
	West	28.2	26.5	29.7
Stay at Home Order (%)				
	Yes	91.7	90.4	93.1
	No	7.9	9.6	6.9
Length of Stay at Home Order (%)				
	Less than a week	1.3	1.1	1.7
	1-2 weeks	11.7	9.6	14.9
	3-4 weeks	38.5	41.6	41.9
	More than 1 month	40.4	47.8	41.6
Living Arrangement (%)				
	Alone	14.1	13.7	14.5
	Spouse/Partner	45.6	46.2	45.1
	Roommate(s)	7.3	4.1	9.1
	Parents	9.7	9.1	10.1
	Children	23.4	26.9	21.1
Household Size		3.13 (1.34)	3.08 (1.36)	3.17 (1.34)
Relationship Status (%)				
	Married	67.1	63.5	69.8
	Cohabitating	5.6	8.1	3.8
	Separated/ Divorced	3.5	4.1	2.8
	Widowed	0.4	1.0	0.0
	Single	23.5	23.4	23.6

APPENDIX B

TABLE 2

Attrited and Completed Wave 2 Participant Demographics

	Total Attrited Participants (N = 375)	Total Participants Completed W2 (N = 144)	Attirited Females (N = 134)	Females Completed W2 (N = 63)	Attirited Males (N =238)	Males Completed W2 (N = 80)
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
Age	36.12b*** (10.49)	41.28a*** (13.50)	36.86b*** (10.98)	41.00a*** (13.19)	35.61b* (10.17)	41.44a* (13.89)
Race/Ethnicity (%)						
White	61.2	68.1	75.4	74.6	52.9	62.5
Black or African American	5.9	11.8	5.2	7.9	6.3	15.0
Latinx	28.9	11.1	15.7	9.5	36.6	12.5
Asian	2.4	7.6	3.0	4.8	2.1	10.0
American Indian or Native Alaskan	1.1	1.4	0.7	3.2	1.3	
Native Hawaiian or other Pacific Islander	0.5	0.0	0.0	0.0	0.8	
Education (%)						
High School/ GED	4.5	11.8	4.5	14.3	4.6	10.0
Some College	17.1	22.9	21.6	15.9	14.8	27.5
College	55.1	44.4	56.7	50.8	53.6	40.0
Advanced Degree	23.3	20.8	17.2	19.0	27.0	22.5
Employment Status (%)						
Full-time	77.6	61.8	66.4	61.9	84.9	62.5
Part-time	4.3	9.0	6.0	9.5	2.9	8.8
Self-employed	6.7	12.5	11.9	7.9	3.4	16.3
Student	1.1	0.7	1.5	1.6	0.8	
Laid off due to COVID	5.6	5.6	9.0	3.2	3.8	7.5
Unemployed	4.8	10.4	5.2	15.9	4.2	5.0
If employed, working remotely						
Yes	77.7	76.9	82.6	76.5	74.9	77.1
No	22.3	23.1	17.6	23.5	25.1	22.9
Household Income (%)						
Less than $20,000	9.1	13.3	10.4	11.3	7.6	15.0
$20,001 - $40,000	20.5	17.5	23.1	17.7	19.3	16.3
$40,001 - $60,000	24.8	31.5	17.9	41.9	29.0	23.8
$60,001 - $80,000	22.1	16.8	21.6	14.5	22.3	18.8

$80,001 - $100,000	9.9	7.7	13.4	6.5	8.0	8.8
$100,001 - $120,000	6.4	4.2	5.2	1.6	7.1	6.3
More than $120,000	7.2	9.1	8.2	6.5	6.7	11.3
Neighborhood (%)						
City	48.0	43.1	35.8	33.3	54.6	50.0
Small Town	13.3	13.2	12.7	17.5	13.9	10.0
Suburban	24.5	34.0	32.8	34.9	19.7	33.8
Rural	14.1	9.7	18.7	14.3	11.8	6.3
Region (%)						
Northeast	15.0	21.0	13.4	25.8	16.0	17.5
Southeast	23.5	36.4	25.4	32.3	21.9	40.0
Midwest	14.4	12.6	14.9	12.9	13.9	11.3
Southwest	16.0	9.1	15.7	11.3	16.5	7.5
West	31.0	21.0	30.6	17.7	31.6	23.8
Living Arrangement (%)						
Alone	12.3	18.8	11.9	17.5	12.7	20.0
Spouse/Partner	48.1	38.9	51.5	34.9	46.4	41.3
Roommate(s)	7.2	7.6	3.0	6.3	9.3	8.8
Parents	9.1	11.1	6.7	14.3	10.5	8.8
Children	23.3	23.6	26.9	27.0	21.1	21.3
Household Size	3.23a* (1.29)	2.89b* (1.45)	3.12a** (1.24)	3.00b** (1.59)	3.30 (1.32)	2.81 (1.35)
Relationship Status (%)						
Married	71.5	55.6	67.2	55.6	74.4	56.3
Coha	5.1	6.9	9.0	6.3	2.9	6.3
Separated/ Divorced	2.9	4.9	3.0	6.3	2.5	3.8
Widowed	0.3	0.7	0.7	1.6		
Single	20.3	31.9	20.1	30.2	20.2	33.8

* p <.05 , **p <.01, ***p < .001 ;
a denotes the larger mean, b denotes the smaller mean

Notes: For the total sample significant differences of race ($\chi 2(5) = 29.04$, $p < .001$), education ($\chi 2(3) = 12.75$, $p < .01$), employment status ($\chi 2(5) = 17.35$, $p < .01$), region ($\chi 2(4) = 16.02$, $p < .01$ and relationship status ($\chi 2(4) = 11.87$, $p < .05$) were found. For females, only a significant difference of household income was found ($\chi 2(6) = 14.67$, $p < .05$). For males, significant differences of race ($\chi 2(5) = 29.88$, $p < .001$), education ($\chi 2(3) = 10.28$, $p < .05$), employment status ($\chi 2(5) = 23.39$, $p < .001$), region ($\chi 2(4) = 12.40$, $p < .05$) and relationship status ($\chi 2(3) = 9.14$, $p < .05$) were found.

APPENDIX C

COVID -19 STRESS MEASURE CONFIRMATORY FACTOR ANALYSIS

Overview of Analyses

A confirmatory factor analysis (CFA) was performed using structural equation modeling (EQS 6.4) in order to confirm the factor structure of this newly created Covid-19 Stress measure. Preliminary examination of the data revealed that major assumptions of structural equation modeling (e.g., linearity, multivariate normality, random residuals) were met and that there was no evidence of multicollinearity (see Table 3). Missing data greater than 5% was assessed and excluded prior to analyses. Model evaluations were based on various fit indices including the chi-square statistic, comparative fit index (CFI), and the root mean square error approximation (RMSEA). A good model fit is indicated by a nonsignificant chi square statistic, a CFI greater than .95 and a RMSEA less than .05. A single factor model was compared to a two factor model to determine if our two factor structure hypothesis was supported. The difference between chi-square statistics of the two models was taken and probability was calculated, in order to determine if models significantly differ.

Results

Table 17.

Descriptive Statistics for Each Item in the COVID-19 Stress Measure

	Mean	Skewness	Kurtosis	Standard Deviation
Item 1. Overall, how much has the COVID-19 pandemic changed your daily life?	3.2534	-0.5093	-0.3317	1.2571
Item 2. How stressed do you currently feel with respect to the COVID-19 pandemic?	2.6803	-0.1394	-0.9054	1.4761
Item 3. How unconcerned are you currently with respect to the COVID-19 pandemic?	2.8168	-0.0527	-1.2121	1.3358
Item 4. How much are you able to control the important things in your life with respect to the COVID-19 pandemic?	2.0351	0.3967	-0.2394	1.6303
Item 5. How fearful are you currently with respect to the COVID-19 pandemic?	2.6335	-0.2128	-0.9065	1.4745
Item 6. How optimistic are you currently with respect to the COVID-19 pandemic?	2.0624	0.3577	-0.5911	1.2495
Item 7. How anxious do you currently feel with respect to the COVID-19 pandemic?	2.6472	-0.1264	-0.9545	1.4994
Item 8. Do you feel you are effectively coping with important changes that are occurring in your life, with respect to the COVID-19 pandemic?	1.6335	0.6661	0.1576	1.365
Item 9. How confident do you currently feel in your ability to handle personal problems with respect to the COVID -19 pandemic?	1.6862	0.5767	0.0098	1.1917
Item 10. How angry are you currently because you feel things are outside of your control with respect to the COVID -19 pandemic?	2.1442	0.1566	-1.1375	1.5857
Item 11. How much do you think about things that you have to accomplish, with respect to the COVID -19 pandemic?	2.9474	-0.4107	-0.4244	1.2251

Table 18.

Bivariate Correlations Between Items in the COVID-19 Stress Measure

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11
Item 1	1.00	.40***	.07	-.05	.40***	-.04	.36***	-.09***	.04	.18***	.33***
Item 2	.40***	1.00	.03	.06	.66***	.17***	.67***	.16***	.21***	.50***	.38***
Item 3	.07	0.03	1.00	.24***	.00	.36***	-.003	.12***	.16**	-.30***	-.08
Item 4	-.05	0.06	.24***	1.00	.07	.51**	.13***	.44***	.37***	.02	-.06
Item 5	.40***	.66***	.00	.07	1.00	.11***	.65***	.12**	.20***	.45***	.34***
Item 6	-.04	.17***	.36***	.51**	.11***	1.00	.16**	.40***	.45***	-.004	-.15***
Item 7	.36***	.67***	-.003	.13***	.65***	.16**	1.00	.12***	.23***	.48***	.40***
Item 8	-.09***	.16***	.12***	.44***	.12**	.40***	.12***	1.00	.55***	.14***	-.12**
Item 9	.04	.21***	.16**	.37***	.20***	.45***	.230***	.55***	1.00	.16***	-.05
Item 10	.18***	.50***	-.30***	.02	.45***	-0.004	.48***	.14***	.16***	1.00	.31***
Item 11	.33***	.38***	-.08	-.05	.34***	-.15***	.40***	-.12**	-.05	.31***	1.00

* $p < .05$, ** $p < .01$, ***$p < .001$

N = 513

Confirmatory Factor Analysis

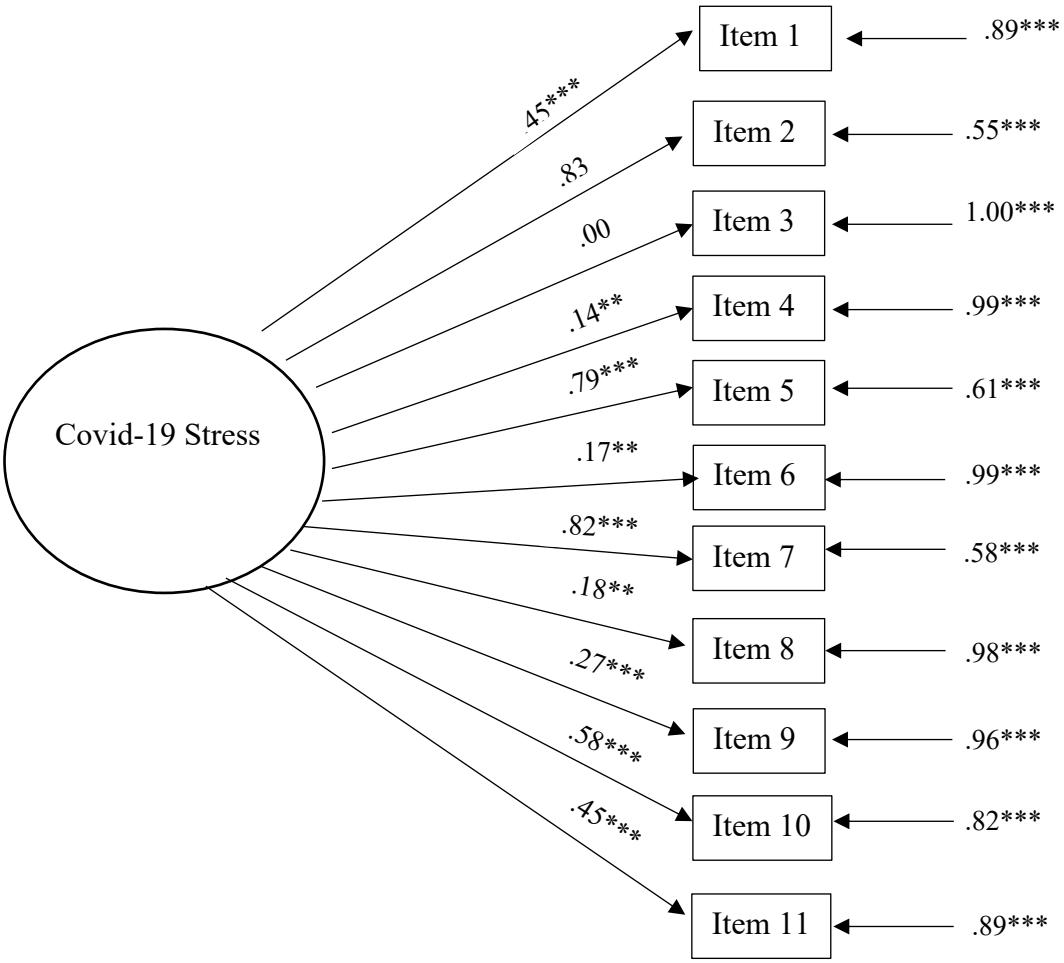
A single factor model was tested where all 11 items in the measure were represented as indicators to a single factor of *COVID- 19 Stress*. All measurement model rules of identification were met. Since factors, or latent variables, are unmeasured, their unit of measurement must be fixed. As such, item 2 (*How stressed do you currently feel with respect to the COVID-19 pandemic?*) was hypothesized to load the heaviest on this single factor of stress, and thus its path from the factor was fixed at 1.0. Additionally, in this model, there was one factor with more than three indicators whose error terms were uncorrelated with each other, thus meeting the second, third, and fourth rules of

identification. Furthermore, there were no double loadings, thereby meeting the fifth rule of identification. The model was over-identified, as there were 66 known and 22 unknown parameters. Data containing more than 5% missing variables was excluded from analyses, thus the sample size dropped to 513. Based on sample size recommendations by Bentler (2006), this adjusted sample size (N =513) was more than sufficient to test our proposed measurement model, as the N:q ratio (where q equals the number of unknown parameters) was approximately 23:1, exceeding recommended ratios for a confirmatory factor analysis between 10:1 and 20:1.

Analyses indicated a univariate normality, but some multivariate kurtosis, as Mardia's coefficient = 22.50. Given the robustness of structural equation modeling and absence of any major assumption violations, this multivariate kurtosis was not problematic for performing analyses. Using maximum likelihood estimation, this single factor model had a poor fit, χ^2 (44, N =513) = 766.13, p = .00, *CFI* = .61, *RMSEA* = .18 (*CI* = .17, .19). Individual standardized parameter estimates for items 3, 4, 6, 8, 9 were all below .40. Calculation of Cronbach's alpha for this one factor model was equal to .73.

Figure 23.

One Factor Model



Note. This model displays standardized parameter estimates for the single factor measurement model. Significance levels for these paths was determined using the unstandardized estimates, as EQS does not provide standard errors which could be used for conducting significance test of standardized parameter estimates. The path from *Covid-19 Stress* to *Item 2* was fixed at 1.0.

*p<.05 **p<.01 ***p<.001

Next, the proposed two factor model was tested. The first factor represented distress, and had 6 indicators (items 1, 2, 5, 7, 10, 11) of the negatively worded questions. The second factor, which represented perceived coping, had 5 indicators (items 3, 4, 6, 8, 9) of the positively worded questions (i.e., reverse-keyed items). All measurement model rules of identification were met. Since factors, or latent variables, are unmeasured, their unit of measurement must be fixed. As such, the path from factor 1 (*Distress*) to item 2 (*How stressed do you currently feel with respect to the COVID-19 pandemic?*) was fixed to 1.0 as it was hypothesized that item 2 loads most heavily on it. The path from factor 2 (*Perceived Coping*) to item 8 (*Do you feel you are effectively coping with important changes that are occurring in your life, with respect to the COVID-19 pandemic?*) was also fixed to 1.0, as it was hypothesized that this item loads most heavily on perceived coping. Additionally, each factor had at least 3 indicators with errors uncorrelated with each other, the two factors were uncorrelated, and there were no double loadings, thereby meeting the third, fourth and fifth measurement model identification rules. The model was over identified, as there were 66 known and 22 unknown parameters.

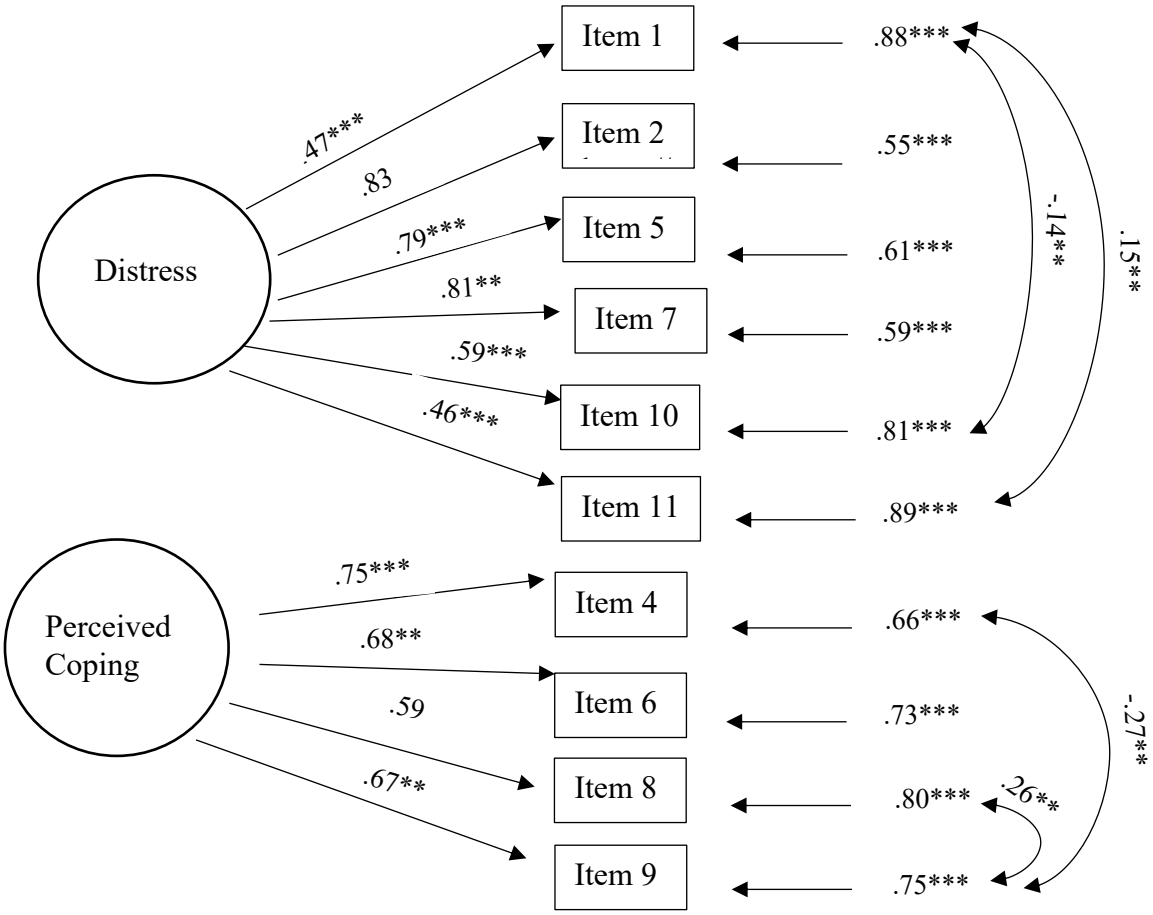
Based on sample size recommendations by Bentler (2006), this sample size excluding data missing more than 5% of variables (N =513) was again more than sufficient to test our proposed two factor model. The N:q ratio (where q equals the number of free parameters, in this model 12) was approximately 23:1. Analyses indicated a univariate normality, but some slight multivariate kurtosis, (Mardia's coefficient = 22.50). Using maximum likelihood estimation, this two factor model also had a relatively poor fit, χ^2 (44, N =513) =286. 73, p = .00, *CFI* = .87, *RMSEA* = .10 (*CI* = .09,

.12). However, parameter estimates for all indicators except for item 3 were all greater than .40. Cronbach's alpha for this model was equal to .73.

Given the poor fit of this initial two factor model, the model was re-specified. Item 3 was removed from the model and error terms for item 1 and 10, item 1 and 11, item 4 and 9, and item 8 and 9, were correlated. Item 3 was removed based on its low loading in previously tested models. All other aspects of this modified two factor model remained identical to the initial model, and all measurement model identification rules were still met. The model was over-identified as there were 66 known and 24 unknown parameters. The sample size was still sufficient to test this re-specified model, as the N:q ratio is approximately 21:1. Analyses indicated a univariate normality, but again some multivariate kurtosis (Mardia's coefficient = 20.34). Using maximum likelihood estimation, this two factor model had an adequate fit, χ^2 (31, N =513) =123.58, p = .00, CFI = .94, $RMSEA$ = .08 (CI = .06, .09). Comparison of chi squares suggested a significant improvement in the fit for this modified two factor model compared to the one factor ($\Delta\chi^2$ = 642.55, p < .001). Individual standardized parameter estimates were all greater than .40. Cronbach's alpha for this model was .77.

Figure 24.

Final 10-Item Two Factor Model



Note. This model displays standardized parameter estimates for the final, two factor measurement model. Significance levels for these paths are determined using the unstandardized estimates, as EQS does not provide standard errors which could be used for conducting significance test of standardized parameter estimates. The paths from *Distress* to *Item 2* and from *Perceived Coping* to *Item 8* were both fixed at 1.0. *p<.05 **p<.01 ***p<.001

Discussion

Overall, results supported our hypothesis of a two factor structure for this novel Covid-19 Stress measure. While the fit of the final, 10-item two factor model was only adequate, it was significantly better than that of the one factor model. This finding was expected, seeing as previous research examining the Perceived Stress Scale (which this current measure is based on), has also found support for two factor models. Additionally, the two factor model had good construct reliability, indicating cohesion among the items stemming from each factor.

Overall, these analyses have allowed for validation and refinement of this novel measure reflecting Covid-19 stress, and specifically two components of distress and perceived coping to in regards to Covid-19. Items that did not well represent the constructs were identified and removed from the measure. While the fit of the final two factor model was adequate at best, it still provides us with a measure of Covid-19 stress useful for future studies. It should be noted that these current findings are specific to this dataset and population. These analyses provide a good starting point for further validation and/or improvement of this measure. Future studies should test validation of this measure with different samples and populations, and explore other potential invariances, such across time, age, race/ ethnicity, and gender. Doing so could potentially strengthen general validation of the measure. Moreover, future studies could also refine or build up this current measure, such as by including additional questions, to determine if it better reflects Covid-19 stress.

References

Bentler, P.M. (2006). *EQS 6 Structural Equations Program Manual*. Multivariate Software, Inc.

Cohen, S., Kamarck, T., and Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, 24, 386-396.

APPENDIX D

POST HOC ANALYSES RESEARCH QUESTION 2

To compare whether those who engaged in more social physical activity pre-COVID fare better than those who engaged in more individual physical activity pre-COVID, the following analyses were performed. First, a new categorical variable was created to reflect whether participants engaged in more individual (*number of times/week*) or more social physical activity (*number of times/week*) prior to COVID. Participants who reported engaging in equal amounts of individual and social activity were not included in these analyses. Next, a MANCOVA was performed with this categorical variable reflecting the pre-COVID PA social environment (i.e., individual or social) entered as the predictor and Wave 1 positive affect, negative affect, depression, anxiety and stress entered as the outcome variables. Covariates of age, gender, race, household composition, household size, SES, relationship status, Wave 1 physical health and Wave 1 total physical activity (*times/week)* were included, as these variables had been previously determined to explain significant variance in the various mental health outcomes.

Results indicated that the pre-COVID PA social environment significantly influenced mental health on a multivariate level (Pillai's Trace = .03 ($F(5,369) = 2.35$, $p < .05$, partial $\eta^2 = .03$). Pre-COVID PA social environment significantly influenced Wave 1 depression ($F(1,373) = 5.86$, $p < .05$, partial $\eta^2 = .02$) and anxiety ($F(1,373) = 8.73$, $p < .01$, partial $\eta^2 = .03$). Pairwise comparisons indicated that those who engaged in more individual PA pre-COVID had significantly less depression ($p < .05$), and anxiety ($p < .05$) at Wave 1, compared to those who engaged in more social PA pre-COVID (see Figures 25, 26).

Figure 25.

Social Environment of Pre-COVID Physical Activity (PA) on Wave 1 Depression

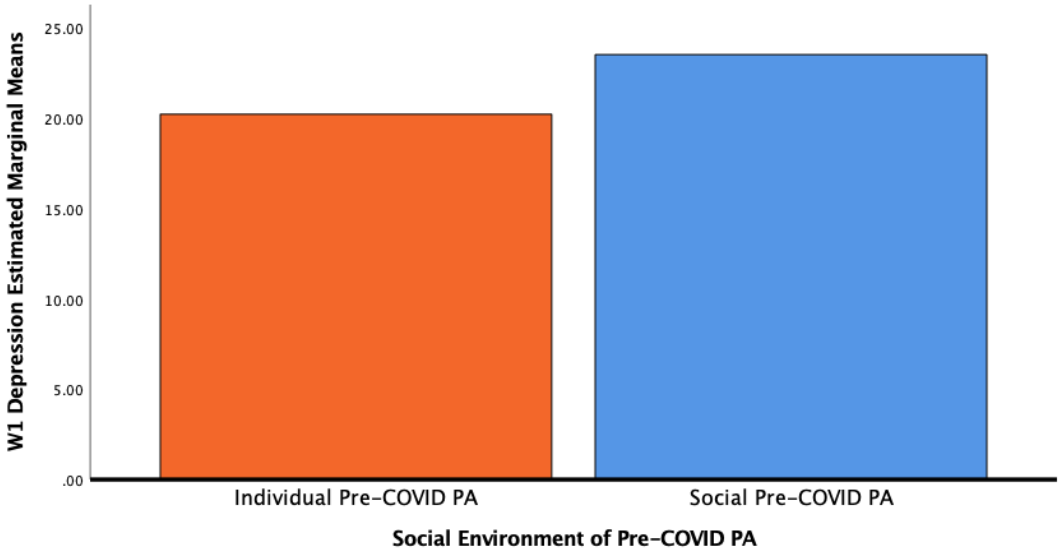
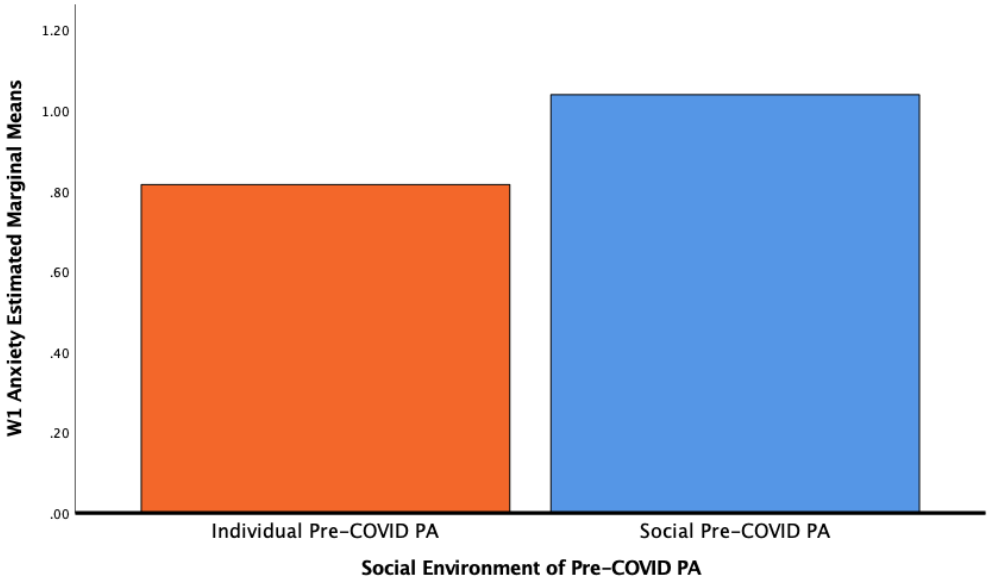


Figure 26.

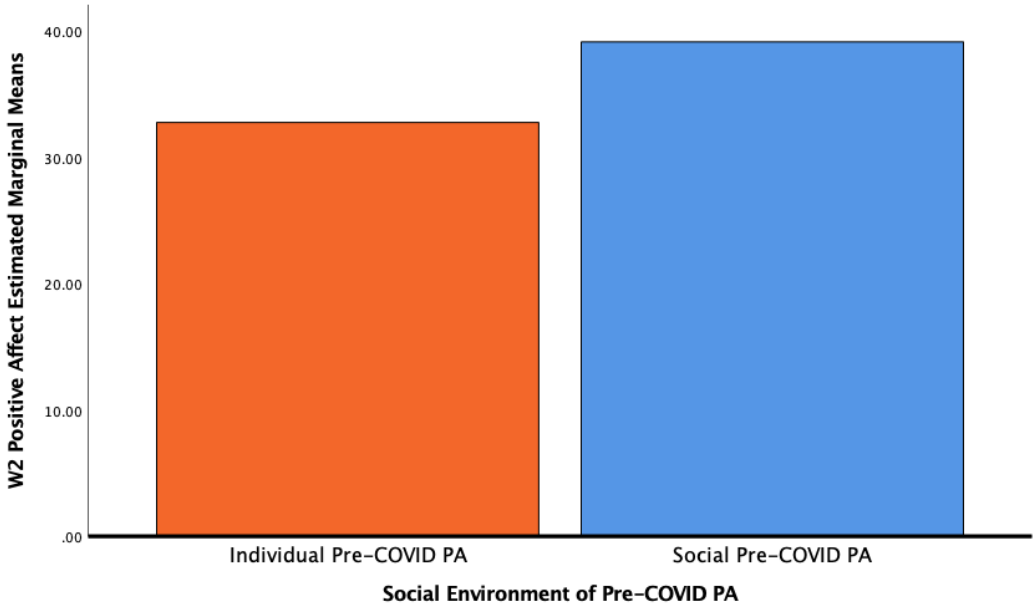
Social Environment of Pre-COVID Physical Activity (PA) on Wave 1 Anxiety



To examine the longer term consequences, a MANCOVA was performed with this categorical variable reflecting the pre-COVID PA social environment (i.e., individual or social) entered as the predictor and Wave 2 positive affect, negative affect, depression, anxiety and stress entered as the outcome variables. Covariates of gender, household composition, household size, athletic identity, Wave 2 physical health and Wave 2 total physical activity (*times/week*) were included, as these variables had been previously determined to explain significant variance in the various mental health outcomes. Results did not indicate that the social environment of pre-COVID PA significantly influences mental health on a multivariate level. However, the pre-COVID PA social environment did significantly influence Wave 2 positive affect ($F(1,76) = 5.83$, $p < .05$, partial $\eta^2 = .07$). Pairwise comparisons indicated that those who engaged in more individual PA pre-COVID had significantly less positive affect ($p < .05$) at Wave 2, compared to those who engaged in more social PA pre-COVID.

Figure 27.

Social Environment of Pre-COVID Physical Activity (PA) on Wave 2 Positive Affect



APPENDIX E

BASELINE/WAVE 1 SURVEY

Start of Block: Basic Demographic Information

Q3 **What is your age?**

_____

Q4 **What is your gender?**

- Male
- Female
- Nonbinary
- Other

Q5 **Are you Hispanic or Latino?**

- Yes
- No

Q6 **Which of the following races/ethnicities apply to you? (Select all that apply)**

- [ ] White
- [ ] Black or African American
- [ ] Asian
- [ ] American Indian or Alaska Native
- [ ] Native Hawaiian or Other Pacific Islander

Q7 **Which best describes your neighborhood?**

- ○ City
- ○ Small town
- ○ Suburban
- ○ Rural

Q8 **Which state in the US do you live in?**

▼ Alabama ... Wyoming

Q9 **What is your current relationship status?**

- ○ Married
- ○ Cohabiting
- ○ Separated/Divorced
- ○ Widowed
- ○ Single

Q10 **Which best further describes your living arrangement? (Check all that apply)**

- ☐ Living alone
- ☐ Living with spouse/partner
- ☐ Living with roommate(s)
- ☐ Living with parent(s)
- ☐ Living with children

Q11 **How many people are in your household?**

_____

Q12 **What is the highest level of education you have completed?**

- ○ Some high school
- ○ High school / GED
- ○ Some college
- ○ College
- ○ Advanced degree

Q13 **What is your household income range?**

- ○ Less than $20,000
- ○ $20,001 - $40,000
- ○ $40,001 - $60,000
- ○ $60,001 - $80,000
- ○ $80,001 - $100,000
- ○ $100,001 - $120,000
- ○ More than $120,000

Q14 **What is your current employment status?**

- ○ Full-time
- ○ Part-time
- ○ Self-employed
- ○ Student
- ○ Was employed but laid off due to COVID-19
- ○ Unemployed (disabled, stay-at-home parent, etc.)

Skip To: Q16 If What is your current employment status? = Was employed but laid off due to COVID-19

Skip To: Q16 If What is your current employment status? = Unemployed (disabled, stay-at-home parent, etc.)

Q15 **Are you currently working remotely or still going into your work place?**

- ○ Remote
- ○ Going into work place

Q16 **Are you currently under a "stay-at-home order" in your state/city?**

- ○ Yes
- ○ No

Skip To: Q19 If Are you currently under a "stay-at-home order" in your state/city? = No

Q17 **How long has the "stay-at-home order" been in effect in your state/city?**

- ○ Less than a week
- ○ 1-2 weeks
- ○ 3-4 weeks
- ○ More than one month

Q18 **How much are you adhering to the stay-at-home order?**

- ○ 0 Not at all
- ○ 1
- ○ 2 Somewhat
- ○ 3
- ○ 4 A lot

Q19 **Are you practicing social distancing?**

- ○ Yes
- ○ Somewhat
- ○ No

Skip To: Q20 If Are you practicing social distancing? = Yes

Q20 **How are you practicing social distancing?**

_____

End of Block: Basic Demographic Information

Start of Block: Physical Activity Questions

Q21 **One month ago (or <u>before</u> social distancing guidelines related to COVID-19 were put in place by the government and/or local authorities), how often did you engage in physical activities or exercises, in a typical week?**

- ○ Never (0 days per week)
- ○ Rarely (1- 2 days per week)
- ○ Moderately (3 - 4 days per week)
- ○ Frequently (5-6 days per week)
- ○ Daily (7 days per week)

Skip To: Q26 If One month ago (or before social distancing guidelines related to COVID-19 were put in place by th... = Never (0 days per week)

Q22 **What type of physical activity or exercise did you typically do PRIOR to the social distancing guidelines?**

_____

Q23 **For the following table, please consider your behavior from ONE MONTH AGO (or <u>BEFORE</u> social distancing guidelines related to COVID-19 were in place by the government and local authorities). On the table, first, please indicate HOW OFTEN you engaged in each type of activity per week outdoors and/or indoors. Second, please indicate WITH WHOM you did the following types of activities.**

	Times per week indoors or outdoors	Social Environment
STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, martial arts, kickboxing, roller skating, ice skating, vigorous swimming, vigorous long-distance bicycling, CrossFit, mountain/rock climbing, parkour, cardio workouts with or without use of fitness machines, or weightlifting)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)
MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, moderate hiking, baseball, tennis, easy bicycling, volleyball, badminton, pickleball, Pilates, Barre, advanced or intense yoga, easy swimming, alpine skiing, popular and folk dancing)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)

MILD/LIGHT EXERCISE (MINIMAL EFFORT) (e.g., yoga, tai chi, archery, fishing from river bank, bowling, horseback riding, golf, easy walking, easy hiking)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone(either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)

Q24 **If you engaged in physical activity with others prior to the social distancing guidelines, were those interactions typically in-person or virtual (e.g. video call, Peloton workout class, phone call)?**

- ○ In person
- ○ Virtual
- ○ Both

Skip To: Q25 If If you engaged in physical activity with others prior to the social distancing guidelines, were t... = In person

Q25 **If you engaged in virtual interactions, were those interactions "live"/in real time (e.g. real time video call, live streamed workout class) or were the interactions not in real time (e.g. watching a pre-recorded workout video)?**

- ○ In real time
- ○ Not in real time
- ○

Q26 **For the next set of question, please answer about your physical activities CURRENTLY during this time of social distancing guidelines related to COVID-19 put in place by the federal government and/or local authorities.**

Q30 **How often do you CURRENTLY engage in a physical activity or exercise in a typical week? (Consider the past 2 weeks as a reference for this question)**

- ○ Never (0 days per week)
- ○ Rarely (1 - 2 days per week)
- ○ Moderately (3 - 4 days per week)
- ○ Frequently (5 - 6 days per week)
- ○ Daily (7 days per week)

Skip To: Q35 If How often do you CURRENTLY engage in a physical activity or exercise in a typical week? (Consider... = Never (0 days per week)

Q31 **What type of physical activity or exercise do you CURRENTLY do?**

Q32 **For the following table, please consider your CURRENT behavior (or <u>SINCE</u> social distancing guidelines related to COVID-19 were in place by the government and local authorities). On the table, first, please indicate HOW OFTEN you engaged in each type of activity per week outdoors and/or indoors. Second, please indicate WITH WHOM you did the following types of activities.**

	Times per week indoors or outdoors	Social Environment
STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, martial arts, kickboxing, roller skating, ice skating, vigorous swimming, vigorous long-distance bicycling, CrossFit, mountain/rock climbing, parkour, cardio workouts with or without use of fitness machines, or weightlifting)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)

MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, moderate hiking, baseball, tennis, easy bicycling, volleyball, badminton, pickleball, Pilates, Barre, advanced or intense yoga, easy swimming, alpine skiing, popular and folk dancing)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)
MILD/LIGHT EXERCISE (MINIMAL EFFORT) (e.g., yoga, tai chi, archery, fishing from river bank, bowling, horseback riding, golf, easy walking, easy hiking)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone(either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)

Q33 **If you engaged in physical activity with others SINCE the federal social distancing guidelines were put in place (March 15th), have those interactions been in-person or virtual (e.g. video call, Peloton workout class, phone call)?**

- ○ In person
- ○ Virtual
- ○ Both

Skip To: Q35 If If you engaged in physical activity with others SINCE the federal social distancing guidelines we… = In person

Q34 **If you engaged in virtual interactions, were those interactions "live"/in real time (e.g. real time video call, live streamed workout class) or were the interactions not in real time (e.g. watching a pre-recorded workout video)?**

- ○ In real time
- ○ Not in real time

Q35 **What has been the most difficult aspect(s) of social distancing for you?**

_____

End of Block: Physical Activity Questions

Start of Block: PANAS

Q36 This scale consists of a number of words and phrases that describe different feelings and emotions. Indicate to what extent you have felt this way during the PAST WEEK.

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	○	○	○	○	○
Distressed	○	○	○	○	○
Excited	○	○	○	○	○
Upset	○	○	○	○	○
Strong	○	○	○	○	○
Guilty	○	○	○	○	○
Scared	○	○	○	○	○
Hostile	○	○	○	○	○
Enthusiastic	○	○	○	○	○
Proud	○	○	○	○	○
Irritable	○	○	○	○	○
Alert	○	○	○	○	○
Ashamed	○	○	○	○	○
Inspired	○	○	○	○	○
Nervous	○	○	○	○	○
Determined	○	○	○	○	○
Attentive	○	○	○	○	○

Jittery	○	○	○	○	○
Active	○	○	○	○	○
Afraid	○	○	○	○	○

Start of Block: CES-D (Radloff, 1977)

Q37 Below is a list of the ways that you might have felt or behaved in general during the last week. Please indicate how often you have felt each of these ways in the LAST 7 DAYS.

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Mo or all of the time (5-7 days)
I was bothered by things that usually don't bother me.	○	○	○	○
I did not feel like eating; my appetite was poor.	○	○	○	○
I felt that I could not shake off the blues even with help from family or friends	○	○	○	○
I felt that I was just as good as other people.	○	○	○	○
I had trouble keeping my mind on what I was doing.	○	○	○	○
I felt depressed.	○	○	○	○
I felt that everything I did was an effort.	○	○	○	○
I felt hopeful about the future.	○	○	○	○
I thought my life had been a failure.	○	○	○	○
I felt fearful.	○	○	○	○
My sleep was restless.	○	○	○	○
I was happy.	○	○	○	○
I talked less than usual.	○	○	○	○
I felt lonely.	○	○	○	○

People were unfriendly.	○	○	○	○
I enjoyed life.	○	○	○	○
I had crying spells.	○	○	○	○
I felt sad.	○	○	○	○
I felt that people disliked me.	○	○	○	○
I could not get "going."	○	○	○	○

Start of Block: TRACKING ALTERNATIVES TO PHYSICAL PROXIMITY – SOCIAL DISTANCIN

Q38 Are you spending more time, less time, or the same amount of time in the following activities DURING THE PAST FEW DAYS compared to before the COVID-19 restrictions?

	Much less time	Somewhat less time	Same amount of time	Somewhat more time	Much more time
Going out in public	○	○	○	○	○
Eating out (includes takeout)	○	○	○	○	○
Cooking	○	○	○	○	○
Shopping	○	○	○	○	○
In-person interactions with friends	○	○	○	○	○
In-person interactions with immediate family	○	○	○	○	○
In-person interactions with extended family	○	○	○	○	○
Online communication with friends	○	○	○	○	○
Online communication with immediate family	○	○	○	○	○
Online communicate with extended family	○	○	○	○	○
In person communication with friends	○	○	○	○	○
In person communication with immediate family	○	○	○	○	○

In person communication with extended family	○	○	○	○	○
Sleeping	○	○	○	○	○
Eating	○	○	○	○	○
Working	○	○	○	○	○
Time outdoors	○	○	○	○	○
Reading email	○	○	○	○	○
Reading the news	○	○	○	○	○
Watching television	○	○	○	○	○
Watching movies	○	○	○	○	○
Time with pets	○	○	○	○	○
Drinking alcohol	○	○	○	○	○

Page Break

Q39 **Which city is not in the United States? This is a data quality check. Regardless of the true value, please select Miami.**

- ○ New York City
- ○ Tokyo
- ○ Boston
- ○ Miami
- ○ Seattle

Start of Block: Beck Anxiety Inventory

Q40 Below is a list of common symptoms. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the PAST MONTH, including today, by choosing the option in the corresponding space in the column next to each symptom.

	Not at all	Mildly, but it didn't bother me much	Moderately - it wasn't pleasant at times	Severely - it bothered me a lot
Numbness or tingling	○	○	○	○
Feeling hot	○	○	○	○
Wobbliness in legs	○	○	○	○
Unable to relax	○	○	○	○
Fear of worst happening	○	○	○	○
Dizzy or lightheaded	○	○	○	○
Heart pounding / racing	○	○	○	○
Unsteady	○	○	○	○
Terrified or afraid	○	○	○	○
Nervous	○	○	○	○
Feeling of choking	○	○	○	○
Hands trembling	○	○	○	○
Shaky / unsteady	○	○	○	○
Fear of losing control	○	○	○	○
Difficulty in breathing	○	○	○	○
Fear of dying	○	○	○	○
Scared	○	○	○	○

Indigestion	○	○	○	○
Faint / lightheaded	○	○	○	○
Face flushed	○	○	○	○
Hot / cold sweats	○	○	○	○

Start of Block: UCLA Loneliness Scale

Q41 **Please indicate how much you have felt the following way within the PAST WEEK.**

	Never	**Rarely**	**Sometimes**	**Often**
I lack companionship	○	○	○	○
There is no one I can turn to.	○	○	○	○
I am an outgoing person.	○	○	○	○
I feel left out.	○	○	○	○
I feel isolated from others.	○	○	○	○
I can find companionship when I want it.	○	○	○	○
I am unhappy being so withdrawn.	○	○	○	○
People are around me but not with me.	○	○	○	○

Q44 **Please provide your response to each of the following questions:**

	0 (Not at all)	1	2	3 (Somewhat)	4	5 (A lot)
Overall, how much has the COVID-19 pandemic **changed your daily life**?	○	○	○	○	○	○
How **stressed** do you currently feel with respect to the COVID-19 pandemic?	○	○	○	○	○	○
How **unconcerned** are you currently with respect to the COVID-19 pandemic?	○	○	○	○	○	○
Please select "**1**" for this answer.	○	○	○	○	○	○
How much are you able to **control** the important things in your life with respect to the COVID-19 pandemic?	○	○	○	○	○	○
How **fearful** are you currently with respect to the COVID-19 pandemic?	○	○	○	○	○	○
How **optimistic** are you currently with respect to the COVID-19 pandemic?	○	○	○	○	○	○

How **anxious** do you currently feel with respect to the COVID-19 pandemic?	○	○	○	○	○	○
Do you feel you are **effectively coping** with important changes that are occurring in your life, with respect to the COVID-19 pandemic?	○	○	○	○	○	○
How **confident** do you currently feel in your ability to handle personal problems with respect to the COVID -19 pandemic?	○	○	○	○	○	○
How **angry** are you currently because you feel things are outside of your control with respect to the COVID -19 pandemic?	○	○	○	○	○	○

How much do you **think** about things that you have to accomplish, with respect to the COVID -19 pandemic?	○	○	○	○	○	○

Q49 **Have you contracted COVID-19?**

- ○ No
- ○ Yes
- ○ Not sure

Q50 **Have you been tested for COVID-19?**

- ○ No
- ○ Yes

Q51 **Have you had any symptoms of COVID-19?**

- ○ No
- ○ Yes
- ○ Not sure

Q52 **How worried are you about personally contracting COVID-19?**

- Not at all
- A little bit
- Somewhat
- Quite a bit
- A lot

Q53 **How worried are you a loved one will contract COVID-19?**

- Not at all
- A little bit
- Somewhat
- Quite a bit
- A lot

Q54 **Do you know anyone personally who has (or had) COVID-19?**

- No
- Yes
- Not sure

End of Block: COVID-19 Specific Questions

Start of Block: General Health Questions

Q42 **CURRENTLY, how would you rate your PHYSICAL health?**

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

Q43 **CURRENTLY, how would you rate your EMOTIONAL health?**

- ○ Excellent
- ○ Very Good
- ○ Good
- ○ Fair
- ○ Poor

Q44 **Do you feel your PHYSICAL HEALTH has improved or worsened over the past month?**

- ○ Significantly Worsened
- ○ Worsened
- ○ Neither Worsened nor Improved
- ○ Improved
- ○ Significantly Improved

Q45 **Do you feel your EMOTIONAL HEALTH has improved or worsened over the past month?**

- ○ Significantly Worsened
- ○ Worsened
- ○ Neither Worsened nor Improved
- ○ Improved
- ○ Significantly Improved

Q46 **Is there anything else you feel we should have asked or that you would like to tell us?**

_____

Q48 **Would you be willing to complete a follow-up survey in the future?**

- ○ Yes
- ○ No

Q47 **Thank you for your participation in this study. Take care and stay healthy!**

APPENDIX F

FOLLOW-UP/WAVE 2 SURVEY

Start of Block: Physical Activity Questions

Q26 **For this set of questions, please answer about your physical activities CURRENTLY during this time of social distancing guidelines related to COVID-19, as put in place by the federal government and/or local authorities.**

Q30 **How often do you CURRENTLY engage in a physical activity or exercise in a typical week? (Consider the past 2 weeks as a reference for this question)**

- ○ Never (0 days per week) (1)
- ○ Rarely (1 - 2 days per week) (2)
- ○ Moderately (3 - 4 days per week) (3)
- ○ Frequently (5 - 6 days per week) (4)
- ○ Daily (7 days per week) (5)

Skip To: Q66 If How often do you CURRENTLY engage in a physical activity or exercise in a typical week? (Consider... = Never (0 days per week)

Q31 **What type of physical activity or exercise do you CURRENTLY do?**

_____

Page Break

Q32 **For the following table, please consider your CURRENT behavior (consider the past 2 weeks as reference).**
On the table, first, please indicate HOW OFTEN you engaged in each type of activity *per week* outdoors and/or indoors. Second, please indicate WITH WHOM you did the following types of activities.

	Times per week indoors or outdoors	Social Environment
STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, martial arts, kickboxing, roller skating, ice skating, vigorous swimming, vigorous long-distance bicycling, CrossFit, mountain/rock climbing, parkour, cardio workouts with or without use of fitness machines, or weightlifting)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)
MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, moderate hiking, baseball, tennis, easy bicycling, volleyball, badminton, pickleball, Pilates, Barre, advanced or intense yoga, easy swimming, alpine skiing, popular and folk dancing)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone (either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a

		structured group such as a class or sports team)
MILD/LIGHT EXERCISE (MINIMAL EFFORT) (e.g., yoga, tai chi, archery, fishing from river bank, bowling, horseback riding, golf, easy walking, easy hiking)	____ times per week indoors ____ times per week outdoors	____ times per week alone ____ times per week with someone(either a personal trainer or another individual engaging in the activity with you) ____ times per week in a group (e.g., in an informal group, in a structured group such as a class or sports team)

Page Break

Q33 **If you engaged in physical activity with others in the past 2 weeks, have those interactions been in-person or virtual (e.g. video call, Peloton workout class, phone call)?**

- ○ In person (1)
- ○ Virtual (2)
- ○ Both (3)
- ○ N/A (4)

Display This Question:

If If you engaged in physical activity with others in the past 2 weeks, have those interactions been... = Virtual

Or If you engaged in physical activity with others in the past 2 weeks, have those interactions been... = Both

Q34 **If you engaged in virtual interactions, were those interactions "live"/in real time (e.g. real time video call, live streamed workout class) or were the interactions not in real time (e.g. watching a pre-recorded workout video)?**

- ○ In real time (1)
- ○ Not in real time (2)

Page Break

Q60 **People engage in physical activity for many reasons. Please indicate how much you engage in physical activity for each of the following reasons.**

	Not at all (1)	A little (2)	Somewhat (3)	Quite a bit (4)	Very much (5)
Fun/enjoyment (1)	○	○	○	○	○
Weight loss (2)	○	○	○	○	○
Competition (3)	○	○	○	○	○
Stress relief/mental health (4)	○	○	○	○	○
Socializing (5)	○	○	○	○	○
Physical Health Reason (e.g., treatment or prevention of an ailment) (6)	○	○	○	○	○
Other (please specify) (7)	○	○	○	○	○

Page Break

Q69 Now, we would like you to rank the following reasons for engaging in physical activity from 1 = primary reason to 7 = least likely reason.
To order the reasons, drag your choice of the reason and click to place it in your desired location.

_____ Fun/enjoyment (1)
_____ Weight loss (2)
_____ Competition (3)
_____ Stress Relief/Mental Health (4)
_____ Socializing (5)
_____ Physical Health Reason (6)
_____ Other (please specify) (7)

Page Break

Q63 **How competitive are you when participating in physical activity with others?**

- ○ Not at all (6)
- ○ A little (2)
- ○ Somewhat (3)
- ○ Quite a bit (4)
- ○ Very much (5)

Q70 **How competitive are you with yourself, when participating in physical activity alone?**

- ○ Not at all (1)
- ○ A little (2)
- ○ Somewhat (3)
- ○ Quite a bit (4)
- ○ Very much (5)

Page Break

Q66 **Since the last survey in April, how have your physical activity behaviors changed - increased, decreased or stayed about the same?**

- ○ Increased (2)
- ○ Decreased (3)
- ○ Stayed about the same (4)

Skip To: End of Block If Since the last survey in April, how have your physical activity behaviors changed - increased, de... = Stayed about the same

Q67 **If your physical activity has increased or decreased since the last survey in April, select the reasons that contributed to this change. (Select all that apply)**

- ☐ Barriers due to social distancing measures (e.g., gyms closed, pools closed, hiking trails closed etc...) (1)
- ☐ Time availability for physical activity (2)
- ☐ Health reasons (3)
- ☐ Changes in desire/ motivation for engaging in physical activity (either increase or decrease) (4)
- ☐ Injury (5)
- ☐ Other (please specify) (6) _____

End of Block: Physical Activity Questions

Start of Block: Athletic Identity

Q71 Select the number that best reflects the extent to which you agree or disagree with each statement regarding your sport participation.

	1 (Strongly Disagree) (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (Strongly Agree) (7)
I consider myself an athlete. (1)	○	○	○	○	○	○	○
I have many goals related to sport. (2)	○	○	○	○	○	○	○
Most of my friends are athletes. (3)	○	○	○	○	○	○	○
Sport is the most important part of my life. (4)	○	○	○	○	○	○	○
I spend more time thinking about sport than anything else. (5)	○	○	○	○	○	○	○
I feel bad about myself when I do poorly in sport. (6)	○	○	○	○	○	○	○
I would be very depressed if I were injured and could not compete in sport. (7)	○	○	○	○	○	○	○

End of Block: Athletic Identity

Start of Block: PANAS

Q36 This scale consists of a number of words and phrases that describe different feelings and emotions. Indicate to what extent you have felt this way during the PAST WEEK.

	Very slightly or not at all (1)	**A little** (2)	**Moderately** (3)	**Quite a bit** (4)	**Extremely** (5)
Interested (1)	○	○	○	○	○
Distressed (2)	○	○	○	○	○
Excited (3)	○	○	○	○	○
Upset (4)	○	○	○	○	○
Strong (5)	○	○	○	○	○
Guilty (6)	○	○	○	○	○
Scared (7)	○	○	○	○	○
Hostile (8)	○	○	○	○	○
Enthusiastic (9)	○	○	○	○	○
Proud (10)	○	○	○	○	○
Irritable (11)	○	○	○	○	○
Alert (12)	○	○	○	○	○
Ashamed (13)	○	○	○	○	○

Inspired (14)	○	○	○	○	○
Nervous (15)	○	○	○	○	○
Determined (16)	○	○	○	○	○
Attentive (17)	○	○	○	○	○
Jittery (18)	○	○	○	○	○
Active (19)	○	○	○	○	○
Afraid (20)	○	○	○	○	○

Page Break

End of Block: PANAS

Start of Block: CES-D (Radloff, 1977)

Q37 Below is a list of the ways that you might have felt or behaved in general during the last week. Please indicate how often you have felt each of these ways in the LAST 7 DAYS.

	Rarely or none of the time (less than 1 day) (1)	**Some or a little of the time (1-2 days)** (2)	**Occasionally or a moderate amount of time (3-4 days)** (3)	**Most or all of the time (5-7 days)** (4)
I was bothered by things that usually don't bother me. (1)	○	○	○	○
I did not feel like eating; my appetite was poor. (2)	○	○	○	○
I felt that I could not shake off the blues even with help from family or friends (3)	○	○	○	○
I felt that I was just as good as other people. (4)	○	○	○	○
I had trouble keeping my mind on what I was doing. (5)	○	○	○	○
I felt depressed. (6)	○	○	○	○
I felt that everything I did was an effort. (7)	○	○	○	○
I felt hopeful about the future. (8)	○	○	○	○
I thought my life had been a failure. (9)	○	○	○	○
I felt fearful. (10)	○	○	○	○
My sleep was restless. (11)	○	○	○	○

I was happy. (12)	○	○	○	○
I talked less than usual. (13)	○	○	○	○
I felt lonely. (14)	○	○	○	○
People were unfriendly. (15)	○	○	○	○
I enjoyed life. (16)	○	○	○	○
I had crying spells. (17)	○	○	○	○
I felt sad. (18)	○	○	○	○
I felt that people disliked me. (19)	○	○	○	○
I could not get "going." (20)	○	○	○	○

End of Block: CES-D (Radloff, 1977)

Start of Block: TRACKING ALTERNATIVES TO PHYSICAL PROXIMITY – SOCIAL DISTANCING

Q38 Are you spending more time, less time, or the same amount of time in the following activities compared to <u>before</u> the COVID-19 restrictions?

	Much less time (1)	**Somewhat less time** (2)	**Same amount of time** (3)	**Somewhat more time** (4)	**Much more time** (5)
Going out in public (1)	○	○	○	○	○
Eating out (includes takeout) (2)	○	○	○	○	○
Cooking (3)	○	○	○	○	○
Shopping (4)	○	○	○	○	○
In-person interactions with friends (5)	○	○	○	○	○
In-person interactions with immediate family (6)	○	○	○	○	○
In-person interactions with extended family (7)	○	○	○	○	○
Online communication with friends (8)	○	○	○	○	○
Online communication with immediate family (9)	○	○	○	○	○
Online communication with extended family (10)	○	○	○	○	○
In person communication with friends (11)	○	○	○	○	○
In person communication with immediate family (12)	○	○	○	○	○

In person communication with extended family (13)	○	○	○	○	○
Sleeping (14)	○	○	○	○	○
Eating (15)	○	○	○	○	○
Working (16)	○	○	○	○	○
Time outdoors (17)	○	○	○	○	○
Reading email (18)	○	○	○	○	○
Reading the news (19)	○	○	○	○	○
Watching television (20)	○	○	○	○	○
Watching movies (21)	○	○	○	○	○
Time with pets (22)	○	○	○	○	○
Drinking alcohol (23)	○	○	○	○	○

Display This Question:

If Are you spending more time, less time, or the same amount of time in the following activities com... = In-person interactions with friends [Same amount of time]

Or Are you spending more time, less time, or the same amount of time in the following activities com... = In-person interactions with immediate family [Same amount of time]

Or Are you spending more time, less time, or the same amount of time in the following activities com... = In-person interactions with extended family [Same amount of time]

Or Are you spending more time, less time, or the same amount of time in the following activities com... = In person communication with immediate family [Same amount of time]

Or Are you spending more time, less time, or the same amount of time in the following activities com... = In person communication with extended family [Same amount of time]

Or Are you spending more time, less time, or the same amount of time in the following activities com... = In person communication with extended family [Same amount of time]

Q73 **You answered "same amount of time" to one or more in-person items above - is the lack of difference because:**

- ○ you are not in the same physical location as your family and/or friends (1)
- ○ you and your family/friends have created a social bubble (2)
- ○ you and your family/friends are not concerned about spreading the virus between each other (3)

Page Break

Q39 **Which city is not in the United States? This is a data quality check. Regardless of the true value, please select Miami.**

- ○ New York City (1)
- ○ Tokyo (2)
- ○ Boston (3)
- ○ Miami (4)
- ○ Seattle (5)

End of Block: TRACKING ALTERNATIVES TO PHYSICAL PROXIMITY – SOCIAL DISTANCING

Start of Block: Beck Anxiety Inventory

Q40 **Below is a list of common symptoms. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the PAST MONTH, including today, by choosing the option in the corresponding space in the column next to each symptom.**

	Not at all (1)	**Mildly, but it didn't bother me much** (2)	**Moderately - it wasn't pleasant at times** (3)	**Severely - it bothered me a lot** (4)
Numbness or tingling (1)	○	○	○	○
Feeling hot (2)	○	○	○	○
Wobbliness in legs (3)	○	○	○	○
Unable to relax (4)	○	○	○	○
Fear of worst happening (5)	○	○	○	○
Dizzy or lightheaded (6)	○	○	○	○
Heart pounding / racing (7)	○	○	○	○
Unsteady (8)	○	○	○	○
Terrified or afraid (9)	○	○	○	○
Nervous (10)	○	○	○	○
Feeling of choking (11)	○	○	○	○
Hands trembling (12)	○	○	○	○
Shaky / unsteady (13)	○	○	○	○

Fear of losing control (14)	○	○	○	○
Difficulty in breathing (15)	○	○	○	○
Fear of dying (16)	○	○	○	○
Scared (17)	○	○	○	○
Indigestion (18)	○	○	○	○
Faint / lightheaded (19)	○	○	○	○
Face flushed (20)	○	○	○	○
Hot / cold sweats (21)	○	○	○	○

End of Block: Beck Anxiety Inventory

Start of Block: UCLA Loneliness Scale

Q41 **Please indicate how much you have felt the following way within the PAST WEEK.**

	Never (1)	**Rarely** (2)	**Sometimes** (3)	**Often** (4)
I lack companionship (1)	○	○	○	○
There is no one I can turn to. (2)	○	○	○	○
I am an outgoing person. (3)	○	○	○	○
I feel left out. (4)	○	○	○	○
I feel isolated from others. (5)	○	○	○	○
I can find companionship when I want it. (6)	○	○	○	○
I am unhappy being so withdrawn. (7)	○	○	○	○
People are around me but not with me. (8)	○	○	○	○

End of Block: UCLA Loneliness Scale

Start of Block: COVID-19 Specific Questions

Q44 **Please provide your response to each of the following questions:**

	0 (Not at all) (1)	1 (2)	2 (3)	3 (Somewhat) (4)	4 (5)	5 (A lot) (6)
Overall, how much has the COVID-19 pandemic **changed your daily life**? (1)	○	○	○	○	○	○
How **stressed** do you currently feel with respect to the COVID-19 pandemic? (2)	○	○	○	○	○	○
How **unconcerned** are you currently with respect to the COVID-19 pandemic? (3)	○	○	○	○	○	○
Please select "**1**" for this answer. (4)	○	○	○	○	○	○
How much are you able to **control** the important things in your life with respect to the COVID-19 pandemic? (5)	○	○	○	○	○	○

How **fearful** are you currently with respect to the COVID-19 pandemic? (6)	○	○	○	○	○	○
How **optimistic** are you currently with respect to the COVID-19 pandemic? (7)	○	○	○	○	○	○
How **anxious** do you currently feel with respect to the COVID-19 pandemic? (8)	○	○	○	○	○	○
Do you feel you are **effectively coping** with important changes that are occurring in your life, with respect to the COVID-19 pandemic? (9)	○	○	○	○	○	○

How **confident** do you currently feel in your ability to handle personal problems with respect to the COVID -19 pandemic? (10)	○	○	○	○	○	○
How **angry** are you currently because you feel things are outside of your control with respect to the COVID -19 pandemic? (11)	○	○	○	○	○	○
How much do you **think** about things that you have to accomplish, with respect to the COVID -19 pandemic? (12)	○	○	○	○	○	○

Page Break

Q49 **Have you contracted COVID-19?**

- ○ No (1)
- ○ Yes (2)
- ○ Not sure (3)

Q50 **Have you been tested for COVID-19?**

- ○ No (1)
- ○ Yes (2)

Q51 **Have you had any symptoms of COVID-19?**

- ○ No (1)
- ○ Yes (2)
- ○ Not sure (3)

Q52 **How worried are you about personally contracting COVID-19?**

- ○ Not at all (1)
- ○ A little bit (2)
- ○ Somewhat (3)
- ○ Quite a bit (4)
- ○ A lot (5)

Q53 **How worried are you a loved one will contract COVID-19?**

- ○ Not at all (1)
- ○ A little bit (2)
- ○ Somewhat (3)
- ○ Quite a bit (4)
- ○ A lot (5)

Q54 **Do you know anyone personally who has (or had) COVID-19?**

- ○ No (1)
- ○ Yes (2)
- ○ Not sure (3)

End of Block: COVID-19 Specific Questions

Start of Block: General Health Questions

Q42 **CURRENTLY, how would you rate your PHYSICAL health?**

- ○ Excellent (1)
- ○ Very Good (2)
- ○ Good (3)
- ○ Fair (4)
- ○ Poor (5)

Q43 **CURRENTLY, how would you rate your EMOTIONAL health?**

- ○ Excellent (1)
- ○ Very Good (2)
- ○ Good (3)
- ○ Fair (4)
- ○ Poor (5)

Page Break

Q44 **Do you feel your PHYSICAL HEALTH has improved or worsened over the past month?**

- ○ Significantly Worsened (1)
- ○ Worsened (2)
- ○ Neither Worsened nor Improved (3)
- ○ Improved (4)
- ○ Significantly Improved (5)

Q45 **Do you feel your EMOTIONAL HEALTH has improved or worsened over the past month?**

- ○ Significantly Worsened (1)
- ○ Worsened (2)
- ○ Neither Worsened nor Improved (3)
- ○ Improved (4)
- ○ Significantly Improved (5)

Page Break

Q46 **Is there anything else you feel we should have asked or that you would like to tell us?**

_____

Page Break

Q56 Thank you for participating in this study.

Take care and stay healthy!

APPENDIX G

IRB APPROVAL BASELINE/WAVE 1 STUDY

APPROVAL: EXPEDITED REVIEW

Kristin Mickelson
NCIAS: Social and Behavioral Sciences, School of (SSBS) 607/543-1632
Kristin.Mickelson@asu.edu

Dear Kristin Mickelson:
On 4/20/2020 the ASU IRB reviewed the following protocol:

Type of Review: Initial Study	
Title: Physical Activity and Mental Health During the COVID-19 Pandemic	
Investigator: Kristin Mickelson	
IRB ID: STUDY00011876	
Category of review: (7)(a) Behavioral research (7)(b) Social science methods	
Funding: Name: Arizona State University (ASU)	
Grant Title:	
Grant ID:	
Documents Reviewed:	• consent form 04_20_2020.pdf, Category: Consent Form; • IRB Social Behavioral 2019 Physical Activity and Mental Health during COVID-19.docx, Category: IRB Protocol; • Qualtrics Survey, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • recruitment_methods_04_20_2020.pdf, Category: Recruitment Materials; • Themes_Follow-up survey_Physical activity and mental health during COVID-19.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);

The IRB approved the protocol from 4/20/2020 to 4/19/2021 inclusive. Three weeks before 4/19/2021 you are to submit a completed Continuing Review application and required attachments to request continuing approval or closure.

If continuing review approval is not granted before the expiration date of 4/19/2021 approval of this protocol expires on that date. When consent is appropriate, you must use final, watermarked versions available under the “Documents” tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Marianna Kaneris Kristin Mickelson Marianna Kaneris

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APPENDIX H

IRB APPROVAL FOLLOW-UP/WAVE 2 STUDY

APPROVAL: MODIFICATION

Kristin Mickelson
NCIAS: Social and Behavioral Sciences, School of (SSBS) 607/543-1632
Kristin.Mickelson@asu.edu

Dear Kristin Mickelson:
On 10/12/2020 the ASU IRB reviewed the following protocol:

Type of Review: Modification / Update	
Title: Physical Activity and Mental Health During the COVID-19 Pandemic	
Investigator: Kristin Mickelson	
IRB ID: STUDY00011876	
Funding: Name: Arizona State University (ASU)	
Grant Title: None	
Grant ID: None	
Documents Reviewed:	• consent_form 10_12_2020.pdf, Category: Consent Form; • Qualtrics Survey _10_8_2020.pdf, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • recruitment_methods_10_12_2020.pdf, Category: Recruitment Materials;

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the “Documents” tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Marianna Kaneris Kristin Mickelson Marianna Kaneris