



Original Research

Social Distancing, Psychological Mood and Physical Activity Behavior During COVID-19 in the United States

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ABSTRACT

International Journal of Exercise Science 15(5): 313-329, 2022. Social distancing, during previous epidemics, has been shown to lead to poor mental health outcomes and reduced physical activity. The purpose of the present study was to examine the relationships between self-reported psychological state and physical activity behaviors of individuals under social distancing policies during the COVID-19 pandemic. 199 individuals (29.85 ± 10.22 yrs) in the United States who had been in social distancing for 2-4 weeks participated in this study. Participants answered a questionnaire regarding feelings of loneliness, depression, anxiety, mood state, and physical activity. 66.8% of participants had depressive symptoms and 72.8% had symptoms of anxiety. Loneliness was correlated with depression ($r = 0.66$), trait anxiety ($r = 0.36$), fatigue ($r = 0.38$), confusion ($r = 0.39$), and total mood disturbance (TMD; $r = 0.62$). Participation in total physical activity was negatively associated with depressive symptoms ($r = -0.16$) and TMD ($r = -0.16$). State anxiety was positively associated with participation in total physical activity ($r = 0.22$). In addition, a binomial logistic regression was performed to predict participation in sufficient physical activity. The model explained 45% of the variance in physical activity participation and correctly categorized 77% of cases. Individuals with higher vigor scores had an increased likelihood of participating in sufficient physical activity. Loneliness was associated with negative psychological mood state. Individuals with higher feelings of loneliness, depressive symptoms, trait anxiety, and negative mood state were observed to spend less time engaged in physical activity. Higher state anxiety was positively associated with engagement in physical activity.

KEY WORDS: Loneliness, Depression, Anxiety

INTRODUCTION

The novel coronavirus (COVID-19) pandemic has resulted in the widespread use of social distancing interventions. The Centers for Disease Control and Prevention (CDC) has described social distancing as a set of actions undertaken to slow or stop the transmission of a highly contagious disease by limiting in-person contact including sheltering in place and/or keeping distance between yourself and others outside your home (14). Social distancing policies urged individuals to work from home, utilize video conferencing, and reduce activities outside of their homes such as eating out and going to the gym. While social distancing and stay-at-home orders

are vital for slowing the transmission of COVID-19, these interventions can be psychologically disruptive (55), including feelings of detachment, uncertainty, boredom, and loss of freedom (7). The lack of regular contact with social relationships can lead to feelings of loneliness, which has been defined as a stressful feeling when a person's relationships are perceived as less than desired (49). Loneliness has been associated with increased levels of depression (11, 38), anxiety (10, 23), and an altered mood state. Previous studies conducted during epidemics have shown that social distancing can increase feelings of isolation (28), depressive symptoms (28, 36), symptoms of anxiety (30, 36), and feelings of psychological distress (32, 71, 78).

It has been well established that insufficient physical activity increases the risk for the development of cardiovascular, pulmonary, and metabolic diseases (73). Accordingly, the American College of Sports Medicine (ACSM) and the World Health Organization (WHO) recommend that individuals should participate in at least 150 minutes of moderate-intensity physical activity, at least 75 minutes of vigorous intensity physical activity, or some combination of the two during the week (3, 75). However, insufficient physical activity is also a key risk factor for developing negative mental health outcomes and changes in health behaviors including physical activity have been linked to loneliness, depression, anxiety, and mood state (5). A decreased likelihood of participating in physical activity has been associated with loneliness (25, 48, 57, 61). Furthermore, individuals with depression or depressive symptoms tend to be less physically active than those without symptoms (2, 8, 39, 71). Additionally, individuals with anxiety disorders or symptoms have shown decreased participation in physical activity (17, 48, 69). Finally, a negative mood state has been associated with decreased participation in leisure time physical activity (34) and reduced fitness level (37).

The uncertainty surrounding the COVID-19 pandemic and the recommended social distancing measures, including closure of recreational facilities such as gyms and parks, present a unique opportunity to examine physical activity behaviors and mental health. Research conducted during the COVID-19 pandemic has shown that social distancing can reduce physical activity (39) and psychological well-being and can increase depressive symptoms (42, 54, 63, 74), symptoms of anxiety (12, 40, 52, 61, 73), and feelings of psychological distress (54, 73). Therefore, the purpose of the present study was to examine self-reported psychological states (loneliness, depression, anxiety, and mood state) and physical activity in US adults aged 18-64 during a period of mandated social distancing. The pandemic provided a unique opportunity to study social distancing impact on mental health and physical activity behavior in younger adults in the United States.

METHODS

Participants

A total of 309 participants attempted the questionnaire; however, our final sample included 199 participants that were included in the study due to incomplete responses. The participants were mostly located in Oklahoma, Texas, and Kansas. Using a 2 dependent Pearson's r 's correlation model, a total sample of 161 participants was determined to be sufficient to detect a small effect (Cohen's d of 0.25 SD). Written informed consent was provided by the participants prior to the

online questionnaire, and all instruments were approved by the University of Oklahoma ethics committee and complied with the Declaration of Helsinki. This research was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science (45). Our sample was between the ages of 18-64, were able to read English, and were residing in a locale that had implemented social distancing measures. No other exclusionary criteria were imposed.

Protocol

The questionnaire was distributed via email and social media to University of Oklahoma students, personnel, and associates. Participants completed the questionnaire using Qualtrics software (Qualtrics, XM, Provo, UT). Upon starting the questionnaire, they provided informed consent and began a series of questions that addressed demographic data, loneliness levels, depression levels, situational and innate anxiety, mood state, and were asked to self-report how much physical activity they had engaged in the previous 7 days. Participants had been under social distancing policies for 2 weeks when the questionnaires were distributed. The participants had 2 weeks to complete and submit the questionnaire. The range of time in quarantine was between 2 and 4 weeks.

Loneliness was quantified using the UCLA Loneliness Scale (UCLA-LS), which has been shown to be a reliable (Cronbach's alpha = 0.96 and test-retest = 0.73) and valid test when comparing the scale to self-reported feelings of loneliness ($r(45) = 0.79$) (59). Each of the 20 items is rated on a scale of 0 (never), 1 (rarely), 2 (sometimes), and 3 (often). Some examples of the items are, "I have nobody to talk to" and "My social relationships are superficial". After reverse scoring appropriate items, loneliness scores are calculated by summing all items. The range of possible scores is 0-60, with higher scores signifying greater loneliness.

Depression was quantified using the Center for Epidemiological Studies Depression Scale (CES-D) (55). The CES-D has been shown to be reliable (Cronbach's alpha = 0.85 for the general population, test-retest = 0.54) and valid when comparing the scale with depression severity ratings by a nurse-clinician ($r = 0.56$) (55). Scoring was 0-3 with 0 indicating that the participant felt this way rarely or none of the time and 3 indicating that the participant felt this way most or all of the time. The scoring of positive items was reversed and included statements such as "I was happy" and "I felt hopeful about the future". Possible ranges of scores run from 0 to 60, with higher scores indicating the presence of more depressive symptomatology.

The State-Trait Anxiety Inventory (STAI) Form Y was used to quantify feelings of anxiety to an emotional state or condition, and individual differences in anxiety as a trait of personality (65). The STAI is divided into two scales: The S-anxiety (state anxiety) and T-anxiety (trait anxiety). The S-anxiety scale (State Anxiety; STAI Form Y-1) consists of twenty statements that evaluate how respondents feel "right now, at this moment" and includes statements such as "I am worried" and "I am tense". The S-anxiety scale has been shown to be internally consistent (Cronbach's alpha = 0.90) (63). While the test-retest reliability is lower (0.33), this may be because state-anxiety is dependent on the situation the individual is experiencing at the time of testing (47). The T-Anxiety scale has been shown to be reliable (Cronbach's alpha = 0.90; test-retest from 0.73 to 0.86) and valid when compared to similar anxiety scales ($r = 0.85$) (63). (Trait Anxiety;

STAI Form Y-2) consists of twenty statements that assess how people generally feel and includes statements such as "I feel like a failure" and "I have disturbing thoughts". In the T-Anxiety scale each STAI item is given a weighted score from 1 to 4 with 1 indicating that the individual feels that statement is "not at all" a description of themselves and 4 being "very much so" a description of themselves. Anxiety scores can vary from a minimum of 20 to a maximum score of 80. For each scale, State Anxiety and Trait Anxiety, a higher score indicates the presence of more anxiety symptomology.

The Profile of Mood States (POMS) questionnaire is a standard validated psychological test regarding mood (42). The POMS questionnaire is available as a full length (65 items) and short version (30 items). This study utilized the 30-item questionnaire to encourage survey completion (62). The short version of the POMS has been shown to be a reliable (internal reliability from 0.803 to 0.907) and had a high correlation with the original long version ($r > 0.95$) (61). The questionnaire contains a series of descriptive words/statements that describe the feelings people might have. Subjects self-report on each of these areas using a 5-point Likert scale. The scoring is from 0-4; 0 being "not at all" and 4 being "extremely". A Total Mood Disturbance (TMD) score was calculated by summing the totals for tension, depression, fatigue, confusion, and anger categories and then subtracting the totals for vigor and self-esteem related affect. A higher score on the TMD metric indicates a higher level of mood disturbance.

The International Physical Activity Questionnaire (IPAQ) was used to collect self-reported physical activity over the previous week and includes 5 activity domains asked independently (15). The purpose of the questionnaire is to provide a common instrument to obtain comparable data on health-related physical activity for use in young and middle-aged adults (15-69 years of age). The IPAQ has been shown to be reliable (test-retest reliability = 0.8) and valid when compared with data from accelerometers ($\rho = 0.33$) (15). The data collected using this questionnaire was used to calculate MET.mins for walking, moderate intensity physical activity, vigorous intensity physical activity, and total MET.mins for the accumulation of all activity within a week (total physical activity). For each activity domain, a higher score indicates a higher participation level in that activity. Vigorous activity is defined as requiring hard effort and harder breathing than normal, while moderate activity is defined as requiring moderate effort and somewhat harder breathing than normal.

To assess the physical activity participation, the participants were divided into three categories: low, moderate, and high (19, 62). Low activity was defined as not meeting the criteria for either the moderate or high activity categories. Moderate activity was defined as 5 or more days per week and a combined total of 600 MET.mins/week of walking, moderate intensity, and vigorous intensity physical activity. The high activity category was defined as 7 days and a combined total of 3000 MET.mins/week. The participants were also separated into insufficient and sufficient categories. Insufficient was defined as belonging to the low activity category, while sufficient was defined as belonging to the moderate or high activity categories.

Statistical Analysis

A Shapiro-Wilk test was performed, and the data were found to be normally distributed ($p < 0.05$). Associations between the psychological mood variables (loneliness, depression, anxiety, and mood state) and the physical activity variables (walking, moderate intensity, vigorous intensity, and total activity) were determined using the Pearson's correlations. A binomial logistic regression was performed to predict participation in physical activity (Insufficient or Sufficient). One-Way ANOVAs with a Bonferroni post-hoc test were performed on the psychological mood and physical activity variables to investigate the effects of the demographic groups (Age Group, Education Level, Employment Status, Family Size, and Living Situation). An Independent Sample T-Test was performed to examine the effect of sex on the psychological mood and physical activity variables. Effect sizes were calculated using Hedge's G . All data were analyzed using SPSS version 24.0 (IBM Corp., Armonk, NY, USA). The significance level for all tests was set *a priori* at $p < 0.05$.

RESULTS

Demographic data is shown in Table 1. One hundred and ninety-nine (199) individuals completed the survey but accounting for missing data, only 192 of the participants provided all demographic data. The age of the sample population was 29.85 ± 10.22 yrs. Table 2 provides the descriptive statistics for the sample population for the psychological mood and physical activity variables.

Loneliness was positively associated with depression, trait anxiety, fatigue, confusion, and TMD (Table 3). In addition, loneliness was negatively associated with vigor (Table 3). Those aged 18-29 (24.46 ± 15.27 ; $F = 6.92$, $p < 0.01$) were observed to have higher feelings of loneliness compared to those age 30-39 (18.17 ± 13.19 , $p < 0.05$, $g = 0.43$) or those aged 40+ (14.40 ± 11.30 , $p < 0.01$, $g = 0.68$). Individuals who had not finished their bachelor's degree (26.59 ± 16.35 ; $F = 6.05$, $p < 0.01$) had higher feelings of loneliness than those who had completed a graduate or professional degree (13.91 ± 1.74 , $p < 0.01$, $g = 1.09$). Individuals who were unemployed (30.84 ± 16.98 ; $F = 10.90$, $p < .001$) were observed to have higher feelings of loneliness than those who were employed (18.75 ± 13.52 , $p < 0.001$, $g = 0.84$). Participants who owned (16.46 ± 13.00 ; $F = 11.54$, $p < .001$) their home were observed to have lower feelings of loneliness than those who rented (21.99 ± 14.02 , $p < 0.05$, $g = 0.41$) or those who lived with their parents (29.48 ± 15.89 , $p < 0.001$, $g = 0.92$). In addition, those who lived with their parents had higher feelings of loneliness than those who rented ($p < 0.05$, $g = 0.51$).

Depression was positively associated with trait anxiety, fatigue, confusion, and TMD (Table 3). Conversely, depression was negatively associated with vigor. A cut-off score of 16 on the CES-D was used to determine whether the participants had relevant symptoms of depression (8). Using this criterion, 56.8% of the sample met the criteria for depressive symptoms. Individuals aged 18-29 (20.53 ± 12.06 ; $F = 4.81$, $p < 0.01$) were observed to have higher depression scores than those aged 40+ (12.76 ± 9.68 , $p < 0.01$, $g = 0.66$). Females (20.19 ± 11.62) had higher depression scores than males (15.77 ± 10.53 ; $t = -2.53$, $p < 0.05$; $g = 0.39$). Individuals who have not attained a bachelor's degree (22.92 ± 12.39 ; $F = 5.40$, $p < 0.01$) had higher depression scores than those who had completed a bachelor's degree (17.59 ± 10.80 , $p < 0.05$, $g = 0.46$) and those

who had completed a graduate or professional degree (16.94 ± 11.00 , $p < 0.05$, $g = 0.51$). Unemployed individuals (26.76 ± 12.32 ; $F = 12.21$, $p < 0.001$) had higher depression scores than those who were employed (16.71 ± 10.90 , $p < 0.001$, $g = 0.89$). Homeowners (14.70 ± 9.98 ; $F = 8.83$, $p < 0.001$) had lower depression scores than those who rented (20.70 ± 11.94 , $p < 0.01$, $g = 0.54$) and those who lived with their parents (22.93 ± 11.60 , $p < 0.01$, $g = 0.77$).

Table 1. Demographic Characteristics

| | Total (%) |
|------------------------|------------|
| Age | |
| 18-29 | 119 (62.0) |
| 30-39 | 48 (25.0) |
| 40+ | 25 (13.0) |
| Sex | |
| Male | 60 (30.6) |
| Female | 136 (69.4) |
| Race | |
| White/Caucasian | 157 (78.9) |
| Black/African-American | 13 (6.5) |
| Native American | 12 (6.0) |
| Other | 17 (8.6) |
| Education | |
| < Bachelor's Degree | 64 (32.2) |
| Bachelor's Degree | 71 (35.7) |
| Graduate/Professional | 64 (32.2) |
| Degree | |
| Employment Status | |
| Employed | 134 (67.3) |
| Unemployed | 37 (18.6) |
| Other | 28 (14.1) |
| Household Size | |
| 1 | 79 (39.7) |
| 2 | 59 (29.6) |
| 3 | 35 (17.6) |
| 4+ | 26 (13.1) |
| Living Situation | |
| Own | 85 (42.7) |
| Rent | 70 (35.2) |
| Live With Parent(s) | 44 (22.1) |

State anxiety and trait anxiety were positively associated with each other (Table 3). State anxiety was positively associated with vigor and confusion (Table 3). To determine relevant symptoms of state anxiety, a cut-off score of 40 or higher was used (1, 31). Using this criterion, 72.8% of the sample had relevant symptoms of state anxiety. Trait anxiety was positively associated with fatigue ($r = 0.36$, $p < 0.001$), confusion ($r = 0.40$, $p < 0.001$), TMD ($r = 0.39$, $p < 0.01$) (Table 3). Females (46.53 ± 4.92) had higher trait anxiety scores than males (44.97 ± 4.23 ; $t = -2.14$, $p < 0.05$;

$g = 0.33$). Individuals aged 18-29 (12.85 ± 4.54 ; $F = 3.72$, $p < 0.05$) had higher feelings of fatigue than those aged 40+ (10.16 ± 4.56 , $p < 0.05$, $g = 0.59$). Females (13.08 ± 4.46) had higher fatigue scores than males (10.71 ± 4.03 ; $t = -3.52$, $p < 0.01$; $g = 0.55$). Participants who were employed (12.07 ± 4.46 ; $F = 3.30$, $p < 0.05$) had lower feelings of fatigue than those who were unemployed (14.19 ± 4.63 , $p < 0.05$, $g = 0.47$). Those who owned their home (11.11 ± 4.40 ; $F = 5.59$, $p < 0.01$) felt lower levels of fatigue than those who rented (12.88 ± 4.56 , $p < 0.05$, $g = 0.39$) and those who lived with their parents (13.82 ± 4.41 , $p < 0.01$, $g = 0.62$).

Table 2. Descriptive Statistics

| | Mean \pm SD |
|--------------------|---------------------|
| Loneliness | 21.70 \pm 14.84 |
| Depression | 19.08 \pm 11.65 |
| State Anxiety | 42.95 \pm 4.99 |
| Trait Anxiety | 46.12 \pm 4.78 |
| Vigor | 12.33 \pm 4.10 |
| Fatigue | 12.47 \pm 4.57 |
| Confusion | 10.39 \pm 2.80 |
| TMD | 43.24 \pm 19.00 |
| Walking (MET.mins) | 344.32 \pm 357.25 |

Employed (10.19 ± 2.66 ; $F = 3.88$, $p < 0.05$) individuals had lower feelings of confusion than those who were unemployed (11.51 ± 3.09 , $p < 0.05$, $g = 0.48$). Also, homeowners (9.68 ± 2.51 ; $F = 3.54$, $p < 0.05$) had lower feelings of confusion compared to those who rented (10.81 ± 2.79 , $p < 0.05$, $g = 0.42$).

Those aged 18-29 (45.35 ± 18.34 ; $F = 3.77$, $p < 0.05$) had higher TMD scores than those aged 40+ (34.80 ± 18.35 , $p < 0.05$, $g = 0.58$). In addition, females (45.44 ± 18.18) had higher TMD scores than males (37.74 ± 17.34 ; $t = -3.134$, $p < 0.01$; $g = 0.43$). In addition, employed individuals (41.38 ± 18.79 ; $F = 5.08$, $p < 0.01$) had lower TMD scores than those who were unemployed (52.03 ± 19.42 , $p < 0.05$, $g = 0.56$). Finally, homeowners (36.88 ± 17.71 ; $F = 6.66$, $p < 0.01$) had lower TMD scores than those who rented (45.86 ± 19.18 , $p < 0.01$, $g = 0.48$) and those who lived with their parents (48.32 ± 18.32 , $p < 0.01$, $g = 0.64$).

None of the demographic groupings showed differences in walking, moderate intensity, vigorous intensity, or total physical activity. Most of the sample (94%) reported walking during the previous week. Loneliness, depression, fatigue, and TMD all had negative associations with participation in walking (Table 3). In addition, vigor was positively associated with walking (Table 3). Most of the sample (92%) reported engaging in at least some moderate intensity physical activity in the past week. State anxiety, vigor, and confusion had a positive association with moderate intensity physical activity (Table 3). In addition, participation in walking was positively associated with engagement in moderate intensity physical activity (Table 3). Seventy-four percent (74%) of the sample reported participating in vigorous intensity physical activity. TMD had a negative association with vigorous intensity physical activity, while vigor had a positive association with vigorous intensity physical activity (Table 3). Depression and

TMD had negative associations with total physical activity (Table 3). State anxiety and vigor had positive associations with total physical activity (Table 3).

Forty-three percent (43%; 86/199) of the participants were categorized in the low physical activity group. While 52% (104/199) and 5% (9/104) were categorized in the moderate and high physical activity groups respectively. Forty-three (43%; 86/199) of the participants were categorized as participating in insufficient amounts of physical activity, while 57% (113/199) were categorized as participating in sufficient amounts of physical activity.

A binomial logistic regression was performed to predict the likelihood that participants would participate in sufficient amounts of physical activity. The model including all the variables was found to be significant ($\chi^2 = 78.275, p < 0.001$). The model explained 45% (Nagelkerke R^2) of the variance in physical activity participation and correctly categorized 77% of cases. Higher vigor scores were related to an increased likelihood of participating in sufficient amounts of physical activity.

DISCUSSION

The purpose of the present study was to examine self-reported psychological mood and physical activity under social distancing policies during the COVID-19 pandemic. While the present study examined the effect of psychological mood, it should be noted that there is a bidirectional relationship between psychological mood and physical activity (16, 17, 46).

There were 4 major findings of the present study: 1) Loneliness was positively associated with depression, anxiety and TMD. 2) A majority of our sample population had relevant symptoms of depression and/or anxiety. 3) Loneliness, depression, and TMD were negatively associated with participation in physical activity. 4) State anxiety was positively associated with moderate intensity physical activity and total physical activity.

Isolation due to social distancing has been shown to lead to feelings of loneliness (51). In a recent study, individuals under a stay-at-home order had a higher likelihood of experiencing loneliness ($r = 0.13$) (70). In the present study, loneliness was associated with depression, trait anxiety, and TMD (Table 3). Research demonstrated that those who were socially isolated or lonely were more likely to experience depression in young adults ($r = 0.38$) (37) as well as in older adults ($r = 0.57$) (27). Loneliness has been linked to increased anxiety (10) and health anxiety ($r = 0.10$) (72). Research has also shown an association between negative mood states and loneliness (37).

Table 3: Pearson's r correlations between mental health variables and self-reported physical activity levels

| | Depres- sion | State Anxiety | Train Anxiety | Vigor | Fatigue | Con- fusion | TMD | Walking | Moderate PA | Vigorous PA | Total PA |
|------------------|-----------------|------------------|------------------|---------|---------|----------------|---------|---------|----------------|----------------|----------|
| Loneliness | 0.66** | -0.04 | 0.35** | -0.28** | 0.38** | 0.39** | 0.52** | -0.21* | -0.03 | -0.10 | -0.14 |
| Depression | - | -0.01 | 0.38** | -0.48** | -0.61** | 0.56** | 0.77** | -0.25** | -0.05 | -0.11 | -0.16* |
| State Anxiety | | - | 0.38** | 0.33** | 0.04 | 0.22** | -0.03 | 0.13 | 0.26** | 0.03 | 0.22* |
| Trait Anxiety | | | - | -0.05 | 0.36** | 0.40** | 0.39** | -0.07 | 0.02 | -0.13 | -0.06 |
| Vigor | | | | - | -0.53** | -0.97 | -0.65** | 0.39** | 0.23* | 0.34** | 0.41** |
| Fatigue | | | | | - | 0.44** | 0.82** | -0.022* | -0.01 | -0.14 | -0.14 |
| Confusion | | | | | | - | -0.66** | -0.05 | -0.19* | -0.04 | -0.09 |
| TMD | | | | | | | - | -0.25** | -0.01 | -0.18* | -0.16* |
| Walking | | | | | | | | - | 0.30** | 0.27** | 0.66** |
| Moderate PA | | | | | | | | | - | 0.36** | 0.85** |
| Vigorous PA | | | | | | | | | | - | 0.66** |
| Total PA | | | | | | | | | | | - |

* p<0.05, **p<0.001. TMD - Total Mood Disturbance; PA - Physical Activity

Another finding of the present study was that most of the sample population experienced relevant symptoms of depression and/or anxiety. The current study found that 56.8% of the sample population had depressive symptoms. This is much higher than rates of depression among the general population before COVID-19. According to the CDC, 8.1% of adult Americans over the age of 20 had depressive symptoms over a two-week period (6). Previous studies regarding social distancing during an epidemic, found that 31.2% of participants had depressive symptoms (28). This study was conducted during the SARS epidemic in the early 2000s and the median time in isolation was 10 days (28). Two recent studies found that 16.5% of participants in China (73) and 32.4% of participants in Italy (41) had depressive symptoms. The first study was performed in the first 3 days after social distancing policies had been enacted and the second study was performed in the first 5 days after social distancing. In the current study, social distancing policies had been in place for at least 14 days and the policies were ongoing. The length of time under social distancing could be one contributing factor for the increased levels of depression in the participants (24, 52). Social distancing and disruptions to daily life have been thought to cause increased anxiety about health, finances, loss of social contacts, and negative psychological outcomes (7, 56, 71).

State anxiety affected 72.8% of the participants in the current study. The CDC reported in 2019, that 15.6% of U.S. adults had at least mild symptoms of anxiety (70). Previous research reported that 47% of the sample population had symptoms of state anxiety during an epidemic while isolated for 14 days (30). Recent studies during the COVID-19 pandemic reported that 18.7% (41), 24.9% (12), and 28.5% (73) of participants had symptoms of anxiety. The first study was conducted in Italy in the first 5 days after social distancing policies had been enacted and the third study was conducted in China in the first 3 days after social distancing policies had been enacted. The studies that included the longest time in isolation had the highest rates of anxiety symptoms in the sampled populations (24, 52). A recent study found that anxiety was positively associated with COVID-19 related stressors including financial worries, disruptions to daily life, and delays or disruptions in the academic lives of college students (17).

While the length of time spent in social distancing is one possible reason for the high rates of depression and anxiety in the participants of the current study, another possible reason might be the ambiguity and/or uncertainty caused by the COVID-19 pandemic. Ambiguous or uncertain situations have been defined as situations that are difficult for an individual to categorize because of a lack of familiarity or complexity (9). While ambiguity and uncertainty have a similar definition, ambiguity refers to the present situation while uncertainty is future oriented (9). Individuals experiencing ambiguous or uncertain situations can experience psychological discomfort including depression and anxiety (4, 13, 24). The experience of ambiguity/uncertainty during the COVID-19 pandemic may be one reason for the high rate of anxiety and depression in the participants of the current study. This can manifest as ambiguity about the current situation or uncertainty about the future including how long social distancing may occur.

Physical activity was affected by certain psychological parameters including loneliness, depression, and TMD. Loneliness was negatively associated with participation in walking ($r = -$

0.21, $p < 0.001$). These data are in line with previous research, where loneliness was negatively associated with participation in physical activity (27, 48, 57). In a study of adults, a negative relationship was found between loneliness and walking ($r = -0.16$) (27). In the present study, depression had a negative association with walking and total physical activity (Table 3). These data agree with a previous study where total MET hours of activity were negatively related to depression ($r = -0.09$) (18). TMD was shown to be negatively associated with walking, vigorous intensity physical activity, and total physical activity (Table 3) in the present study. Previous studies have found a negative relationship between mood state and leisure time physical activity ($r = -0.243$) (33) and fitness level ($r = -0.26$) (67).

Physical activity participation in the current study is higher than data reported before COVID-19 (19). Recent studies have found decreased participation in individuals following COVID-19 compared to pre-COVID participation (43, 58, 66). This seems at odds with the present study which found that over half of participants participated in sufficient physical activity. Other studies conducted during COVID-19 found that in some groups there was an increase in physical activity (20, 21, 29, 35). One study found that 76% of formerly active individuals increased their physical activity (29). Another study found that 80% of participants engaged in either low or moderate intensity physical activity, which is similar to the present study (53). While the current study did not assess physical activity pre-COVID, there is supporting evidence that in some populations physical activity levels stayed the same or increased following COVID-19.

Interestingly, state anxiety had a positive association with both engagement in moderate intensity physical activity and total physical activity (Table 3). This data is inconsistent with some previous studies that had found a negative association between state anxiety and physical activity (17, 49, 68). One study found that individuals who participated in low levels of physical activity had a 1.47 times higher probability of having symptoms of anxiety (68). Although these studies found a negative association between anxiety and physical activity, one study found a positive association between state anxiety and participation in leisure time physical activity ($r = 0.21$) and total physical activity ($r = 0.216$) (34).

Two reasons for the positive association between anxiety and physical activity are the distraction hypothesis and the self-efficacy hypothesis. The distraction hypothesis is the idea that distraction or diversion from stressful situations may lead to improved mood following exercise (17, 44, 50). The self-efficacy hypothesis is the idea that since physical activity is a challenging activity, that the ability to consistently exercise might lead to an improved mood and increased self-confidence (17, 47, 50). Using exercise as a distraction from the current events or to have success or control over something in their life might have prompted people to participate in higher amounts of moderate intensity activity and total physical activity.

The current study had several limitations. Because social distancing policies were already in place, no data for psychological mood or physical activity from before social distancing began were available. It was determined not to ask participants to remember their mood or physical activity from previous weeks due to recall bias. In addition, only participants who lived in towns

or states with social distancing policies were surveyed. Because of this, no control group of participants who lived in areas without such policies were surveyed, so no comparisons could be made. This was because most of the world had adopted some form of social distancing protocols. Previous research has shown that the subjective recall of physical activity on the IPAQ can overestimate physical activity compared to an objective measure like accelerometry (32). Mood has been shown to be affected by menstrual cycle (22) and this may have influenced some of the data. However, we did not collect information from the female participants about their menstrual cycle. It is important to note that our sample included mostly University of Oklahoma personnel and affiliates and these observations cannot be applied to the whole population.

The current study examines the effect of psychological mood states during social distancing on physical activity. Social distancing and/or loneliness were associated with negative physical mood states including depression, anxiety, and negative mood state. Individuals with higher levels of loneliness, depression, trait anxiety, and total mood disturbance were observed to participate in lower amounts physical activity. Conversely, those with higher state anxiety were observed to participate in higher amounts of moderate intensity physical activity and total physical activity. Future research conducted under similar social distancing policies could investigate how psychological mood states and physical activity changed from baseline levels before social distancing. In addition, future research could investigate the effects of long-term social distancing and how psychological mood states and physical activity change during prolonged social distancing policies.

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