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*Original Research*

# Physical Activity and Mindfulness are Associated with Lower Anxiety in Different but Complementary Ways

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ABSTRACT

***International Journal of Exercise Science 15(7): 1075-1084, 2022.*** Introduction: Anxiety is the most prevalent mental illness worldwide. Physical activity and mindfulness both reduce anxiety. The two are highly related; however, the relative association of physical activity and mindfulness on anxiety has yet to be examined. The present study aimed to evaluate the unique variance accounted for by physical activity and mindfulness on anxiety. Methods: Fifty young adults from a student population *(M* ± *SD* = 19 ± 0.2 years old; 58% female) reported their physical activity, mindfulness, and anxiety symptoms at the start of the study and reported their change in state anxiety to an acute psychological stress test, Trier Social Stress Test. Results: Mindfulness explained more of the variance associated with anxiety symptoms at baseline, whereas physical activity explained more of the variance associated with change in state anxiety in response to the acute stressor. Females had higher rates of anxiety symptoms than males suggesting that females may benefit more from mindfulness. In contrast, both males and females reacted similarly to an acute stressor suggesting that both genders may benefit from physical activity. Conclusions: Our findings suggest that physical activity and trait mindfulness may have related, but distinct impacts on anxiety levels. These results have important implications for using these lifestyle interventions to support mental health and point to personalizing interventions to help ease the burden of anxiety felt by the individual.

KEY WORDS: Physical activity, trait mindfulness, acute anxiety, trait anxiety, stress

## INTRODUCTION

Anxiety is the most prevalent mental illness worldwide, and its prevalence has doubled during the COVID-19 pandemic (1, 22, 35, 45). Pharmaceutical treatments options for anxiety are not effective for all, and there is urgent need to identify lifestyle factors that both help prevent anxiety and reduce its burden. It is well established that physical activity reduces anxiety symptoms (32, 40, 43) as well as one's state anxiety reactivity to an acute stressor (31). Evidence also points to the anxiolytic benefits of mindfulness, defined as a "non-judgmental, present-

oriented focused attention" where being "mindful" means becoming more aware of one's thoughts, feelings, and sensations and accepting them regardless of their positive or negative nature (17). One's predisposition to being mindful in daily life is characterized as trait mindfulness (3), and is associated with better perceived health and lower susceptibility to anxiety symptoms (5). Mindfulness-based stress reduction interventions (16) reduce anxiety in both healthy samples (19, 36) and in patients with an anxiety disorder (39). Individuals with higher trait mindfulness also have significantly lower state anxiety in response to an acute psychological stressor (6). However, these effects of mindfulness have not been examined together with physical activity and therefore the independent contribution of the two to anxiety remains unclear.

Examining physical activity and mindfulness together in the same study is important because the two are highly related (14, 44). Individuals who are physically active tend to be more mindful(18, 41), and vice versa (42). Some researchers propose that physical activity increases trait mindfulness by naturally fostering moment-to-moment attention and awareness on breathing and movement (2, 33). In support of this viewpoint is the observation that a twelve-week aerobic exercise intervention not only increased fitness but mindfulness as well (28). This begs the question: how independent are the benefits of physical activity and trait mindfulness on anxiety? Or more specifically, to what extent are the anxiolytic benefits of physical activity independent of those gained from being more mindful? Therefore, the aim of the present study was to investigate the unique variance of physical activity and mindfulness on trait anxiety symptoms (used to indicate clinically relevant anxiety levels) and state anxiety in response to an acute stressor.

## METHODS

*Participants*

Fifty young adults were recruited from McMaster University. Inclusion criteria included being between the ages of 18-30 years ($M \pm SD$ = 19 ± 0.2 years old; 58% female), a current student enrolled at McMaster University, and no current diagnosis of a psychiatric illness. No inclusion criteria were set based on training status; a range of current activity levels was desired, including sedentary, moderately active, recreationally active, and highly active individuals. Enrolled participants informed consent and were modestly compensated for their time according to standards outlined by national granting agencies and took the form of course credit in their introductory psychology course or monetary compensation. Participants with a current diagnosis of a psychiatric illness were excluded from the study. This was listed as an exclusion criterion in all study recruitment materials and re-verified on the Demographic Information Form (see details under "Protocol" below). The sample size satisfied a priori power calculations (G*Power version 3.1.9.3) (12) based on an effect size of $d$ = 0.49 (31). The study was approved by the McMaster Research Ethics Board, #2017-205. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (29).

*Protocol*

Prior to the experiment, participants refrained from vigorous exercise for twelve hours, food for two hours, and caffeine for eight hours prior to the session. Sessions were held between 1:00PM to 4:30PM to control for time-of-day effects. Upon arrival to the lab, participants completed questionnaires of physical activity, trait mindfulness, and trait anxiety. The Demographic Information Form was a self-report questionnaire that asked participants for their age, gender (self-reported gender identity), and to verify with a "yes" or "no" that they had refrained from vigorous exercise for twelve hours, food for two hours, and caffeine for eight hours prior to the session. This form also asked participants to affirm that they had "no current diagnosis of a psychiatric illness made by a health care professional in the last six months". No participants indicated that they had a current diagnosis of a psychiatric illness on the Demographic Information Form. The International Physical Activity Questionnaire-Long Form (IPAQ) (10) was used to measure physical activity level. The IPAQ is a validated instrument for measuring physical activity across four activity domains (job, transportation, housework, and leisure) with 27 items. Physical activity was calculated using MET minutes, a multiple of estimated resting energy expenditure. One MET is what one expends at rest; 2 METS is twice what one expends at rest. Thus, a continuous variable score in MET minutes/week can be obtained by scaling physical activity minutes according to intensity as described by Forde (13): low intensity minutes were multiplied by 3.3, moderate intensity minutes were multiplied by 4, and vigorous intensity minutes were multiplied by 8. Higher scores indicate that one is more physically active (13). The Five Facets Mindfulness Questionnaire (FFMQ-15) (4) is a validated instrument for measuring trait mindfulness with 15 items to assess the five factors of mindfulness: observing, describing, acting with awareness, nonjudging of inner experience, and nonreactivity to inner experience (max = 75 points; range = 15-75 points). Higher scores indicate greater trait mindfulness. The State-Trait Anxiety Inventory-Form Y-2 (STAI-t) (38) is a validated instrument for measuring general trait anxiety with 20 items (max = 80 points). Higher scores indicate more anxiety symptoms. A cut-off score of 35-40 points is typically used to suggest clinical levels of anxiety (11). The State-Trait Anxiety Inventory (Short Form: STAI-6) (25) is a validated measured state anxiety with six items that assess feelings of current anxiety (max = 80 points; range = 20-80 points). Higher scores indicate greater state anxiety.

Subsequently, participants took part in the Trier Social Stress Test (TSST) (21), which consisted of a 5-minute speech task followed by a 5-minute arithmetic task. To capture the rise and fall of the stress response to the acute stressor heart rate (HR) and state anxiety were assessed at four time points: 1) pre-TSST, 2) mid-TSST (completed during a 4-minute break that separated the speech task and arithmetic task), 3) post-TSST and 4) recovery. HR was measured using a Polar FT1 Heart Rate Monitor and Polar T31 sensor using beats per minute and used as a manipulation check to verify that the TSST did indeed significantly increase heart rate from baseline, thus, indicating an acute stress response.

*Statistical Analysis*

Data were analyzed using IBM SPSS Statistics Software 23. Statistical significance was set at $p < 0.05$. Normality was assessed using skewness and kurtosis based on current recommendations

and all variables were normally distributed based on histogram plots (20). For hierarchical regression analyses, multicollinearity was assessed; tolerance was .88 and variance inflation factor was 1.13 indicating no issues. Partial correlations, with gender entered as a covariate, assessed associations between physical activity, trait mindfulness, trait anxiety, and state anxiety. Hierarchical regression analyses evaluated the relative association of physical activity and mindfulness on mental health and stress reactivity, and the model consisted of gender entered as a covariate in step 1, physical activity entered in step 2, and trait mindfulness entered in step 3. It should be noted that gender was included as a covariate because females tend to have higher rates of anxiety than males (27).

## RESULTS

*Trait Anxiety:* Trait anxiety was higher for females (47.1 ± 11.2) than males (40.8 ± 7.6), and both genders scored above the cut-off score of 35-40 suggesting clinical levels of anxiety (11). This elevated anxiety level is a common finding amongst university student populations (9, 24, 30). The university student population faces frequent evaluation through tests and examinations, financial pressures, and the need to balance employment and extra-curricular activities with an academic course load, which may explain the elevated anxiety levels seen in both our sample as well as others.

Partial correlations were conducted between physical activity, trait mindfulness, and trait anxiety, controlling for gender (Table 1). Physical activity and trait mindfulness were positively correlated with each other ($r(47) = .34$, $p = .021$), and both were negatively correlated with trait anxiety (Physical Activity: $r(47) = -.29$, $p = .033$; Trait mindfulness: $r(47) = -.64$, $p < .001$).

**Table 1.** Partial correlations between physical activity, trait mindfulness, and change in acute stress, controlling for gender

| | PA | Trait MF | Trait Anxiety | Δ HR | Δ State Anxiety |
|---|---|---|---|---|---|
| PA | - | .34* | -.29 | -.37* | -.36* |
| Trait MF | | - | -.64 | -.27 | -.03 |
| Trait Anxiety | | | - | | |
| Δ HR | | | | - | .16 |
| Δ State Anxiety | | | | | - |

*Note:* Changes in heart rate (HR) and state anxiety are from pre-Trier Social Stress Test (TSST) to mid-TSST. PA = physical activity. MF = mindfulness. *$p < .05$, **$p < .01$.

A hierarchical regression was run to determine the relative contribution of physical activity and mindfulness to trait anxiety variance (Table 2). In Step 1, gender was entered as a covariate and accounted for 9% of the variability demonstrating that females reported higher trait anxiety than males. In Step 2, physical activity was entered into the model and explained an additional 7% of variance and this change in $R^2$ was significant, $\Delta F(1, 48) = 4.30$, $p = .037$. In Step 3, mindfulness

was entered into the model and explained an additional 30% of the variance and this change in $R^2$ was significant, $\Delta F(1, 46) = 25.64$, $p < .001$.

**Table 2.** Regression: Trait Anxiety

| | $\Delta R^2$ | β |
|---|---|---|
| Step 1 | .09 | -.31* |
| Step 2 | | -.28* (Gender) |
| | .07* | -.28*(PA) |
| Step 3 | | -.29**(Gender) |
| | | -.08 (PA) |
| | .30** | -.58** (MF) |

*Note*: Gender was coded as 1 = female, 2 = male. PA = physical activity. MF = mindfulness. Step 1 of the model included gender. Step 2 of the model included gender and physical activity. Step 3 of the model included gender, physical activity, and trait mindfulness. * = $p < .05$, ** = $p < .01$.

*State Anxiety:* HR increased in response to the TSST administration, demonstrating the effectiveness of the TSST at inducing an acute stress response (Table 3). State anxiety followed suit, peaking mid-TSST, and therefore, mid-TSST minus pre-TSST was used to examine the relative contribution of physical activity and mindfulness on state anxiety reactivity. Only physical activity was negatively correlated with the change state anxiety during the TSST; mindfulness was not (Table 1). Likewise, only physical activity was negatively correlated with the change in HR during the TSST whereas mindfulness was not.

**Table 3.** Acute stress measures tracked across the Trier Social Stress Test

| | Pre | Mid | Post | Recovery |
|---|---|---|---|---|
| Heart rate (bpm) | 76 (10) | 90 (14) | 90 (13) | 74 (10) |
| State Anxiety (max score = 80) | 31 (8) | 41 (12) | 39 (10) | 28 (8) |

*Note:* Raw values are presented as M(SD), without adjusting for covariates.

A hierarchical regression was run to determine the relative contribution of physical activity and mindfulness to state anxiety during the TSST (Table 4). In Step 1, gender was entered as a covariate and only accounted for 6% of the variability, which was not significant. In Step 2, physical activity was entered into the model and explained an additional 12% of variance and this change in $R^2$ was significant, $\Delta F(1, 47) = 7.13$, $p = .030$. In Step 3, mindfulness was entered into the model and explained an additional 1% of variance, which was not significant, $\Delta F(1, 46) = .49$, $p = .491$.

**Table 4.** Regression: Change in state anxiety

| | Δ State Anxiety | |
|---|---|---|
| | $\Delta R^2$ | β |
| Step 1 | .06 | -.24 (Gender) |
| Step 2 | .12* | -.20 (Gender)<br>.35* (PA) |
| Step 3 | .01 | -.20 (Gender)<br>-.39**(PA)<br>.10 (MF) |

*Note*: Gender was coded as 1=female, 2=male. Changes in state anxiety are from pre-Trier Social Stress Test (TSST) to mid-TSST. PA = physical activity. MF = mindfulness. Step 1 of the model included gender. Step 2 of the model included gender and physical activity. Step 3 of the model included gender, physical activity, and trait mindfulness.* = $p < .05$, ** = $p < .01$.

## DISCUSSION

The purpose of the current study was to determine the unique variance of physical activity and mindfulness on anxiety. The results demonstrate that mindfulness was a stronger predictor of anxiety symptoms that may be indicative of an anxiety disorder, whereas physical activity was a stronger predictor of state anxiety in response to an acute stressor.

The observation that an individual's trait mindfulness was associated with symptoms of anxiety independent of physical activity level is in line with prior research reporting a strong association between mindfulness and mental health (7, 15). Mindfulness practice helps develop specific cognitive and behavioural strategies for maintaining a calm state of mind through the development of non-judgmental acceptance of one's thoughts (34); however, unlike a program of regular exercise, mindfulness practice may not evoke advantageous physiological adaptations needed to minimize stress reactivity in the face of an immediate threat to the same extent (16). Indeed, when considering acute stress reactivity, trait mindfulness did not explain unique variance associated with state anxiety, whereas physical activity did. This unique dissociation found in our results suggests that trait mindfulness may be more important for reducing general anxiety symptoms rather than the temporary rise in anxiety one feels in response to an acute stressor.

In contrast, higher physically activity was associated with lower heart rate and state anxiety during the TSST, suggesting less stress reactivity to an acute stressor. This result lends support for the cross-stressor adaptation hypothesis which purports that physical activity-related adaptations minimize one's reactivity to all types of stressors by inducing adaptative physiological changes in the stress system (37). Here, the adaptive changes afforded by being more physically active resulted in a less reactive physiological (HR) and psychological (state anxiety) stress response. Using physical activity to reduce stress reactivity is important because people who are more reactive to stressors are also more likely to develop a mental illness (8) and therefore, this may be one pathway through which physical activity may also reduce symptoms of anxiety. Our research provides a unique perspective to the field by lending support to the

idea that physical activity and trait mindfulness work in related but unique ways to impact difference aspects of anxiety.

Gender explained a significant amount of variance in trait anxiety, even after accounting for physical activity and mindfulness. Specifically, females had higher trait anxiety than males. This is consistent with prior research suggesting that females may be more susceptible to experiencing anxiety symptoms (23, 26) and therefore, a practice of mindfulness training may be particularly beneficial for female's mental health. However, gender was not a significant predictor of state anxiety during stress reactivity, lending further support for a potential dichotomy between the two, and suggesting that the mental wellbeing of both males and female may stand to benefit from a regular program of physical activity.

The current study employed a validated, objective, and effective test to induce the stress response with the TSST to gain insight into how one's acute stress response is related to their mindfulness and physical activity behavior. The present data were collected using a young adult sample who were enrolled in university at the time of participation and therefore it is unclear whether the same association would be observed in a more representative sample of the general population. Additional factors may affect one's stress reactivity including adverse childhood experiences, socio-economic status, and current income, which were not assessed in this study. These factors may act as potential moderators of the relationship between physical activity, trait mindfulness, and anxiety, and should be included in future follow-up research. We also used MET minutes to quantify physical activity, which factors in the impact of physical activity intensity. However, additional measures of physical activity, such as steps per day and measures of physical fitness, such as $VO_2$ max should be considered, to assess the impact of daily movement and aerobic fitness on these relationships between activity, mindfulness, and anxiety. Similarly, the specific types of exercise that participants engaged in, such as aerobic or resistance exercise, were not recorded. Mode of exercise and its impact on trait mindfulness and, in turn, anxiety, is an important factor to be examined in future studies. Finally, the data were assessed using correlations and regression analyses from which causation cannot be determined. Here, we provide evidence of that individuals who are more physically activity and mindful are less anxious; however, experimental manipulations of physical activity and mindfulness levels across a longitudinal, intervention-based design is needed to determine causality.

In summary, trait mindfulness was associated with anxiety symptoms whereas physical activity was associated with both anxiety symptoms and anxiety reactivity in response to an acute stressor. Taken together, the results may suggest that a physical activity program designed to reduce anxiety should include elements that deliberately cultivate mindfulness including attention to breathing or movement; however, future research is needed to test this directly.

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