

Physical Activity and Prevention of Depressive Symptoms in the Spanish Population During Confinement due to COVID-19

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Abstract

Background: In March 2020, the Spanish government established an official lockdown across the country in response to the COVID-19 pandemic and confined the population to their homes, restricting their mobility. The objectives of the study are twofold: a) to examine dose-response relationships between physical activity (PA) components (volume, intensity, frequency, duration) and depressive symptoms of the population during confinement, and b) to identify the optimal levels of PA to mitigate notable depressive symptoms (NDS). **Methods:** 4,811 (2,952 women) Spanish citizens, age range 16-92 years, completed an online questionnaire (snowball sampling) to measure their levels of depressive symptoms, PA, and various anthropometric and sociometric variables. Volume (METs-min/week), frequency (days/week), and duration (hours) were examined using logistic regressions with restricted cubic splines. **Results:** The PA components were inversely associated with NDS. Performing at least 477 METs-min/week was associated with a 33% decrease in probability of NDS, and reaching 3,000 METs-min/week was associated with the lowest risk of NDS (47%). As for frequency, with 10 times/week the probability of NDS was 56% lower. At 10 hours of weekly practice, the probability of NDS was 39% lower. **Conclusions:** A range and optimal amount of PA is suggested to reduce the appearance of SDN during confinement.

Keywords: COVID-19; mental health; depression, quarantine, physical activity.

Resumen

Actividad Física y Prevención de Síntomas Depresivos en Población Española durante el Confinamiento por COVID-19. Antecedentes: en marzo de 2020 el gobierno español decretó el estado de alarma debido a la pandemia por COVID-19 y confinó a la población. Los objetivos son dos: a) examinar las relaciones dosis-respuesta entre los componentes de actividad física (AF: volumen, intensidad, frecuencia y duración) y los síntomas depresivos de la población durante el confinamiento, y b) identificar los niveles óptimos de AF para mitigar los síntomas depresivos notables (SDN). **Método:** 4.811 (2.952 mujeres) ciudadanos de España, de 16 a 92 años respondieron a un cuestionario on line (muestreo de bola de nieve) para medir sus niveles de síntomas depresivos, AF, y variables antropométricas y sociométricas. El volumen (METs-min/sem), la frecuencia (días/sem) y la duración (horas) se examinaron mediante regresiones logísticas con splines cúbicas restringidas. **Resultados:** los componentes de AF se asociaron inversamente con las probabilidades de SDN. La realización de 477 METs-min/sem se asoció con una disminución del 33% en las probabilidades de SDN, y alcanzar 3.000 METs-min/sem se asoció con el menor riesgo de SDN (47%). En cuanto a frecuencia, con 10 días/sem las probabilidades de SDN fueron un 56% más bajas. A las 10 horas de práctica semanal, las probabilidades de SDN fueron un 39% más bajas. **Conclusiones:** se sugiere un rango y cantidad óptima de AF para reducir la aparición de SDN en confinamiento.

Palabras clave: COVID-19; salud mental; depresión, cuarentena, actividad física.

Coronavirus disease (COVID-19) continues to spread worldwide. The pandemic affects more than 19,380,000 people, of whom more than 721,411 have passed away. In Spain, more than 314,362 tested positive for COVID-19 and 28,500 have died. On March 15, 2020, health authorities in Spain established the confinement in their homes of the entire Spanish population to avoid infection (Spanish Government, 2020). Sudden lockdown is the best option but implies changes in entire lifestyle of the population, including reduction in their physical activity (PA).

During quarantine, individuals were allowed to leave their homes only for a few and strict reasons (e.g., buy food, walk the pet...).

Brooks et al. (2020) and Duan and Zhu (2020) predicted an increase in psychological problems during this epidemic, including anxiety, depression, and stress. Stressors include both direct causes (fear of infection, frustration, length of quarantine, inadequate information, boredom), and indirect causes (social and economic chaos, stigmatization or inadequate supplies). Some researchers have suggested lasting effects (Wind et al., 2020). Empirical evidence indicates that having relatives or acquaintances infected with COVID-19, home economy and the effects on daily life (such as delays in academic activities) are positively associated with anxiety symptoms (Cao, Fang et al., 2020). Depressive symptoms manifest in many elements of daily life, including appetite, interest, energy level, mood, psychomotor behavior, sleep, and even suicidal intent (Turecki & Brent, 2016). An estimated 1.1 million

adults in the United States have depressive symptoms, although they never felt depressed (Cao, Hu et al., 2020). Up to 16% of adults reportedly experience depressive symptoms (Blazer, 2003), and depressive disorders are usually more frequent in women than in men (Seedat et al., 2009).

Physical activity is related to greater well-being, better cognitive functioning, and a decrease in depression and anxiety. Specifically, PA reduces the severity, the risk of onset, and the relapse of depression (Currier et al., 2020). The relationship between PA and depression appears to be two-way: depressed people tend to be less active, while lower levels of PA increase the risk of depression (Schuch et al., 2017).

However, the findings regarding the protective effect of PA against depression in terms of duration and intensity fluctuate and are inconsistent. Evidence has shown that, compared to sedentary behavior, any type of PA/week (from 20 to 420 min/week) reports benefits for mental health (Harvey et al., 2018; Teychenne et al., 2008; Mammen & Faulkner, 2013). The World Health Organization (WHO, 2010) recommends doing at least 150 minutes of moderate activity or 75 minutes of vigorous activity/week to obtain beneficial, in general, physical and mental well-being. If these ranges are converted to METs-min / week, the WHO recommended PA level for the adult population 18-64 years is 600 METs-min / week. Those guidelines list specific physical health conditions for which PA is beneficial, but generally do not identify specific mental health conditions.

Ku et al. (2018) concluded that although LPA (light) and MVPA (moderate and vigorous) were associated with a reduced risk of depressive symptoms in the elderly, LPA is a stronger predictor than MVPA in this age cohort. Pavey et al. (2013) concluded that doing MVPA does not have significant additional benefits in terms of depressive symptoms in women, above those obtained by MPA (moderate) alone, except in very high levels of PA.

Recently, Kim et al. (2018) suggested that the range of PA to obtain a preventive or treatment effect for depression is wide. The lower end of this range is the minimum PA recommendations (600 METs-min/week), and the upper end would be 15 times the recommended minimum (9000 METs-min/week). This study established a U-shaped dose-response relationship between physical activity and depression, with individuals participating at 2-3 times the minimum recommended (1200-1800 METs-min/week) showing the strongest association with reduced depression. Along the same lines, the results of the study by Kim et al. (2019) showed that, compared to the sedentary state (<600 METs-min/week), reaching 1200-3000 METs-min/week was associated with a lower risk of incidents of depressive symptoms, which also illustrates a U-shaped relationship.

The objectives of the study are twofold: a) to examine dose-response relationships between PA components (volume, intensity, frequency, duration) and depressive symptoms of the population during confinement, and b) to identify the optimal levels of PA to mitigate notable depressive symptoms.

Method

Participants

A total of 4,811 (2,952 women, *Age* = 43.24, *SD* = 15.64, and 1,859 men, *Age* = 40.48, *SD* = 14.90) citizens from all regions of Spain participated, aged between 16 and 92 years. Participation

was distributed as follows: first week *n* = 1,413 (873 women and 540 men), second week *n* = 1,420 (962 women and 458 men), third week *n* = 1,083 (593 women and 490 men), fourth week *n* = 895 (524 women and 371 men).

Instruments

The International Physical Activity Questionnaire (IPAQ). It is an instrument originally developed for cross-national monitoring of PA and inactivity (Craig et al., 2003). The measurement properties of IPAQ are very acceptable, being as accurate as other established self-reports. The IPAQ has shown reasonable measurement properties for monitoring population levels of PA among 18 to 65 years old adults in diverse situations (Craig et al., 2003). In the present study, we used the IPAQ short form (IPAQ-SF) "last 7 days recall" which is recommended for national monitoring (Craig et al., 2003). This version provides information about the time spent being involved in three intensity levels of PA: 1) walking, 2) moderate PA, and 3) vigorous PA; including the time spent doing sedentary activities (i.e., inactivity). However, the inactivity level was not included in this work. To measure the intensity of PA, it is commonly used as a continuous indicator known as MET (Metabolic Equivalent of Task). It allows us to classify the intensity of PA in low, moderate, or high. The METs are a system to calculate the energy requirements for PA. One MET is defined as 1 Kcal/Kg/hour which is the equivalent of the energy needed for the basal metabolic rate. METs can be calculated by a multiplication of the corresponding MET of some type of activity by the minutes of executing it during a day or a week. In this paper, the different levels are expressed as METs-minutes/week of vigorous activity (METs-V), moderate activity (METs-M), and walking (METs-W).

The data resulting from the psychometric analysis indicated that the IPAQ has reasonable properties to monitor PA levels in people 18 years old. For the short version of IPAQ, 75 % of the observed correlation coefficients were above 0.65 with ranges between 0.88 and 0.32 (*r* = .76, 95% CI .73-.77). The availability of IPAQ in Spanish was obtained at the website www.ipaq.ki.se. Rodríguez-Muñoz et al. (2017) assessed and verified the Spanish IPAQ-SF reliability for measuring PA levels for both high school and university students (*r* = .49, *p* < .001).

MET Values and Formula for Computation of MET-minutes/week. The selected MET values were derived from work undertaken during the IPAQ Reliability Study undertaken in 2000-2001. Using the Ainsworth et al. (2000) Compendium an average MET score was derived for each type of activity. For example; all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. The following values continue to be used for the analysis of IPAQ data: Walking = 3.3 METs, Moderate PA = 4.0 METs, and Vigorous PA = 8.0 METs. Using these values, four continuous scores were defined:

Walking METs-minutes/week = 3.3 × walking minutes × walking days.

Moderate METs-minutes/week = 4.0 × moderate-intensity activity minutes × moderate days.

Vigorous METs-minutes/week = 8.0 × vigorous-intensity activity minutes × vigorous-intensity days.

Total physical activity METs-minutes/week = sum of Walking + Moderate + Vigorous METs-minutes/week scores.

The following variables were used in the present study: *Frequency* or days per week in which each type of PA was performed (vigorous, moderate or light); *Duration* or time (hours) per week in which PA was performed (vigorous, moderate or light) and *Volume* or METs-minutes/week, based on the next formula: (Walking METs-minutes/week \times 3.3) + (Moderate METs-minutes/week \times 4) + (Vigorous METs-minutes/week \times 8).

Depressive Symptoms. The Spanish version (Cecchini et al., 2019) of the six-item self-report scale developed by Kandel and Davies (1982) was used. Participants respond to the stem: "During the past 12 months, how often...". The six questions are related to social activities that may affect their health. Participants have to indicate whether the situation occurs "often", "sometimes", "rarely" or "never" (1-4). To address the goal of this study, this root was modified to match the time of confinement: "During the last week of isolation, how often..." for each question (e.g., "...have you felt too tired to do things?"). Previous studies have reported an acceptable reliability of the scale in Spanish university populations (Cronbach's alpha = .72, .84, respectively; Cecchini et al., 2015; 2019), and adolescent girls (Cronbach's alpha = .72; Cecchini et al., 2020). In this research Cronbach's alpha was .83 for the entire scale. The responses to the elements are added together to produce an overall depressive symptom score ranging from 6 to 24 points. Following Choi et al. (1971), the scores were increased in 10 points to produce a range between 16 and 34 points such that participants achieving a score of 29 or higher are defined as having notable depressive symptoms.

Anthropometric parameters. Participants' height and current weight were requested. Based on this information, individual's body mass index was calculated using the following formula: weight (kg) / [height (m)]² and these categories: underweight < 18.5, normal weight: 18.5-24.9, overweight: 25.0- 29.9, and obese: \geq 30.0. (Centers for Disease Control and Prevention, 2020).

Sociometric information. Questions were included in the survey to obtain additional information: sex, age, as well as personal *ad-hoc* questions with pre-confinement reference: "Did you do exercise (i.e., run, swim, play tennis, aerobic, strength training...) regularly (at least to times a week)? How much exercise per week? And during confinement: "How many days have you been shelter at-home? Have you been out on the streets?"

Procedure

First, permission to conduct the study was obtained from the researchers' State Ethics Research Committee. A cross-sectional study was carried out during the confinement phase due to the coronavirus pandemic (Spanish Government, 2020); from March 19, 2020, to April 18, 2020 (end of the first phase of the alarm state). The affected population was contacted by email, Facebook, WhatsApp, and Twitter to invite them to complete an online questionnaire. Participants could read on the first page of the questionnaire that their responses would be anonymous and could withdraw from the questionnaire at any time since participation was voluntary. To advance in the questionnaire, the participants had to expressly accept a clause on the first screen with their informed consent.

Data Analysis

Dose-response relationships between physical activity components and depressive symptoms. Sex, age, BMI, pre-

confinement PA, and METs-minutes/week performed in confinement by participants with and without current symptoms of significant depression were compared using contingency tables and chi-square association tests (χ^2). A binary logistic regression model was estimated with the current depressive symptoms (notable depressive symptoms: 0 = Yes, 1 = No) and as result compliance with METs-minutes/week presented in quartiles (25, 50, 75) that are adjusted for all the other covariates (see Table 1).

Three restricted cubic spline models were adjusted to evaluate the linearity of the relationship between depressive symptoms with: a) METs-minutes/week (Volume), b) days/week of vigorous PA, moderate PA and light PA (Frequency), and c) the hours/week of vigorous PA, moderate PA or light PA (Duration). Cubic splines are generally defined as piecewise polynomial line segments whose function values and first and second derivatives coincide at the limits where they meet. The boundaries of these segments are called nodes, and the fitted curve is continuous and smooth at the boundaries of the nodes (Smith, 1979). To avoid the instability of the fitted curve at the ends of the covariate, the strategy of restricting the curve to be a straight line before the first knot or after the last knot was used (Orsini & Greenland, 2011). Three splines were generated using knots at 20, 40, 60, and 80 percentiles to produce a smooth fitted curve (Currier et al., 2020).

Optimal levels of physical activity to mitigate notable depressive symptoms. In each model an isotemporal substitution model was calculated (Mekary et al., 2009) in which the intensities of vigorous PA, moderate PA, and light PA were replaced, one by one, keeping constant the total PA. The isotemporal substitution model, by definition, combines the effect of replacing one type of PA with another type of PA with the same amount of time. As with the previous analysis, restricted cubic spline models were fitted (Currier et al., 2020). For example, the spline coefficients for hours of vigorous PA represent the effect of substituting moderate PA for hours of vigorous PA/week for depressive symptoms, adjusting for all covariates. If any substitution model is not significant, a partition model will be tested (Mekary et al., 2009). In this model, the coefficient for one type of PA represents the effect of increasing this type of PA while keeping other types of PA constant. Therefore, it represents the effect of adding, rather than sub-creating, a type of PA. It should be noted that the total time does not remain constant, so this model is not isotemporal.

Results

Dose-response relationships between physical activity components and depressive symptoms

Table 1 presents a comparison of the quartiles of METs-minute / week, sex, age, the practice of physical-sports activity before confinement, and BMI. The number of participants with notable depressive symptoms decreased progressively as METs increased (quartiles 1-4). After adjusting for possible confounding variables, achieving at least 477 METs-minutes/week was associated with a 33% decrease in the probabilities of notable depressive symptoms.

Optimal levels of physical activity to mitigate notable depressive symptoms

Volume per Week of Physical Activity. Results of the cubic spline model (Figure 1) show that METs-minute/week were

Table 1
Comparison of participant characteristics and physical activity by current depressive symptoms

	Total (n = 4811)	DS < 28 (n = 4023)	DS ≥ 29 (n = 788)	Adjusted model OR 95% CI	Adjusted p-value
	Frequency (%)	Frequency (%)	Frequency (%)		
Sex					
Male	1859 (38.6)	1687 (41.9)	172 (21.8)	1.00	
Female	2952 (61.4)	2336 (58.1)	616 (78.2)	2.385 (1.973-2.883)	0.000
Age					
<26	1070 (22.2)	748 (18.7)	322 (41.1)	1.00	0.000
27-41	1251 (26.0)	1026 (25.7)	225 (28.7)	0.510 (0.417-0.623)	
42-53	1186 (24.7)	1058 (26.5)	128 (16.3)	0.293 (0.232-0.370)	
>53	1270 (26.4)	1161 (29.1)	109 (13.9)	0.240 (0.187-0.306)	
BMI					
Underweight	170 (3.5)	121 (3.00)	49 (6.20)	1.00	0.406
Healthy weight	2842 (59.1)	2349 (58.4)	493 (62.6)	0.760 (0.526-1.098)	
Overweight	1314 (27.3)	1139 (28.3)	175 (22.2)	0.807 (0.542-1.202)	
Obese	485 (10.1)	414 (10.3)	71 (9.00)	0.877 (0.561-1.371)	
Previous PA					
No	1144 (23.8)	906 (22.5)	238 (30.2)	1.00	0.038
Yes	3667 (76.2)	3117 (77.5)	550 (69.8)	0.824 (0.686-0.989)	
METs in confinement					
1° quartile	1196 (24.9)	938 (23.3)	258 (32.7)	1.00	0.000
2° quartile	1208 (25.1)	1009 (25.1)	199 (25.3)	0.767 (0.618-0.953)	
3° quartile	1195 (24.8)	1006 (25.0)	189 (24.0)	0.756 (0.606-0.943)	
4° quartile	1212 (25.2)	1070 (26.6)	142 (18.0)	0.540 (0.427-0.683)	

DS = Depressive symptoms; BMI = Body mass index; PA = Physical activity; METs = Metabolic equivalent of task

inversely associated with the probabilities of notable depressive symptoms, although the slope moderated above approximately

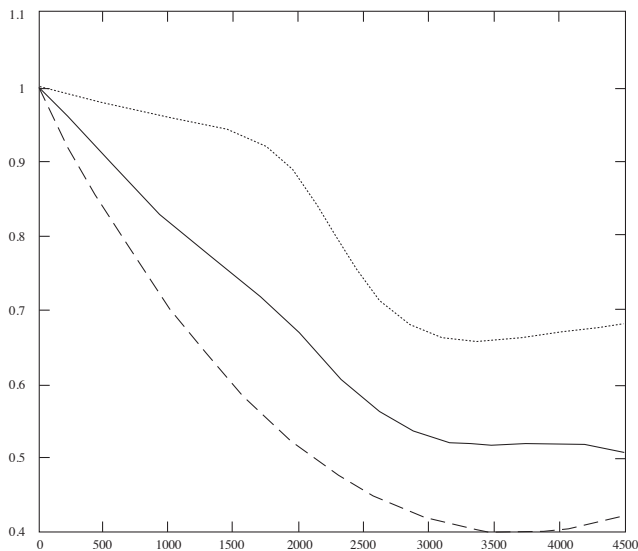


Figure 1. Adjusted ORs with 95% CIs for the association of the weekly volume of physical activity (METs- min/week) with notable depressive symptoms in people confined in Spain (Covid-19) aged 16-92. Note: METs/week were modelled by restricted cubic splines with three knots using a multivariate logistic regression model, adjusting for age, sex, BMI and PA prior to home confinement

3000 METs-min/week. From this point on (3000 METs/week), the probabilities of notable depressive symptoms were 47% lower (OR .53, 95% CI .42 to .67). Substitution of 500 METs of vigorous PA for moderate PA was associated with a 22% lower likelihood of notable depressive symptoms (500 METs, OR = .77, 95% CI .61 to .98).

Frequency per Week of Physical Activity. Results from the second restricted cubic spline model (Figure 2) show that PA weekdays were inversely associated with the probabilities of notable depressive symptoms. The slope continues in a downward progression moderating its fall from the tenth, reaching the final point to show that the probabilities of notable depressive symptoms were 56% lower (OR .46; 95% CI: .33 to .64). None of the substitution models was significant. In the partition model, the probability inversely associated with notable depressive symptoms was significantly higher on weekly vigorous PA days 3 and 4 (OR .68, 95% CI .52 to .88). Therefore, for the same number of days of light PA, moderate PA, and vigorous PA, practicing 3 and 4 days of vigorous PA was inversely and to a greater degree associated with notable depressive symptoms.

Duration per Week of Physical Activity. Figure 3 shows the results of the third restricted cubic spline model that inversely associates the hours of PA/week with the probabilities of notable depressive symptoms. The slope also continues to progress downward, moderating its fall from the sixth hour (OR .68; 95% CI: .53 to .88), showing in the 10 hours of practice/week that the probabilities of notable depressive symptoms were 39% lower (OR .61, 95% CI .49 to .76). The substitution model suggests that

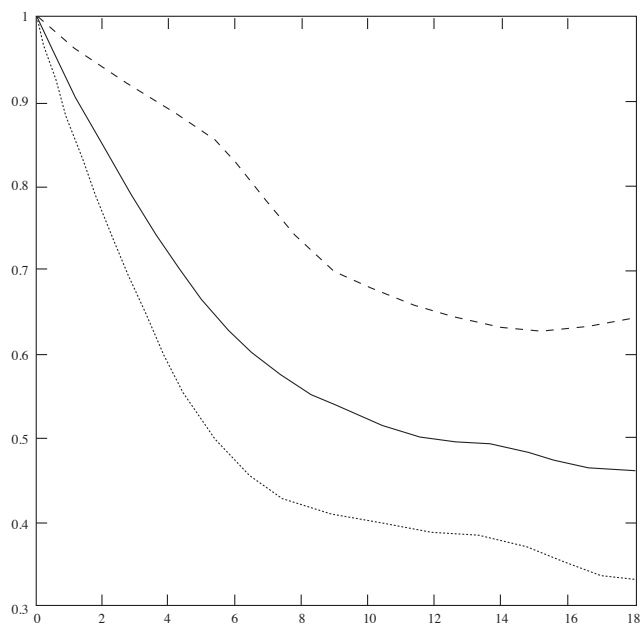


Figure 2. Adjusted ORs with 95% CIs for the association of the weekly frequency of physical activity (days per week of VPA, MPA and LPA) with notable depressive symptoms in people confined in Spain (Covid-19) aged 16-92.

Note: Days/week were modelled by restricted cubic splines with three knots using a multivariate logistic regression model, adjusting for age, sex, BMI and PA prior to home confinement

replacing 4 hours (OR .68, 95% CI .49 to .94) or 5 hours (OR .66, 95% CI .47 to .93) of vigorous PA with moderate PA was inversely associated more likely to notable depressive symptoms.

Discussion

The objectives of the study are twofold: a) to examine dose-response relationships between PA components (volume, intensity, frequency, and duration) and depressive symptoms of the population during confinement, and b) to identify the optimal levels of PA to mitigate notable depressive symptoms.

In this study, 16.38% of the participants reported notable depressive symptoms during the four weeks of confinement, a figure that is similar to the data presented by Blazer (2003) in the general population and normal conditions. Of them, 78.2% were women. The literature is consistent in pointing out gender differences in most mental disorders. Depressive symptoms are more prevalent in women than in men (Salokangas et al., 2002). Several possible explanations for this gender difference have been suggested (e.g. greater exposure to life stress). From the “gender roles” hypothesis, it is suggested that these differences should narrow as the roles of men and women become more equal (Seedat et al., 2009). In recent years, a narrowing of the differences in major depression has been found concerning changes in the traditionalism of female gender roles (Seedat et al., 2009). However, the confinement scenario could have caused a new imbalance between the roles of each other related to housework and childcare, which could have been a source of greater stress for women.

Regarding age, the youngest (16-26 years) were more sensitive, and the oldest (> 53 years), the least, to the restrictions of confinement. These results converge with those of the study by

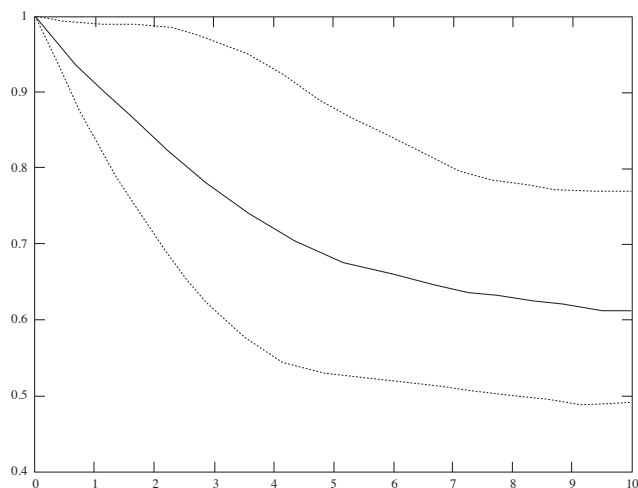


Figure 3. Adjusted ORs with 95% CIs for the association of the duration of physical activity (hours/week of VPA, MPA, and LPA) with notable depressive symptoms in people confined in Spain (Covid-19) aged 16-92. Note: Hours/week were modelled by restricted cubic splines with three knots using a multivariate logistic regression model, adjusting for age, sex, BMI and PA prior to home confinement

Wang et al. (2020), who reported that prolonged confinement had several adverse impacts on mental health, especially among 12-21-year-old respondents, who had a greater psychological impact from COVID-19. This age group was affected by the prolonged closure of the institutes and universities, as well as by a social limitation and leisure activities. Tang et al. (2020) explored the prevalence of post-traumatic stress disorder and depression in a sample of home-quarantined college students. They identified being in their graduating year (4th year) as one of the most significant risk factor for psychological distress. Similarly, Huang and Zhao (2020) also reported a significantly higher prevalence of generalized anxiety disorder and depressive symptoms in young people than in older people during the Coronavirus outbreak in China. Likewise, the youngest may have less resilience to face vital challenges than adults. McGowan et al. (2018) showed how resilience increases with age.

Moreover, PA before confinement was also a protective factor against depressive symptoms during confinement. It is well accepted that being physically active is effective in preventing depression (Currier et al., 2020).

Concerning the first PA component, Volume per week, the amount of 477 METs-minute/week was associated with a 33% decrease in the probabilities of notable depressive symptoms. This threshold is below the 600 METs-minute/week (150 minutes of moderate PA \times 4) generally accepted to obtain benefits (Kim et al., 2008; 2009). Kim et al. (2018) defined the sedentary group as those who perform PA below that recommended level; however, considering that people with depression may have less initial motivation, the minimum effective dose of PA on depressive symptoms could be below this limit in a situation of confinement at home.

Furthermore, starting at 3000 METs-min/week, the chances of notable depressive symptoms were reduced by almost half (47%). These data are partially convergent with those of the study by Kim et al. (2019), who reported that reaching 1800-3000 METs-min/week was associated with a 14% lower risk of incidents of depressive

symptoms compared to sedentary patients. However, the effective amount of PA to reduce the appearance of depressive symptoms was higher in men than in women. In the present study, from 3000 METs-min/week, the probabilities of notable depressive symptoms were 47% lower, which could indicate that in confinement the protective effect of PA against depressive symptoms would be more powerful than in a non-confined contexts. Furthermore, in the present study the substitution of 500 METs of vigorous PA for moderate PA was associated with a 22% less probability of notable depressive symptoms, which suggests that it is not so much the intensity, but the amount of PA that represents the antidepressant effect in terms of volume. Kim et al. (2019) concluded that according to the risk-benefit ratio of PA, performing high PA levels has no positive effect on depressive symptoms.

The second PA component, Frequency per week, was also inversely associated with the probabilities of notable depressive symptoms, reaching the endpoint to show that the odds of notable depressive symptoms were 56% lower. The slope moderated after 10 days per week of PA of any intensity. In the partition model, for the same number of days of light PA, moderate PA, and vigorous PA, practicing 3 and 4 days of vigorous PA was inversely and to a greater degree associated with notable depressive symptoms. In other words, considering the weekly frequency of 3-4 days of PA, it seems that the vigorous-intensity levels could be related to a reduction in notable depressive symptoms. This apparent contradiction with the data obtained with the volume should be studied in future investigations in confinement situations.

The third PA component, Duration per week, was again inversely associated with the probabilities of notable depressive symptoms, and its fall moderated from the sixth hour, showing in the 10 hours of weekly practice that probabilities of notable depressive symptoms were 39% lower. The substitution model suggests that replacing 4 or 5 h of vigorous PA with moderate PA was inversely associated with a higher probability of notable depressive symptoms. These results are in line with those reported on volume and reinforce the thesis that in terms of duration, moderate PA exerts greater protection against depressive symptoms. Harvey et al. (2018) suggested an exponential decline model, in which there is a decreasing benefit as the total time spent on PA increases, and that 12% of future cases of depression could have been prevented if all participants had performed at less 1 hour of PA every week.

In line with our findings, they concluded that PA of any intensity in leisure time protects against future depression.

Considering our findings, the recommended amount and types of PA to prevent the appearance of notable depressive symptoms in a confined population can be described in the following terms. Regarding the range of PA to reduce notable depressive symptoms, it would imply walking 2 hours and 24 minutes/week at a medium pace, being 15 hours and 15 minutes/week the optimal amount found. Regarding activities of moderate intensity, such as carrying light loads, cycling or running at a regular pace, it was found that the range varies from 1 h 58 min/week to the optimal level of PA to prevent the onset of depression, which is 12 h and 30 min/week. For vigorous-intensity activities, such as lifting heavy objects, digging, doing aerobics or cycling quickly, the range is from 59 min/week to the optimal level of PA to prevent the onset of depression, which was 6 h and 15 minutes/week. Regarding Frequency, up to 10 periods of PA/week of different intensities could be recommended to reduce depressive symptoms, taking into account that only 3-4 days/week of vigorous-intensity could be very efficient. And as for the total duration per week, from just a few accumulated minutes to 6 hours the improvements are exponential effects, and from there to the tenth, the benefits are more moderate. These results are consistent with the previous literature that reports the benefits of PA/week for mental health (Harvey et al., 2018; Mammen & Faulkner, 2013; Teychenne et al., 2008).

The results of our study have important implications for public health. The threat of new outbreaks of coronavirus until an efficient vaccine is available and the possible reaction of governments by decreeing new confinements of the population (either total or partial) mean that these findings must be taken into account. PA of confined citizens should be promoted, emphasizing the found ranges of volume, frequency, intensity, and duration. Depending on the characteristics, physical condition level, pathologies, or diseases, each individual should select the type and quantity of PA according to their confinement context.

This study has several limitations. On the one hand, self-reported questionnaires were used to measure PA (IPAQ-SF). The absolute amount of PA could be better determined using objective devices such as accelerometers. On the other hand, causal relations cannot be derived from the results because of the research design followed.

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