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Moderate and Vigorous Physical Activity as a Protective Factor Against Anxiety in University Students

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A B S T R A C T

Objective: The COVID-19 pandemic has been one of the most significant adverse events contributing to increased anxiety worldwide. In response to the growing deterioration in mental health during and after the pandemic, health organizations and the scientific community have sought effective strategies to promote well-being, especially in preparation for future global crises. Moderate and vigorous physical activity (MVPA) has been identified as a potential protective factor that enhances resilience in the face of adversity. This study aimed to analyze the moderating effect of MVPA levels on the relationship between suspected COVID-19 infection and anxiety levels in university students.

Methods & Materials: A cross-sectional, correlational-explanatory study was conducted with a sample of 922 Mexican university students (36.66% men, 63.34% women; M age = 19.97, SD = 2.92). Anxiety was measured using the Generalized Anxiety Disorder Scale (GAD-7), and MVPA levels were assessed through the short form of the International Physical Activity Questionnaire (IPAQ-s). A dichotomous-response questionnaire was used to evaluate concern about COVID-19. ANOVA and simple moderation analyses were performed.

Findings: Results indicated a significant and negative moderating effect of MVPA on the relationship between suspected COVID-19 infection and anxiety levels. Additionally, significant sex differences were found in both MVPA levels and generalized anxiety.

Conclusion: In this sample, higher levels of MVPA were associated with lower anxiety, suggesting its potential as a protective factor in adverse contexts like a pandemic.

Keywords: *Physical activity, generalized anxiety, Mexican students, moderation analysis, COVID-19*

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1. Introduction

For years, it has been reported in the literature that regular moderate and vigorous physical activity (MVPA) can help generate and maintain changes in the body, such as reducing the risk of stroke, (1) improving mood, improving the perception of social well-being (2), benefits in cognitive abilities (3), and quality of self-esteem (4), among other benefits such as the prevention of chronic non-communicable diseases (5).

According to the advisory report on physical activity guidelines proposed by the USDHHS (6), scientific evidence concludes that vigorous exercise performed for 20 to 30 minutes three days a week results in significant mental health benefits (6). Despite this, the complexity of promoting PA has been pointed out due to the wide variability in human response depending on age, gender, and the environmental setting in which it is carried out (7). In a 30-year longitudinal study, Nagata et al. (8) determined the health changes associated with PA levels during the transition from young adulthood to middle age. Their results showed that during this stage of life there are various barriers that limit opportunities to practice sport or physical activity, highlighting the importance of maintaining and increasing MVPA as a priority objective for promoting health throughout life.

The effect of PA on human physiology varies depending on the level of PA performed (light, moderate, or vigorous). In other words, the greater the intensity of PA, the greater the physiological effects on the individual's health and physical development (5, 9). Thus, according to previous research, measuring the effects of PA levels in individuals involves specifying the type of activity with caloric expenditure, as well as clinical measurements (10). The United States Department of Health and Human Services (USDHHS) (6) has updated the physical activity guidelines that determine the criteria for assessing and measuring PA intensity in line with scientific advances in research. These guidelines indicate that PA is measured based on the criteria of frequency, type, and relative and absolute intensity. Intensity is determined by the metabolic cost of human movement (MET); Based on METs, activities can be classified by intensity as: sedentary: < 1.5 MET, light: 1.6 to 2.9 METs, moderate: 3 to 5.9 MET, vigorous: > 6.0 MET. In accordance with the above, promoting activities that meet the criteria for MVPA is necessary to help improve the health of the population.

During the COVID-19 pandemic, contingency measures and social isolation exacerbated sedentary lifestyles, along with symptoms of anxiety and depression, generally affecting the emotional and mental health of the global population (11). Concern about the effects of the COVID-19 pandemic remains, as reflected in a WHO report (12) that highlights the ongoing work to jointly address the threats of future pandemics around the world. Lockdown and reduced options for physical activity were factors that contributed to an increase in sedentary lifestyles (13, 14), highlighting the importance of increasing physical activity and counteracting the negative effects (15). While MVPA is well established as a determinant of both physical and psychological well-being, empirical evidence concerning its specific function in attenuating anxiety among university students during adverse circumstances, such as the COVID-19 pandemic, remains scarce. Additional investigation is required to elucidate the extent to which MVPA may mitigate generalized anxiety and thereby lessen its deleterious consequences for the health and prospective professional development of this vulnerable population.

Therefore, the objective of this study was to analyze the moderating effect of MVPA levels on generalized anxiety levels during the first period of the COVID-19 pandemic. In line with the literature, the hypothesis is that MVPA levels will positively moderate the response to generalized anxiety during the COVID-19 pandemic.

2. Methods and Materials

2.1 Study Design and Participants

The study was conducted during the first wave of the COVID-19 pandemic using a cross-sectional correlational-descriptive design. The sample was obtained in a non-probabilistic manner and consisted of 922 Mexican university students (36.66% men, 63.34% women) from the north of the country. To participate, they had to meet the following inclusion criteria: i) be currently enrolled students, ii) be over 18 years of age; excluding those who: iii) did not accept the informed consent to participate; and eliminating those who: v) did not complete the survey. The project was approved by the ethics committee of the Autonomous University of Occident (Official Letter CM-UAdeO 13.10/2020). Participants gave their consent to participate in the same form on which the measurement instruments were sent. At all times, the well-being and confidentiality of student information were ensured in accordance with the provisions of the Declaration of Helsinki, as well as

compliance with the ethical and procedural requirements for conducting research in sports medicine and exercise science (16).

2.2 Instruments

Ad hoc COVID-19 questionnaire: A sociodemographic questionnaire was developed including questions related to the experience during the COVID-19 pandemic. Given that, during the critical period of the COVID-19 pandemic, there were no standardized or validated instruments specifically designed to assess the impact of this contingency on the mental health of university students, the present study sought to address this gap. Participants answered "yes / no" to five questions related to their experience during the first wave of the pandemic: *i)* have you suspected COVID-19 infection at home?; *ii)* have you or any at home been infected by COVID-19?; *iii)* have you been afraid that you or any at home will become seriously ill due to the virus that causes COVID-19?; *iv)* have any from your family died due to or as a consequence of COVID-19?; *v)* are you afraid for the economy of your household? Each question was evaluated separately. The design of the questionnaire was validated through expert judgment and allowed for the immediate assessment of the subjective experience of anxiety, fear, and stress associated with the pandemic context.

Generalized Anxiety Disorder Scale (GAD-7): The Generalized Anxiety Disorder Scale-7 (GAD-7) (17) was applied in its Spanish version (18). It consists of seven items that are scored from 0 (not at all sure) to 3 (almost every day), yielding scores from 0 to 21. The cut-off scores for mild, moderate, and severe levels are 5, 10 and 15 respectively. The scale has demonstrated adequate reliability and validity indices, even in a population of young Mexicans (19).

International Physical Activity Questionnaire short version (IPAQ-s): The short version of the International Physical Activity Questionnaire (IPAQ-s) was used to measure the level of PA. It consists of seven items that measure levels of physical activity and sedentary behavior. Respondents report the frequency (days per week) and duration (minutes per day) of each activity type. For each activity category (vigorous, moderate, walking), the minutes of activity per week are calculated by multiplying the reported days per week by the average minutes per day. Each activity type is converted into MET-minutes per week (One MET is equivalent to an O_2 consumption of 3.5 ml ● kg-1 ● min-1 or 1 kcal/kg/h) (19). Total physical activity is obtained by summing all MET-minutes/week across the three categories. Sedentary behavior is reported separately as average sitting time (minutes per day) and is not included in the total physical activity score. It has been tested meeting reliability and validity levels in several countries, as well as demonstrating adequate reliability and moderate correlation with accelerometry (20).

2.3 Statistical analysis

Descriptive and reliability analyses for the scales using Cronbach's alpha, as well as normality analyses using the Kolmogorov-Smirnov test were performed with SPSS v25.0 software (SPSS Inc., Chicago, IL, USA). Relationships between variables were evaluated using Spearman's Rho test and differences between gender in general were analyzed by the Mann-Whitney U test while categorical analysis was made with Chi-square test. For all statistical determinations, $p < .05$ was considered as the cutoff point. A simple moderation analysis (Model 1) was run through PROCESS V.4.3 macro (21) for SPSS. The moderation effect that PA has on the interaction between suspected COVID-19 infection at home (Suspected COVID-19) and anxiety levels was tested for the total sample and segmented by women and men. Confidence intervals (95%) were generated by bootstrapping for 10,000 samples to determine the three model effects (*b1*, *b2*, and *b3*). PA levels were divided into three using the pick-a-point approach, resulting in three groups corresponding to low, moderate, and high levels of PA.

3. Results

Table 1 show frequency results by gender of PA levels (IPAQ-s) and generalized anxiety levels (GAD-7) respectively. The Chi-square test analysis performed on university students (n = 922) by sex and physical activity (x2 = 32.48, p < .01) or anxiety (x2 = 46.04, p < .01) levels were significant. The GAD-7 results show mean values between 0.61 to 1.12 (SD = 0.85 to 1.01), while the reliability level was α = 0.86. Spearman's Rho correlation test for the overall sample showed a negative relationship (r = -.10, p < .01) between participants' PA and anxiety levels.

Table 1. Frequency and percentage of PA and generalized anxiety levels according to sex.

PA level		Men (*n* = 338)	Women (*n* = 584)	All (*n* = 922)
Low PA level	Count	59	179	238
	%	6.4%	19.4%	25.8%
Moderate PA level	Count	153	276	429
	%	16.6%	30.0%	46.6%
Vigorous PA level	Count	126	129	254
	%	13.6%	14.0%	27.6%
Total	Count	338	584	922
	%	36.6%	63.4%	100%
Anxiety levels		Men (*n* = 338)	Women (*n* = 584)	All (*n* = 922)
Without anxiety	Count	214	244	458
	%	23.2%	26.5%	49.7%
Mild anxiety	Count	84	200	284
	%	9.1%	21.7%	30.8%
Moderate anxiety	Count	31	90	121
	%	3.4%	9.8%	13.1%
Severe anxiety	Count	9	50	58
	%	0.9%	5.4%	6.3%
Total	Count	338	584	922
	%	36.6%	63.4%	100%

Note. PA = Physical activity; *n* = sample size.

The results of the Mann Whitney U test show a difference ($p < .05$) between women and men, with lower level of PA and a higher level of anxiety for women (Table 2). Similarly, Table 1 shows that women have a higher percentage of low PA than men (16.4% -6-4%) as well as higher percentage of moderate (9.8%-3.4%) and severe anxiety (5.4%-0.9%) than men.

Table 2. Analysis of inter-subject variance by sex of PA and anxiety levels.

	Women	Men	Z
PA levels	1797.22± 1733.19	2,411.72 ±1,803.23	-5.57*
Anxiety levels	6.65 ±5.36	4.36 ±4.47	-6.84*

Nota. PA = physical activity.
* $p < .01$.

Regarding the main analysis, moderation effect showed in Figure 1 suggest that higher engagement in physical activity buffered the impact of COVID-19–related anxiety among male and female students. When testing the proposed moderation model, the effect that PA (W) has on the interaction between COVID-19 suspicion of infection (X) with anxiety levels (Y), a result with significant difference ($F [3,918] = 17.380$; $p < .01$) and negative (b[PA] = -0.001; $p < .01$) in the effect of PA on anxiety is obtained. This evidence suggests that subjects who practice more PA present lower levels of anxiety, while the interaction effect between COVID-19 suspicion on anxiety resulted positive and with significant difference (b[COVID-19 suspicion] = 3. 104; $p < .01$), demonstrating that those who had gone through the suspicion of a possible contagion of someone at home by COVID-19 present higher levels of anxiety. Finally, a negative effect with significant difference of the interaction between the two variables on anxiety was found (b[Suspicion COVID-19XAF] = -0.001; $p = .01$).

In Figure 1-A is possible to observe that subjects with low ($\vartheta X \rightarrow Y/M = 269.40$, $\beta = 2.97$, $p < .01$), moderate ($\vartheta X \rightarrow Y/M = 1,542.00$, $\beta = 2.33$, $p < .01$) and high ($\vartheta X \rightarrow Y/M = 4,031.60$, $\beta = 1.09$, $p = .04$) levels of physical activity, their anxiety levels are significantly higher in those who have experienced COVID-19 suspicion of infection at home compared to those who have not. However, through the results obtained using the Johnson-Neyman technique (Figure 1-B) it is possible to observe that subjects with PA values above 4,095.51 (15.62%) the effect of suspected COVID-19 at home on anxiety levels disappears.

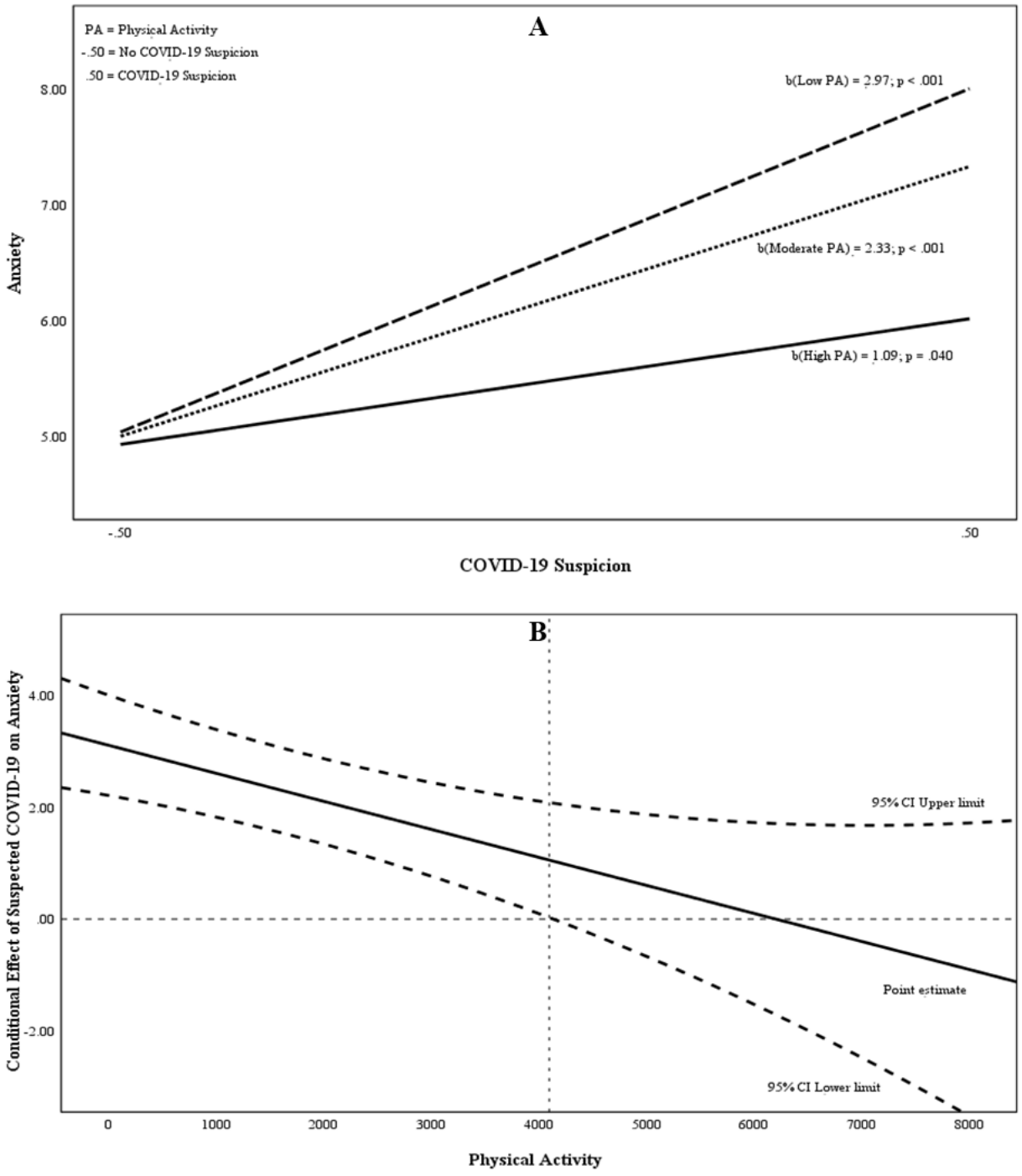

Figure 1. Moderating effect of PA level on the influence of suspected COVID-19 home infection interaction with anxiety levels in the total study sample. n = 922; PA = physical activity; Suspicious of COVID-19 = subjects who suspected a possible COVID-19 infection at home.

Table 3. Gender analysis of the moderating capacity of physical activity on the effect of fear of suspected COVID-19 at home on anxiety levels.

	Anxiety levels (*Y*)

		Women		Male		All	
		Coefficient (SD)	95% CI	Coefficient (SD)	95% CI	Coefficient (SD)	95% CI
(*X*) Suspected COVID-19 infection at home	b^1	3.2736 (0.6367)***	2.0231, 4.5241	2.2870 (0.8245)**	0.6652, 3.9088	3.1042 (0.2561)***	2.0990, 4.1094
(*W*) *Physical activity*	b^2	-0.0002 (0.0001)	-0.0004, 0.0001	-0.0002 (0.0001)+	-0.0005, 0.0000	-0.0003 (0.0001)**	-0.0005, -0.0001
X * *W*	b^3	-0.0007 (0.0003)**	-0.0012, -0.0002	-0.0002 (0.0003)	-0.0007, 0.0004	-0.0005 (0.0002)*	-0.0009, -0.0001
Constant		7.0874 (0.3183)***	6.4621, 7.7127	5.2304 (0.4122)***	4.4195, 6.0413	6.5951 (0.2561)***	6.0925, 7.0977
		R^2 = 0.0478; *F* (3, 580) = 9.7054***		R^2 = 0.0493; *F* (3, 334) = 5.7762***		R^2 = 0.0537; *F* (3, 918) = 17.3799***	

Note. + $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

Separate moderation analysis by sex (Table 3 and Figure 2) revealed, that only in women PA significantly moderates the relationship between suspicion of infection by COVID-19 at home and generalized anxiety symptoms. Figure 2-A shows that women with low (ϑX→Y/M = 64.03, β = 3.23, p < .01) and moderate (ϑX→Y/M = 1,797.22, β = 2.00, p < .01) PA, anxiety levels are higher in those who have experienced COVID-19 suspicion of infection at home compared to those who have not. Whereas in those who perform high PA (ϑX→Y/M = 3,530.41, β = 0.77, p = .23) the effect of suspected of infection by COVID-19 at home on generalized anxiety is moderated. This behavior can be seen more clearly through the results obtained using the Johnson-Neyman technique (Figure 2-B), evidencing that in women with PA values above 3,069.10 (20.89%) the significant effect of suspicion of COVID-19 at home on anxiety levels disappears.

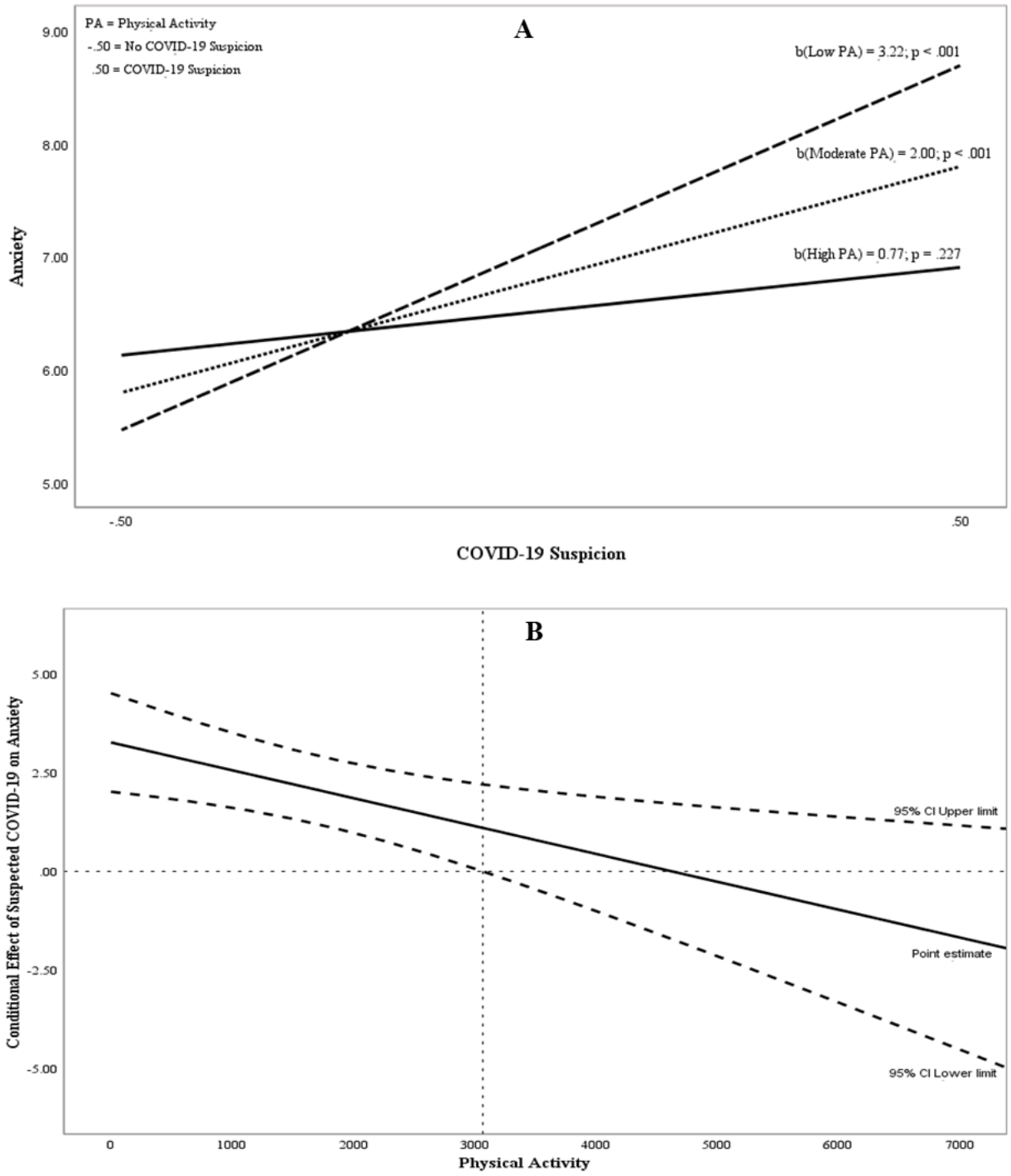

Figure 2. Moderating effect of PA level on the influence of suspected COVID-19 home infection interaction with anxiety levels in women. n = 584; PA = physical activity; Suspicious of COVID-19 = subjects who suspected a possible COVID-19 infection at home.

4. Discussion and Conclusion

The present study aimed to analyze the moderating effect of VMPA levels on the interaction between experiences during the COVID-19 pandemic and generalized anxiety levels in young university students. The main finding is the moderating effect that vigorous-level PA has on the interaction between the lived experience of the COVID-19 pandemic and levels of generalized anxiety, noting that this tendency is observed to a greater extent in females.

These results are similar to other studies. Since the beginning of the pandemic, research has been conducted regarding health impacts of PA on people's lives. Gerber et al. (22) studied the lifestyle and the impact that the pandemic caused in people hospitalized for depression, demonstrating the improvement in physical and cardiorespiratory health, as well as the increase in cognitive functions in those who performed MVPA, concluding that this can be an adjuvant in hospital treatment through comprehensive intervention achieving the objective of preventing chronic disease and reducing depressive episodes. On the other hand, during this same period, one study carried on in college students from United States (23), determined how mental health suffered a decrease, since symptoms of depression associated with social isolation increased by 64% and in a general way anxiety increased due to uncertainty about the development of professional careers. The research emphasized that universities need to have accessible clinical treatment options to mitigate the effects of the long journey that the pandemic has meaning, as well as systematize the intervention addressing the possibility of future disruptive events.

According to another study in line with our research results, MVPA is an option that contributed to the management and mitigation of mental health problems derived from the experience during the COVID-19 pandemic. In this sense, Du et al. (24) analyzed the effect of exercise at different intensities with university students on mental health, observing an increase in psychological resilience, social interaction, anxiety management and decrease, as well as self-ideation, in addition to improving cardiovascular health. Meanwhile, the scores in psychopathological traits such as somatization, compulsion, and paranoia were significantly higher in control groups. Finally, they concluded that PA at moderate intensity can favor mental health as well as promote self-training and emotional emancipation, increasing mental strength. Following this line, a study conducted in China (25) also determined the effect different intensities of physical exercise over participants mental health. Their findings indicate that college students reported low and medium intensity levels of PA (2,500 METs / week), which helps improve cognitive development and allows them to learn and preserve body coordination and synchronization. In addition, literature support that PA performed through sport can stimulate the central nervous system, improve skills of time, space, perception, and improve reaction speed and coordination of thought and intelligence (11). In relation to mental health, a large-scale study by Alizadeh (25) reports that a lifestyle strengthened by regular exercise, explained through brain physiology and the involvement of multiple body systems, has a beneficial effect on achieving mental health balance, thereby reducing the use of medications and their associated side effects.

On the other hand, it has been shown that moderate-intensity PA can effectively ameliorate negative physiological energy by decreasing symptoms of anxiety and stress (24). Using machine learning models Zhao et al. (26) measured and analyzed variables such as perceived stress, personal-emotional adjustment, as well as coping and distancing avoidance, being the variables that are more predictive of emotional adjustment during the pandemic. Thus, emotional adjustment also involves mental toughness, understood as the ability to cope with adverse situations and negative emotions, the lack of which increases the risk of experiencing anxiety. In the study by Qin et al. (27), it was demonstrated that physical activity, as a moderating variable, contributed to a more balanced psychological state in young people; in other words, MVPA was found to foster mental toughness. Based on their results, universities' need to present students with alternatives to support stress management is evident, helping them to cope with the current era of uncertainty and new challenges for the future. In this sense, moderate PA is also associated with more effective coping styles and well-being (11, 28).

In the study by Zhong et al. (29), the effects of physical activity levels on anxiety and sleep quality were examined in a population of Chinese university students. This research focused on determining the optimal dose of exercise to moderate anxiety levels. The findings demonstrated that the moderating effect of physical activity was more pronounced when intensity, duration, and frequency were higher. Specifically, students with greater levels of physical activity reported lower anxiety and better sleep quality. Our results coincided with the literature reported, finding that the moderating effect that PA has in women on the anxiety generated by the suspicion of suffering from COVID-19 at home, reinforces the relevance of PA in holistic interventions for emotional management, providing a support strategy for the reduction of symptoms related to generalized anxiety since women tend to suffer from higher levels of anxiety than men (30), this result has been similarly observed in female university athletes (31), who demonstrated a better ability to regulate their emotions compared to those who performed lower levels of PA. In

other words, PA turns out to be a protective agent for mental health.

Regarding the differences in the variance of physical activity (PA) and anxiety levels by sex observed in this study, female university students were found to engage in less physical activity and report higher levels of anxiety. However, physical activity significantly moderates the effect of suspected COVID-19 infection on generalized anxiety levels. These results are similar to previous studies, showing a higher level of anxiety, depression, perceived stress (32) and a lower level of PA in women. This may be produced by sociocultural factors such as, attending to traditional roles (being the household caregiver), patriarchal social attitudes, as well as the lack of facilities that promote PA and other psychosocial factors such perceived self-efficacy and motivation that increase the risk of chronic diseases.

The present study was not without limitations. The sampling method employed does not allow the generalization of the results for a larger population of the moderation effect of PA on generalized anxiety. Furthermore, the use of an *ad hoc* questionnaire to assess fear of COVID-19 represents a limitation in terms of the replicability of the results; however, it was deemed necessary given the unique circumstances of the global pandemic. However, the findings in the present study contribute to the strong evidence associated with differences between men and women with respect to the levels of PA they performed during the pandemic and the levels of generalized anxiety they perceived. Therefore, future studies should evaluate PA promotion intervention protocols considering some characteristics such as sex. In addition, the support of research centers of university institutions is required to strengthen spaces and psychoeducational programs based on scientific evidence to promote in the university community strategies for the improvement of their quality of life through MVPA during one of the most demanding stages of their human development, which will impact their immediate and long-term future.

The practice of MVPA is favorable for reducing anxiety levels in university students generated by the adverse situations present during the COVID-19 pandemic. In addition, it is concluded that female university students tend to perceive higher levels of anxiety and perform less PA than male students. Therefore, it is essential to promote with greater emphasis the reduction of sedentary practices through the performance of MVPA in groups of university women, since, according to the results of moderation observed in the present study, this helps to reduce the symptoms of anxiety derived from negative situations such as the COVID-19 pandemic.

Authors' Contributions

R.A.M.-B, G.H.-C. and L.F.R.-S. designed and directed the project; R.A.M.-B, G.H.-C., R.A.G.-F. and L.F.R.-S conceived and planned the method; R.A.M.-B, G.H.-C., D.K.Z.-B. and L.F.R.-S. carried out the data collection; R.A.M.-B, G.H.-C. and L.F.R.-S. analyzed the data; R.A.M.-B, G.H.-C., R.A.G.-F. and L.F.R.-S. contributed to interpreting the results; R.A.M.-B and D.K.Z.-B. took the lead in writing the manuscript with input from all authors; All authors discussed the results and commented on the manuscript; G.H.-C., R.A.G.-F. and L.F.R.-S review and edited the final version of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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