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Article

Association of Self-Reported Depression Symptoms with Physical Activity Levels in Czechia

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Abstract: Worldwide, depressive disorder is one of the leading determinants of disability-adjusted life years. Although the benefits associated with physical activity (PA), there is a lack of information related to depression, especially in countries like Czechia, where modern approaches to mental health care only recently emerged. The PA levels were associated with aspects of depression such as clinician-diagnosed history; different severities; continuous depression scores; and specific symptoms that characterize the depression. The multivariable-adjusted Poisson regression models were carried out on 2123 participants (45.3% men, median 48 years). Compared to subjects with insufficient PA, the moderate and high PA levels were inversely associated with clinician-diagnosed depression history (respectively, prevalence rate [PR]= 0.60; 95% CI 0.44-0.81 and PR=0.49; 95% CI 0.35-0.65); and with continuous depression scores (PR=0.85; 95% CI 0.75-0.97; and PR=0.80; 95%CI 0.70-0.92).; but only high PA showed association with depression categories (PR=0.75; 95%CI 0.60-0.95). Depressed mood and worthlessness were the symptoms associated with moderate and high PA. Tiredness, change in appetite, and problems with concentration only with high PA. Although only high PA was associated with depression categories, the moderate PA may be enough for slight changes in depressive symptoms, and a good strategy when starting.

Keywords: Mental Health; Depression; Physical Activity; Population Health; Adult; Middle Aged.

1. Introduction

Major depressive disorder is defined as the experience of depressed mood for at least two weeks or losing pleasure in most activities, which is not caused by a temporary medicine or medical condition[1]. Worldwide, depressive disorder is one of the leading determinants of disability-adjusted life years (DALYs)[2], affecting over 300 million subjects in 2015 (4.4%) [3]. In Europe, about 53 million adults suffer from depression, and Central and Eastern countries (CEE) report higher prevalences than other parts of Europe [3]. CEE has experienced profound structural changes since the fall of communist regimes in 1989 [4] when the concepts of health promotion and primary prevention first emerged in countries such as the Czechia [5]. Since then, numerous

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policy initiatives have emerged to improve care for people with mental illness. However, modern approaches to mental health care have emerged only recently [6] intending to provide mental health services that are achievable, of high quality, and based on needs, and providing programs for promotion, prevention, and mental health education [7]. Despite this, there is still a lack of sufficient information on the prevention of mental disorders [8].

Physical activity (PA) represents all body movements in everyday life that lead to the expenditure of energy above the resting state [9]. Although mechanisms by which exercise modulates depression remain unclear, several studies reported that higher levels of PA contribute favorably to the prevention and treatment of depression [10-12]. Although Czechia is considered an "active country" [13] of "walkers and cyclists" [14], the prevalence of physically inactive adults has increased from 37.3% in 2013 to 42.7% in 2017 [15]. Among 36 countries, Czechia had the highest and most significant association between the presence of depression and low levels of PA (Odds Ratio [16]: 6.02) [17], and evidence shows that this association is detected earlier in Czech adolescents [18].

Most of the evidence evaluating the association between depression and PA is focused on the comparisons between higher versus lower levels of PA and their impact on the incidence of depressive episodes, with a low number of studies evaluating the protective effects of a moderate to a high level of PA [19]. Additionally, comparisons among studies are not clear due to the different approaches to estimating depression. For instance, some studies base their outcomes on the presence or absence of depression from a single question, while others use validated questionnaire scores [20]. The association of PA with specific symptoms of depression is also unclear, especially considering the diversity of these symptoms (cognitive, emotional, and somatic) [21, 22].

Based on the findings, it is hypothesized that the association with physical activity levels is dependent on the different outcomes used to determine aspects of depression. Furthermore, associations differ according to the specific symptom. Therefore, this study aims to evaluate, in a probability based-sample of the Czech population, the association between PA levels and different aspects of depression such as a) clinician-diagnosed depression history based on patient's history; b) different severities of depression according to a questionnaire; c) continuous depression score from a questionnaire; and d) the association of different symptoms that characterize the depression.

2. Materials and Methods

2.1. Study Design and Population.

The Kardiovize is a cross-sectional population-based study with a random sample of 1% of the adult (25–64 years old) population of Brno, Czech Republic. Brno, the second-largest city in the Czech Republic, had 373,327 residents in 2013. The eligibility criteria included permanent residence in Brno and registration with any of the five state-run health insurance companies operating in the country, covering 91.1% of the population.

2.2. Sampling:

A random stratified sample by age and gender of 3,300 persons was adjusted for a response rate of 64.4% as projected from the Czech post-MONICA study. The MONICA (Multinational MONItoring of Trends and Determinants in CArdiovascular Disease) project, for a period of ten years or more, from the early 1980s to the mid-1990s, implemented cardiovascular disease surveillance in 21 countries. It included mortality, morbidity, coronary care, and population-based risk factor surveillance [23]. In 1997/1998, 2000/2001, 2006–2009 and 2015–2018 Czechia followed up on the MONICA

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study and conducted four additional independent cross-sectional surveys of a 1% randomly selected population sample of nine counties aged 25–64 years (Czech post-MONICA study) [24].

Health insurance companies mailed invitation letters with a description of the study, ensuring confidentiality. Because the sample size was not reached, a second random sample was done following the same methodology as the first sample. For the second invitation, 3,077 invitations were mailed. Based on the two samplings with a total of 6,377 randomly selected invitees, the overall response rate was 33.9% [2]. No information on non-respondents was available. A total of 2,160 individuals signed informed consent to participate and were enrolled in the Kardiovize study. The Kardiovize study was approved by the ethics committee of St Anne's University Hospital, Brno, Czech Republic (Ref. Number: 2G/2012).

2.3. Data Collection.

A questionnaire was developed, which includes information about demographics (e.g., age, education, and marital status), socioeconomic status, and cardiovascular risk behaviors (e.g., smoking, alcohol consumption). Laboratory analyses were performed on 12-hour fasting whole blood samples using a Modular SWA P800 analyzer (Roche, Basel, Switzerland). Glucose was analyzed by the enzymatic colorimetric method (Roche Diagnostics GmbH, Mannheim, Germany). Blood pressure was measured with the patient alone using an automated office measurement device (BpTRU, model BPM 200; Bp TRU Medical Devices Ltd., Canada). Body composition analyses were performed using a scale with bioelectrical impedance analysis capabilities (InBody 370; BIOSPACE Co., Ltd., Korea) [24]. All the informations were collected in the same period of time.

2.4. Variables Definition.

Hypertension was defined as BP ≥ 140/90 mmHg, self-reported hypertension, or use of anti-hypertensive medications. Diabetes was defined as fasting blood glucose ≥ 7 mmol/L, self-report of diabetes, or taking antidiabetic medications. The cutoff points for high body fat used were 25% for men and 35% for women. Self-reported PA was assessed using the International Questionnaire of Physical Activity (IPAQ) long version [25]. Subjects classified as "high PA" were those who participated in a vigorous-intensity activity at least 3 days per week, achieving a minimum of 1500 MET-minutes/week, or 7 days per week in any combination of walking, moderate-intensity, or vigorous-intensity activities achieving a minimum of 3000 MET-minutes/week. Subjects classified as "moderate PA" were those who participated in at least 20 minutes of vigorous physical activity 3 or more days per week, or at least 30 minutes of moderate-intensity physical activity or brisk walking 5 or more days per week, or 5 or more days per week of any combination of walking, moderate-intensity, or vigorous-intensity activities, achieving a minimum of 600 MET-min/week. Subjects classified as "insufficient PA" were those who did not reach the activity levels listed above. The weekly MET minutes were calculated by multiplying the MET factor assigned to each activity (walking = 3.3 MET, moderate-intensity activity = 4.0 MET, vigorous-intensity activity = 8.0 MET) by the duration (in minutes) and the number of days that the respective activity was performed (ref).

Marital status was classified as "living alone" (including single, divorced, and widowed) or "living in a couple" (including married and other partnerships). Educational level was classified as primary, secondary, and higher (representing the highest level achieved). Household income was expressed in Euros per month and classified as "low" (<1200), "middle" (1200-1800), or "high" (>1800). Smoking status was classified as "Non-smokers" or "current smokers" (smoking in any amount during the past year). Alcohol consumption was assessed by the reported alcohol intake of the last week, expressed in

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the number of standard drinks. One standard drink contained approximately 10 g ethanol (100-125 ml of wine, 250 ml of beer, or 30 ml of spirits [26]. Participants were classified as "non-alcohol users" (including abstainers and those who did not drink in the previous 12 months) and "alcohol users"[24].

2.5. Outcomes of Depression.

The clinician-diagnosed depression history [20] was assessed through the question: "Have you ever been diagnosed with depression?". Depressive symptoms were assessed by the Patient Health Questionnaire (PHQ-9), a nine-item questionnaire designed to screen for depression [27]. The PHQ-9 consists of nine questions that assess the presence of each of the symptoms of the episode of depression, described in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). The nine symptoms consist of depressed mood, anhedonia (loss of interest or pleasure in doing things), problems with sleep, tiredness or lack of energy, change in appetite or weight, feelings of guilt or worthlessness, and problems with concentration, feeling slow or restless and suicidal thoughts. The frequency of each symptom in the last two weeks is evaluated on a 4-point Likert scale from 0 to 3, corresponding to the answers "Not at all," "Several days," "More than half the days," and "Nearly every day," respectively. PHQ-9 final score ranges from 0 to 27; a score of less than 5 suggests no depression, and a score of 5 or higher indicates depression. A total score of 5 to 9 suggests mild depression; a score of 10 to 14 suggests moderate depression, 15 to 20 suggests moderately severe depression, and a score higher than 20 suggests severe depression.

2.6. Data analysis.

Analyses were done with STATA software (version 14.0, StataCorp, College Station, TX, USA). The Kolmogorov-Smirnov test was used to assess the normal distribution of variables. Continuous variables were reported as the median and range and compared using the Mann-Whitney U test. Categorical variables were reported as percentages and compared using the chi-squared or Fisher test. The depression outcomes were determined in four different approaches: 1) clinician-diagnosed depression history of depression (presence or absence); 2) the classification of depression in different categories (categories with a sample size ≤1% were merged with another category to improve clinical generalizability of findings); 3) the total score from the PHQ-9 (0-27) and; 4) each symptom of PHQ-9 separately (0-3). The Poisson regression model was used to test for the presence or absence of depression, and the categories of each symptom as counts or frequency. For the total PHQ-9 score, a zero-inflated Poisson regression was used to model count data with an excess of zero counts. For all the analysis, a generalized Poisson model using robust error variances was applied to estimate appropriately narrow 95% Confidence Intervals (CI) of raw and adjusted Prevalence Rates (PR). The variables included in the full model were age [28], gender [29], educational level [30], household income [31], living in couple [31], alcohol use [32], high body fat percentage [33] and diabetes [34]. Age and gender were included in model 2 and all the variables in model

3. Results.

3.1. Subject's characteristics.

In total, 2123 subjects that answered the questions about depression were included (45.3% men), with a median age of 48.0 (IQR 19.0) years. The prevalence of depression history was 11.8 %. Females, older age, low household income, no living in couple, and lack of alcohol consumption were associated with a history of depression (Table 1). The figure 1 shows the statistically difference among physical activity levels. The total prevalence of depression categories was mild 21.4 %, moderate 4.4 %, and severe 2.1 %. For

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analysis, the moderately severe and severe depression categories were merged into a single group because of the small size of the individual groups (1%). Mild and moderate depression were higher in women than men (p <0.001), in subjects without alcohol consumption (p = 0.041), with diabetes (p = 0.034), not living in couple (p = 0.001), and with lower income (p = 0.013) (Table 2). There was only statistically difference between Insufficient and High physical activity level (Figure 2).

Table 1. Population Characteristics and Clinician-diagnosed Depression History

	History	p
Gender		
Male	6.7%	
Female	16.1%	<0.001
Age Categories		
25-34	7.5%	
35-44	11.4%	
45-54	10.6%	
55-64	15.5%	0.001
Educational Level		
Primary	13.4%	
Secondary	11.9%	
Higher	11.0%	0.461
Household income (Euro)		
Low (<1200)	16.4%	
Middle (1200-1800)	8.6%	
High (>1800)	8.4%	<0.001
Living in Couple		
No	15.6%	
Yes	9.5%	0.002
Alcohol Users		
No	16.9%	
Yes	10.9%	0.002
Smokers		
No	10.8%	
Yes	12.9%	0.134
High Body Fat Percentage		
Absent	11.1%	
Present	13.5%	0.118
Diabetes		
Absent	11.8%	
Present	12.3%	0.764
Hypertension		
Absent	12.0%	
Present	11.6%	0.802

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Cardiovascular Disease History		
Absent	11.9%	
Present	10.1%	0.544

Continuous variables are median and IQR. Mann Whitney U test was used to determine different medians. The Chi-square test was used to determine different proportions.

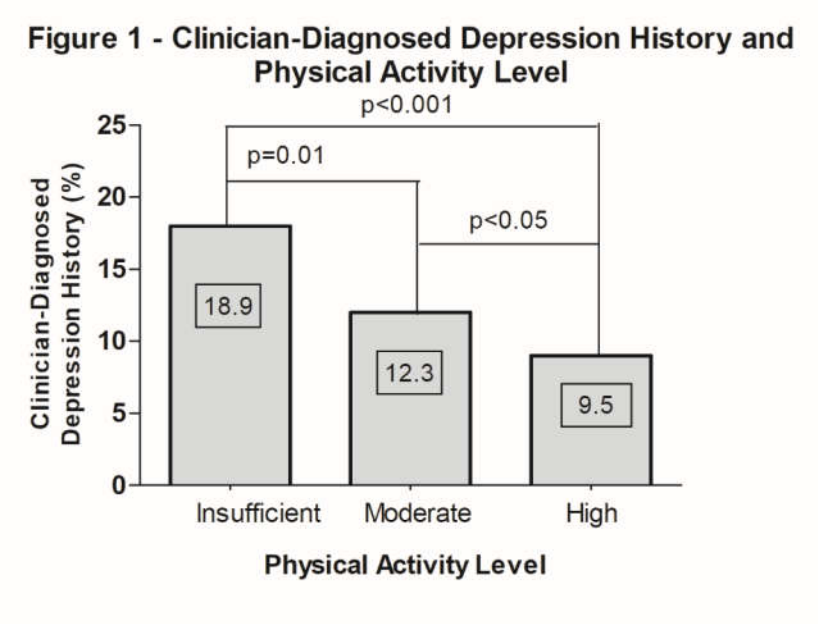

Table 2. Population characteristics across depression categories (n = 2123)

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	No Depression (n = 1531)	Mild Depression (n = 454)	Moderate Depression (n = 94)	Severe Depression (n = 44)	p
Gender					
Male	76.4%	18.8%	2.6%	2.2%	
Female	68.6%	23.5%	5.9%	2.0%	<0.001
Age Categories					
25-34	66.6%	24.5%	6.3%	2.6%	
35-44	73.9%	20.3%	3.4%	2.4%	
45-54	70.4%	22.2%	5.5%	1.9%	
55-64	75.0%	19.9%	3.4%	1.6%	0.119
Educational Level					
Primary	66.3%	25.6%	5.6%	2.4%	
Secondary	73.6%	20.2%	3.8%	2.4%	
Higher	73.6%	20.5%	4.5%	1.4%	0.083
Household income (Euro)					
Low (<1200)	69.4%	22.0%	5.8%	2.8%	
Middle (1200-1800)	73.4%	21.4%	3.8%	1.4%	
High (>1800)	76.3%	19.6%	2.5%	1.6%	0.013
Living in Couple					
No	69.5%	21.7%	5.7%	3.0%	
Yes	73.7%	21.2%	3.6%	1.5%	0.001
Alcohol Users					
No	67.2%	24.8%	6.5%	1.5%	
Yes	73.1%	20.7%	4.0%	2.2%	0.041
Smokers					
No	72.3%	21.6%	4.2%	1.8%	
Yes	71.5%	20.8%	5.2%	2.6%	0.56
High Body Fat Percentage					
Absent	73.4%	20.1%	4.2%	2.3%	
Present	69.0%	24.5%	4.8%	1.7%	0.087
Diabetes					
Absent	72.7%	20.8%	4.4%	2.1%	
Present	61.8%	31.8%	5.4%	0.9%	0.034
Hypertension					
Absent	72.6%	20.3%	4.6%	2.4%	
Present	71.7%	23.1%	4.1%	1.6%	0.305
Cardiovascular Disease History					

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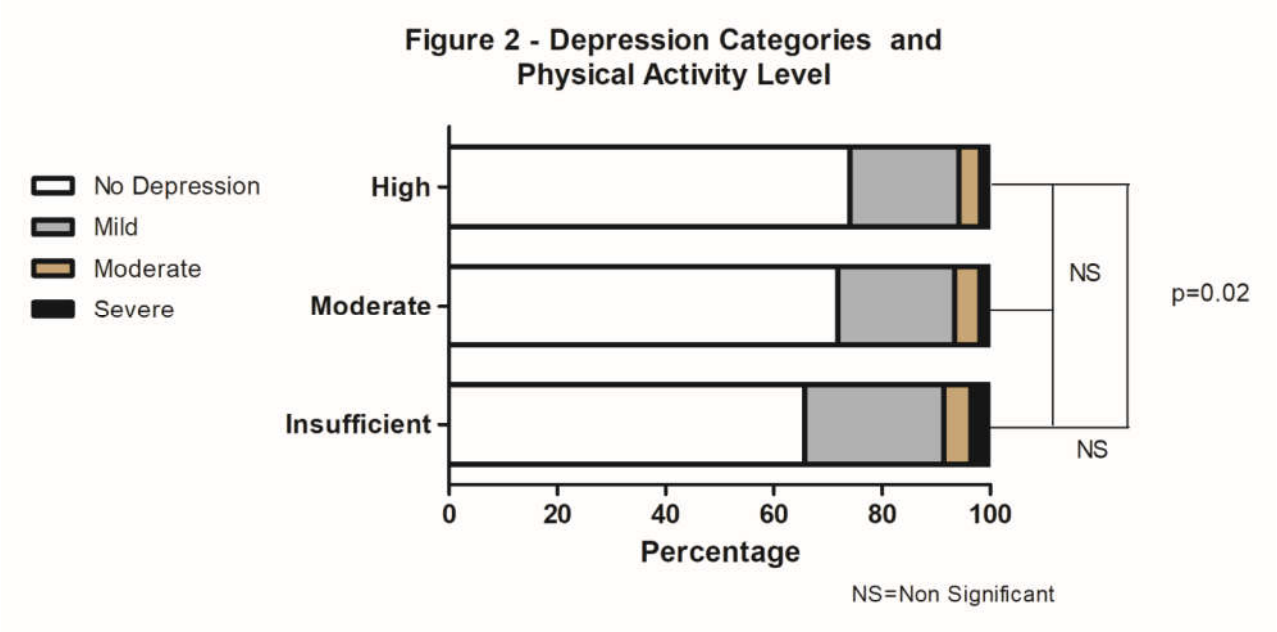
Absent	72.3%	21.2%	4.4%	2.0%	
Present	68.9%	24.4%	4.2%	2.5%	0.839

The Chi-square test was used to determine different proportions.



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Median PHQ-9 scores were 2 points in males and 3 points in females ($p < 0.001$). The score was also higher in subjects between 25 to 44 years old, in those with primary education, low household income, not living in a couple, lack of alcohol consumption, and having a high body fat percentage (Table 3). The figure 3 highlights the difference between insufficient and high physical activity.

Table 3. Population Characteristics across PHQ-9 Scores

	PHQ-9 (Score Median Range)	p
Gender		
Male	2.0 (0-20)	
Female	3.0 (0-23)	<0.001
Age Categories		
25-34	3.0 (0-20)	
35-44	3.0 (0-19)	
45-54	2.5 (0-23)	
55-64	2.0 (0-23)	0.023
Educational Level		
Primary	3.0 (0-23)	
Secundary	2.0 (0-23)	
Higher	2.0 (0-20)	0.002
Household income (Euro)		
Low (<1200)	3.0 (0-23)	
Middle (1200-1800)	2.0 (0-18)	
High (>1800)	2.0 (0-19)	<0.001
Living in Couple		
No	3.0 (0-23)	
Yes	2.0 (0-19)	0.002
Alcohol Users		
No	3.0 (0-18)	
Yes	2.0 (0-23)	0.006
Smokers		
No	2.0 (0-23)	
Yes	2.0 (0-23)	0.591
High Body Fat Percentage		
Absent	2.0 (0-23)	
Present	3.0 (0-20)	0.002
Diabetes		
Absent	2.0 (0-23)	
Present	3.0 (0-14)	0.370
Hypertension		

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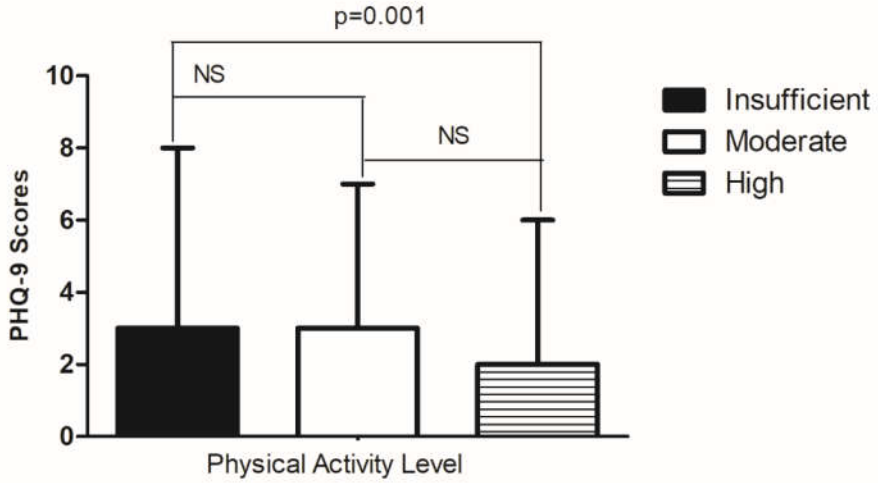
Absent	2.0 (0-23)	
Present	2.0 (0-23)	0.443
Cardiovascular Disease History		
Absent	2.0 (0-23)	
Present	3.0 (0-17)	0.312
Mann Whitney U test was used to determine different medians.		

Figure 3 -Patient Health Questionnaire-9 (PHQ-9) Scores (Median, Interquartile) and Physical Activity Level



3.2. Adjusted Association between Physical Activity Level and Depression

History of depression was inversely associated with higher levels of PA compared to subjects with insufficient PA (Table 4). The moderate PA levels had 35% lower PR in the raw model (PR-0.65; 0.48-0.88), 42% lower adjusting by age and gender (model 2) (PR-0.58; 0.43-0.78) and 16% lower in the full model (model 3) (PR-0.84; 0.66-0.82). The high level of PA presented 50% lower PR similarly in model 1 and model 3 and 53% lower in model 2 (PR-0.47; 0.35-0.63).

In the raw model, a high level of PA had an inverse association with the depression categories (PR-0.72; 0.58-0.91). In model 2, a high level of PA had 30% lower PR (0.70; 0.57-0.87) than subjects with insufficient PA. In addition, a high level of PA had 25% lower PR (0.75; 0.60-0.95) than subjects with insufficient PA (model 3). A significant association was found between moderate PA levels and depression categories in models 1 and 2. However, in model 3, the moderate PA levels were not significant.

Regarding the depression (PHQ-9) scores, moderate PA had an inverse association, with significantly lower values (from 15% to 18%) in PR, suggesting the importance of moderate PA to influence small changes in depression levels even though it was not enough to change the depression categories. High PA level was also significantly associated with the depression score (PR decreasing from 21% to 23%) (Table 4).

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Table 4. Association between Physical Activity Level and Depression Outcomes

	Physical Activity Level# and clinician-diagnosed depression history		
Physical Activity Level	Model 1	Model 2	Model 3
	PR (95% CI)	PR (95% CI)	PR (95% CI)
Insufficient	1	1	1
Moderate	**0.65** (0.48-0.88)**	**0.58*** (0.43-0.78)**	**0.60*** (0.44-0.81)**
High	**0.50*** (0.37-0.68)**	**0.47*** (0.35-0.63)**	**0.49*** (0.35-0.65)**
	Physical Activity Level# and depression categories		
Physical Activity Level	Model 1	Model 2	Model 3
	PR (95% CI)	PR (95% CI)	PR (95% CI)
Insufficient	1	1	1
Moderate	**0.80* (0.63-0.99)**	**0.75* (0.60-0.94)**	0.84 (0.66-1.06)
High	**0.72*** (0.58-0.91)**	**0.70*** (0.57-0.87)**	**0.75* (0.60-0.95)**
	Physical Activity Level# and PHQ-9 Scores		
Physical Activity Level	Model 1	Model 2	Model 3
	PR (95% CI)	PR (95% CI)	PR (95% CI)
Insufficient	1	1	1
Moderate	**0.85* (0.74-0.97)**	**0.81** (0.71-0.93)**	**0.85* (0.75-0.97)**
High	**0.80** (0.70-0.91)**	**0.78*** (0.68-0.88)**	**0.80** (0.70-0.92)**

#Low level as the reference; *<0.05;**<0.01;***<0.001; Model 1 - raw model; Model 2 - adjusted by age categories and gender; Model 3 - adjusted by age categories, gender, educational level, household income, living in couple, alcohol users, high body fat percentage and diabetes; PR-Prevalence Ratio; CI-Confidence Interval

3.3. Association between Physical Activity Level and PHQ-9 Items

Compared with the low level of PA, "feeling down", "depressed", or "hopeless" was 34% and 41% lower in the moderate and high PA levels, respectively, and "feeling bad about yourself" was 26% and 34% lower in those with moderate and high levels of PA, respectively (Table 5). In turn, only those with high PA levels had significantly lower PR of "feeling tired" (24%), "poor appetite or overeating" (25%), and "trouble concentrating" (29%), but not those with moderate levels of PA (Table 5).

Table 5. Association between Physical Activity Level and PHQ-9 Items

	Physical Activity Level#	
	Moderate	High

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	PR (95% CI)	PR (95% CI)
"Little interest or pleasure in doing things"	0.90 (0.73-1.12)	0.83 (0.67-1.06)
"Feeling down, depressed, or hopeless"	**0.66 (0.48-0.91)**	**0.59 (0.44-0.81)**
"Trouble falling or staying asleep, or sleeping too much"	0.96 (0.80-1.16)	0.97 (0.81-1.16)
"Feeling tired or having little energy"	0.89 (0.78-1.08)	**0.86 (0.76-0.98)**
"Poor appetite or overeating"	0.80 (0.61-1.06)	**0.75 (0.57-0.98)**
"Feeling bad about yourself or that you are a failure or have let yourself or your family down"	**0.74 (0.56-0.98)**	**0.66 (0.51-0.86)**
"Trouble concentrating on things, such as reading the newspaper or watching television"	0.84 (0.64-1.10)	**0.71 (0.54-0.94)**
Moving or speaking so slowly that other people could have noticed. Or the opposite, being so fidgety or restless that you have been moving around a lot more than usual	0.68 (0.43-1.08)	0.69 (0.44-1.08)
"Thoughts that you would be better off dead, or of hurting yourself"	0.96 (0.36-2.51)	0.64 (0.24-1.70)

#Low level as the reference; PHQ - Patient Health Questionnaire; PR-Prevalence Ratio; CI-Confidence Interval

4. Discussion

The analysis showed an inverse relationship between moderate and high PA levels with clinician-diagnosed depression history and depression scores. However, only high PA levels were inversely associated with depression categories after all adjustments. Regarding specific symptoms, moderate and high levels of PA were related to a few depression symptoms. The present findings suggest that high levels of PA seem to contribute to a lower prevalence of 5 out of 9 specific depression symptoms.

Exercise guidelines suggest PA with a focus on general health benefits [16, 35]. In this study, a dose-response relationship between PA and depressive symptoms was observed and should be considered for public health policies of management and prevention of depression. The combination of frequency, intensity, time, and type [35] should result in a high PA level to provide a significant improvement in depressive symptoms. For example, Helgadottir et al. [36] conducted a randomized controlled trial to investigate the effect of different exercise intensities (low, moderate, and high) on depression severity. The results indicated that all exercise conditions attenuate the depression severity compared to control. Still, the isolated effect of exercise intensity may not be sufficient to provide improvements for depressive patients. Byeon [37] showed that flexibility exercise reduced the risk for depression, indicating that the type of PA might also be associated with depressive symptoms. Additional aspects related to mental health have to be considered to improve moods, such as mastery, social interaction, distraction, and environment [38, 39]. In a practical setting, individuals should be encouraged to perform moderate levels of PA to promote small changes in depression levels (as indicated by the PHQ-9), but larger changes (especially across depression categories) seem to be achieved only with high PA levels.

The PA is thought to have its antidepressant effect through multiple biological and psychosocial pathways, and it could influence depression in two ways: with a preventive

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value (it is used to protect against the development of depressive symptoms) and as a "treatment"[40]. Changes occur in the brain to produce an environment that is protective against depression. For instance, cellular processes such as angiogenesis are stimulated by neurotrophins causing changes in brain blood flow that improves functioning [12]. The other theory would be related to the endorphin effect. β-endorphins have a similar effect to morphine, which can reduce the sensation of pain and produce a state of euphoria [41]. Depression is also related to impaired transmission at some central aminergic synapses, due to defects in the production, transfer, or loss of amines. There is also the biological hypothesis that physical exercise associated with treatment promotes the improvement of the alteration of one or all brain monoamines (such as serotonin and norepinephrine) since these substances are neurotransmitters (as are dopamine and endorphin) and are related respectively to satisfaction, pleasure, sleep, mood, appetite, etc. [42]. Also, psychosocial factors accompany and interact with these biological changes to influence depression, such as the distraction of stressful stimuli, better self-esteem, greater control over your body and your life, and social interaction - provided by living with other people [43].

Three negative factors (feeling tired, poor appetite or overeating, and trouble concentrating) of PHQ-9 were lower in individuals who reported high levels of PA. Similar results were observed by Stewart et al.[44], who verified that higher cardiorespiratory fitness (maximal oxygen uptake) resulted in lower levels of anger and total mood disturbance, indicating an inverse relationship between negative mood and cardiorespiratory fitness. Therefore, it seems that PA level is associated with specific negative factors related to depression symptoms; however, future studies are needed to confirm which factors are more susceptible to changes provided by the increase in PA levels.

Some limitations should be considered in the interpretation of this study. The IPAQ questionnaire is not specific concerning the exercise type, only PA performed continuously for at least 10 minutes is considered in IPAQ [25]. Therefore, activities with interval characteristics such as resistance exercise may not be appropriately recorded despite their benefits for depression [45]. On the other hand, the use of questionnaires for PA estimation is necessary for epidemiological studies due to the large sample size. No control for depression dosage medication was done. Thus, people with depression under the use of medications could be included in the sample and influence the results. Also, the PHQ-9 does not replace a professional diagnosis, but it has a sensitivity, compared with semistructured reference standards, substantially greater [46]. The cross-sectional design is another limitation because it does not allow a causal relationship, and the relationship between PA and depression is bidirectional.

5. Conclusions

In conclusion, the present study showed that PA levels have an inverse relationship with depressive symptoms. In this sense, it seems that only high levels of PA are sufficient for people intending changes among depression categories, however, moderate PA levels may be enough for slight changes in depressive symptoms, and a good strategy in the beginning. Despite the abovementioned limitations, this epidemiological study was conducted with a large sample using simple instruments to identify depressive symptoms and PA levels, which may be used by health professionals. Therefore, this study has practical implications for health professionals and public health policies that should emphasize the attainment of, at least, a moderate level of PA for people with self-reported depression.

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