International Journal of EXERCISE SCIENCE

Original Research

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

GRANT A. CHESBRO†1, JESSICA A. PETERSON†1, CHRISTOPHER D. BLACK‡1, DANIEL J. LARSON‡1, and REBECCA D. LARSON‡1

[1]Department of Health & Exercise Science, University of Oklahoma, Norman, OK, USA

†Denotes graduate student author, ‡Denotes professional author

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 (ρ = 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 Degree	64 (32.2)
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 ± SD
Loneliness	21.70 ± 14.84
Depression	19.08 ± 11.65
State Anxiety	42.95 ± 4.99
Trait Anxiety	46.12 ± 4.78
Vigor	12.33 ± 4.10
Fatigue	12.47 ± 4.57
Confusion	10.39 ± 2.80
TMD	43.24 ± 19.00
Walking (MET.mins)	344.32 ± 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 finding 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 presents 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**	-.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 physicalactivity (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 distractionor 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 stateswith 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 shownto 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 affiliatesand 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 moodstates 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.

ACKNOWLEDGEMENTS

The authors wish to thank the participants for their time and effort. No sources of funding were used for the completion of this study.

REFERENCES

1. Addolorato G, Capristo CA, Graziosetto R, Di Rienzo L, Maurizi M, Gasbarrini G. State and trait anxiety in women affect by allergic and vasomotor rhinitis. J Psychosom Res 46(3):283-89, 1999.

2. Allan JL, Johnston DW, Johnston M, Mant D. Depression and perceived behavioral control are independent predictors of future activity and fitness after coronary syndrome events. J Psychosom Res 63(5):501-8, 2007.

3. American College of Sports Medicine. The science of exercise, 2017. Retrieved from: https://www.acsm.org/blog-detail/acsm-blog/2017/05/16/science-of-exercise#:~:text=The%20American%20College%20of%20Sports%20Medicine%20recommends%20150%20minutes%20of,it%20up%20the%20stairs%20counts

4. Andersen SM, Schwartz AH. Intolerance of ambiguity and depression: a cognitive vulnerability factor linked to hopelessness. Soc Cogn 10(3): 271-298, 1992.

5. Biddle S. Physical activity and mental health: evidence is growing. World Psychiatry 15(2): 176-177, 2016.

6. Brody DJ, Pratt LA, Hughes JP. Prevalence of depression among adults aged 20 and over: United States, 2013-2016, 2018. Centers for Disease Control and Prevention. Retrieved from: https://www.cdc.gov/nchs/products/databriefs/db303.htm

7. Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, Rubin GJ. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 39(10227): 912-920, 2020.

8. Brummett BH, Babylak MA, Siegler IC, Mark DB, Williams RB, Barefoot JC. Effect of smoking and sedentary behavior on the association between depressive symptoms and mortality from coronary heart disease. Am J Cardiol 92(5): 529-532, 2003.

9. Budner S. Intolerance of ambiguity as a personality variable. J Pers 30(1): 29-50, 1962.

10. Cacioppo JT, Hawkley LC, Ernst JM, Burleson M, Berntson GG, Nouriani B, Spiegel D. Loneliness within a nomological net: an evolutionary perspective. J Res Pers 40(6): 1054-1085, 2006.

11. Cacioppo JT, Hughes ME, Waite LJ, Hawkley LC, Thisted RA. Loneliness as a specific risk factor for depressive symptoms: cross-sectional and longitudinal analyses. Psychol Aging 21(1): 140-151, 2006.

12. Cao W, Fang Z, Hou G, Han M, Xu X, Dong J, Zheng J. The psychological impact of the COVID-19 epidemic on college students in China. Psychiatry Res 287: 112934, 2020.

13. Carleton RN, Mulvoge MK, Thibodeau MA, McCabe RE, Anthony MM, Amundson GJ. Increasingly certain about uncertainty: intolerance of uncertainty across anxiety and depression. J Anxiety Disord 26(3): 468-479, 2012.

14. Centers for Disease Control and Prevention. Social distancing: keep safe distance to slow the spread, 2020. Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html#:~:text=Keep%20a%20Safe%20Distance%20to%20Slow%20the%20Spread.&text=Limiting%20close%20face%2Dto%2Dface,2019%20(COVID%2D19)

15. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports and Exerc 35(8): 1381-1395, 2003.

16. Cushing CC, Mitchell TB, Bejarano CM, Walters RW, Crick CJ, Noser AE. Bidirectional associations between psychological states and physical activity in adolescents: a mHealth pilot study. J Pediatr Psychol 42(5): 559-568, 2017.

17. Da Silva MA, Singh-Manoux A, Brunner EJ, Kaffashian S, Shipley MJ, Kivimäki M, Nabi H. Bidirectional association between physical activity and symptoms of anxiety and depression: the Whitehall II study. Eur J Epidemiol 27(7): 537-546, 2012.

18. De Moor MH, Boomsma DI, Stubbe JH, Willemsen G, de Geus EJ. Testing causality in the association between regular exercise and symptoms of anxiety and depression. Arch Gen Psychiatry 65(8): 897-905, 2008.

19. de Moraes SA, Suzuki CS, de Freitas ICM. Comparison between the International Physical Activity Questionnaire and the American College of Sports Medicine/American Heart Association criteria to classify the physical activity profile in adults. Rev Lat Am Enfermagem 21(4): 835-840, 2013.

20. Ding D, del Pozo Cruz B, Green MA, Bauman AE. Is the COVID-19 lockdown nudging people to be more active: a big data analysis. Br J Sports Med 54(20): 1183-1184, 2020.

21. Duncan GE, Avery AR, Seto E, Tsang S. Perceived change in physical activity levels and mental health during COVID-19: findings among adult twin pairs. PLoS One 15(8): e0237695, 2020.

22. Endicott J. The menstrual cycle and mood disorders. J Affect Dis 29(2-3): 193-200, 1993.

23. Ernst JM, Cacioppo JT. Lonely hearts: psychological perspectives on loneliness. Appl Prev Psychol 8(1): 1-22, 1999.

24. Gan Y, Ma J, Wu J, Chen Y, Zhu H, Hall BJ. Immediate and delayed psychological effects of province-wide lockdown and personal quarantine during the COVID-19 outbreak in China. Psychol Med13: 1-12, 2020.

25. Grenier S, Barrette AM, Ladouceur R. Intolerance of uncertainty and intolerance of ambiguity: similarities and differences. Pers Individ Differ 39(3): 593-600, 2005.

26. Hawkley LC, Masi CM, Berry JD, Cacioppo JT. Loneliness is a unique predictor of age- related differences in systolic blood pressure. Psychol Aging 21(1): 152-164, 2006.

27. Hawkley LC, Thisted RA, Cacioppo JT. Loneliness predicts reduced physical activity: cross-sectional & longitudinal analyses. Health Psychol 28(3): 354-363, 2009.

28. Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styra R. SARS control and psychological effects of quarantine, Toronto, Canada. Emerg Infect Dis 10(7): 1206-1212, 2004.

29. Huber BC, Steffen J, Schlichtiger J, Graupe T, Deuster V, Strouvelle VP, Fischer MR, Massber S, Brunner S. Alteration of physical activity during COVID-19 pandemic lockdown in young girls. J Transl Med 18(1): 410, 2020.

30. Jeong H, Yim HW, Song Y, Ki M, Min J, Cho J, Chae J. Mental health status of people isolated due to Middle East Respiratory Syndrome. Epidemiol Health 38: e2016048, 2016.

31. Julian LJ. Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). Arthritis Car Res 63(S11): S647-S672, 2011.

32. Lee PH, Macfarlane DJ, Lam TH, Stewart SM. Validity of the international physical activity questionnaire short form (IPAQ-SF): a systematic review. Int J Behav Nutr Phys Act 21(8): 115, 2011.

33. Lee S, Chan LY, Chau AM, Kwok KP, Kleinman A. The experience of SARS-related stigma at Amoy Gardens. Soc Sci Med 61(9): 2038-2046, 2005.

34. Legey S, Aquino F, Lamego MK, Paes F, Nardi AE, Neto GM, Gioia M, Sancassiani F, Rocha N, Murillo-Rodrguez, Machado S. Relationship among physical activity level, mood, and anxiety states and quality of life in physical education students. Clin Pract Epidemiol Ment Health 13: 82-91, 2017.

35. Lesser IA, Nienhus CP. The impact of COVID-19 on physical activity behavior and well-being of Canadians. Int J Environ Res Public Health 17(11): 3899, 2020.

36. Liu X, Kakade M, Fuller CJ, Fan B, Fang Y, Kong J, Guan Z, Wu P. Depression after exposure to stressful events: lessons learned from the severe acute respiratory syndrome epidemic. Compr Psychiatry 53(1): 15-23, 2012.

37. Loucks S. Loneliness, affect, and self-concept: construct validity of the Bradley Loneliness Scale. J Pers Assess 44(2): 142-147, 1980.

38. Matthews T, Danese A, Wertz J, Odgers CL, Ambler A, Moffitt TE, Arsenault L. Social isolation, loneliness, and depression in young adulthood: a behavioural genetic analysis. Soc Psychiatry Psychiatr Epidemiol 51(3): 339-348, 2016.

39. Maugeri G, Castrogiovanni P, Battaglia G, Pippi R, D'Agata V, Palma A, Di Rosa M, Musumeci. The impact of physical activity on psychological health during COVID-19 pandemic in Italy. Heliyon 6(6): e04315, 2020.

40. Mayou RA, Gill D, Thompson DR, Day A, Hicks N. Volmink J, Neil A. Depression and anxiety as predictors of outcome after myocardial infarction. Psychosom Med 2(2): 212-219, 2000.

41. Mazza C, Ricci E, Biondi S, Colasanti M, Ferracuti S, Napoli C, Roma P. A nationwide survey of psychological distress among Italian people during the COVID-19 pandemic: immediate psychological responses and associated factors. Int J Environ Res Public Health 17(9): 3165, 2020.

42. McNair DM, Lorr M, Droppleman LF. Manual for the Profile of Mood States. Educational and Industrial Testing Service; 2010.

43. Meyer J, McDowell C, Lansing J, Brower C, Smith L, Tully M, Herring M. Changes in physical activity and sedentary behavior in response to COVID-19 and their associations with mental health in 3052 US adults. Int J Environ Res Public Health 17(18): 6469, 2020.

44. Morgan WP. Affective beneficence of vigorous physical activity. Med Sci Sports Exerc 17(1): 94-100, 1985.

45. Navalta JW, Stone WJ, Lyons TS. Ethical issues relating to scientific discovery in exercise science. Int J Exerc Sci 12(1): 1-8, 2001.

46. Newall NE, Chipperfield JG, Bialis DS, Stewart TL. Consequences of loneliness on physical activity and mortality in older adults and the power of positive emotions. Health Psychol 32(8): 921-924, 2013.

47. North TC, McCullagh P, Tran ZV. Effect of exercise on depression. Exerc Sport Sci Rev 18(1): 379-416, 1990.

48. Page RM, Hammermeister J. Shyness and loneliness: relationship to the exercise frequency of college students. Psychol Rep 76(2): 395-398, 1995.

49. Park S, Cho MJ, Cho S, Bae JN, Lee K, Park JI, et al. Relationship between physical activity and mental health in a nationwide sample of Korean adults. Psychosomatics 52(1): 65-73, 2011.

50. Peluso MA, de Andrade LH. Physical activity and mental health: the association between exercise and mood. Clinics 60(1): 61-70, 2005.

51. Peplau LA, Perlman D. "Perspectives on loneliness". In: Peplau LA, Perlman D, eds. Loneliness: A Sourcebook of Current Theory, Research and Therapy. Wiley; 1982.

52. Peterson JA, Chesbro G, Larson R, Larson D, Black CD. Short-term analysis (8 weeks) of social distancing and isolation on mental health and physical activity behavior during COVID-19. Front Psychol 12(652086):1-11, 2021.

53. Qi M, Li P, Moyle W, Weeks B, Jones C. Physical activity, health-related quality of life, and stress among Chinese adult population during the COVID-19 pandemic. Int J Environ Res Public Health 17(18):6494, 2020.

54. Qui J, Shen B, Zhao M, Wang Z, Xie B, Xu Y. A nationwide survey of psychological distress among Chinese people in the COVID-19 epidemic: implications and policy recommendations. Gen Psychiatr 33(2):e100213, 2020.

55. Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1(3):385-401, 1977.

56. Reger M., Stanley IH, Joiner TE. Suicide mortality and coronavirus disease 2019 – A perfect storm? JAMA Psychiatry 77(11):1093-94, 2020.

57. Richard A, Rohrmann S, Vandeleur CL, Schmid M, Barth J, Eichholzer M. Loneliness is adversely associated with physical and mental health and lifestyle factors: results from a Swiss national survey. PLoS One 12(7):e0181442, 2017.

58. Robinson E, Boyland E, Chisholm A, Harrold J, Maloney NG, Marty L, et al. Obesity, eating behavior and physical activity during COVID-19 lockdown: a study of UK adults. Appetite 156:104853, 2021.

59. Russell D, Peplau LA, Ferguson ML. Developing a measure of loneliness. J Pers Assess 42(3):290-94, 1978.

60. Sacham S. A shortened version of the Profile of Mood States. J Pers Assess 47(3):305- 306, 1983.

61. Schrempft S, Jackowska M, Hamer M, Steptoe A. Associations between social isolation, loneliness, and objective physical activity in older men and women. BMC Public Health 19(1):74, 2019.

62. Sjöström M, Ainsworth B, Bauman A, Bull F, Hamilton-Craig C, Sallis J. Guidelines for data processing analysis of the International Physical Activity Questionnair (IPAQ) – short and long forms. 2005.

63. Skapinakis P. "Spielberger State-Trait Anxiety Inventory". In: Michalos AC, editor. Encyclopedia of Quality of Life and Well-Being Research. Springer; 2014.

64. Sønderskov KM, Dinesen PR, Santini ZI, Østergaard SD. The depressive state of Denmark during the COVID-19 pandemic. Acta Neuropsychiatr 32(4):226-28, 2020.

65. Spielberger CD, Gorsuch R, Lushene RE, Vagg PR, Jacobs GA. Manual for the State- Trait Anxiety Inventory: STAI Form Y. Consulting Psychologists Press; 1983.

66. Stanton R, To QG, Khalesi S, Williams SL, Alley SJ, Thwaite TL, et al. Depression, anxiety, and stress during COVID-19: associations with changes in physical activity, sleep, tobacco, and alcohol use in Australian adults. Int J Environ Res Public Health 17(11):4065, 2020.

67. Stewart KJ, Turner KL, Bacher AC, DeRegis JR, Sung J, Tayback M, Ouyang P. Are fitness, activity, and fatness associated with health-related quality of life and mood in older persons? J Cardiopulm Rehab 23(2):115-21, 2003.

68. Stubbs B, Koyanagi A, Hallgren M, Firth J, Richards J, Schuch F, et al. Physical activity and anxiety: a perspective from the World Health Survey. J Affect Disord 208(15):545- 52, 2017.
69. Taylor MR, Agho KE, Stevens GJ, Raphael B. Factors influencing psychological distress during a disease epidemic: data from Australia's first outbreak of equine influenza. BMC Public Health 8:347, 2008.

70. Terlizzi EP, Villaroel MA. Symptoms of generalized anxiety disorder among adults: United States, 2019. Centers for Disease Control and Prevention, 2020. Retrieved from: https://www.cdc.gov/nchs/products/databriefs/db378.htm#:~:text=The%20total%20percentage%20of%20adults,and%20over%20(Figure%202)

71. Tull MT, Edmonds KA, Scamaldo KM, Richmond JR, Rose JP, Gratz KL. Psychological outcomes associated with stay-at-home orders and the perceived impact of COVID-19 on daily life. Psychiatry Res 289:113098, 2020.

72. van Gool CH, Kempen GI, Penninx BW, Deeg DJ, Beekman AT, van Ejik JT. Relationship between changes in depressive symptoms and unhealthy lifestyles in middle aged and older persons: results from the Longitudinal Aging Study Amsterdam. Age Ageing 32(1):81-87, 2003.

73. Wang C, Pan R, Wan X, Tan Y, Xu L, Ho CS, Ho RC. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. Int J Environ Res Public Health17(5):1729, 2020.

74. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ 174(6):801-9, 2006.

75. World Health Organization. Physical activity, 2018. Retrieved from: https://www.who.int/news-room/fact-sheets/detail/physical-activity

76. Wu P, Fang Y, Guan Z, Fan B, Kong J, Yao Z, Liu X, Fuller CJ, Susser E, Lu J, Hoven CW. The psychological impact of the SARS epidemic on hospital employees in China: exposure, risk perception, and altruistic acceptance of risk. Can J Psychiatry 54(5):302-11, 2009.