

# On the Move: A Cross-Sectional Study on Physical Activity, Sedentary Behavior, and Depressive Symptoms among Older People in Rural Portugal

## En Movimiento: Un Estudio Transversal sobre la Actividad Física, el Comportamiento Sedentario y los Síntomas Depresivos en Ancianos de Zonas Rurales de Portugal

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**Abstract.** In the field of gerontological health, depression is a major challenge that is often associated with decreased physical activity and an increase in sedentary behavior. This study explored these relationships in a sample of 54 non-depressed older adults ( $\geq 60$  years) from rural Portugal who were divided into two groups: that engaged in both self-initiated and structured physical activity, and the other that was limited to self-initiated activity only. Activity levels and depressive symptoms were assessed using the International Physical Activity Questionnaire – Short Form and the Geriatric Depression Scale-27. The results showed a positive correlation between physical activity and depressive symptoms in the self-initiated activity group. In contrast, there were no significant differences in depressive symptoms in the structured activity group, suggesting a possible protective function of structured physical activity against depression. This study highlights the complex dynamics between physical activity, sedentary behavior and depressive symptoms in older adults and emphasizes the need for tailored intervention approaches. To further advance our understanding in this field, future research should focus on addressing the specific protective mechanisms of structured physical activity against depression and evaluating the long-term efficacy of such interventions in different older populations.

**Keywords:** physical activity, sedentarism, depression, older adults, rural population

**Resumen.** La compleja relación entre los síntomas depresivos, la actividad física y el comportamiento sedentario tiene implicaciones importantes para la salud gerontológica. Este estudio exploró estas relaciones en una muestra de 54 adultos mayores no deprimidos ( $\geq 60$  años) de zonas rurales de Portugal, divididos en dos grupos: uno que participó en actividades físicas autoiniciadas y estructuradas, y otro limitado solo a actividades autoiniciadas. Los niveles de actividad y los síntomas depresivos se evaluaron utilizando el Cuestionario Internacional de Actividad Física – Forma Corta y la Escala de Depresión Geriátrica-27. Los resultados mostraron una correlación positiva entre la actividad física y los síntomas depresivos en el grupo de actividad autoiniciada. En contraste, no hubo diferencias significativas en los síntomas depresivos en el grupo de actividad estructurada, lo que sugiere una posible función protectora de la actividad física estructurada contra la depresión. Este estudio destaca la compleja dinámica entre la actividad física, el comportamiento sedentario y los síntomas depresivos en adultos mayores y enfatiza la necesidad de enfoques de intervención personalizados. Las investigaciones futuras deberían centrarse en abordar los mecanismos protectores específicos de la actividad física estructurada contra la depresión y evaluar la eficacia a largo plazo de tales intervenciones en diferentes poblaciones de adultos mayores.

**Palabras clave:** actividad física, sedentarismo, depresión, adultos mayores, población rural

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### Introduction

Depression, a common mental disorder in the global geriatric population, is a major health and economic challenge (Malhi & Mann, 2018). With more than one billion people aged 60 and over, a number that is expected to double by 2050, there is an urgent need to develop effective treatments for depression (WHO, 2022). Approximately 28.4% of older adults worldwide suffer from depression, characterized by persistent low mood, loss of interest in daily activities, sleep disturbances and, in severe cases, suicidal thoughts (Hu et al., 2022; Koo & Kim, 2020; WHO, 2021). The overlap of depressive symptoms with age-related problems or physical illness, especially in people suffering from hopelessness and low self-esteem, requires special attention for this population (WHO, 2021).

The demographic structure in Portugal is undergoing profound change. According to projections, the ratio of older to younger people will increase from 159 to 300 per 100 inhabitants by 2080 (Instituto Nacional de Estatística, 2021). This demographic shift requires targeted mental health initiatives, especially given the prevalence of chronic depression in Portugal, which at 12.2% is one of the highest

in Europe and the second highest after Iceland (Eurostat, 2019). This prevalence rises to 19.6% in the over-65 age group. This underlines the urgency of more comprehensive research and robust health strategies to tackle the growing challenge of depression in the aging population

Depression in older adults often arises from the interplay of declining physical health and eroding social networks, which promotes isolation and exacerbates depressive symptoms (DS) (Cai et al., 2023; Garzón Mosquera & Aragón Vargas, 2021; Moreno-Agostino, 2021). Recent research findings describe a multidimensional relationship between physical activity (PA), sedentary behavior (SB), and DS. SB in particular has been identified as a critical health problem that warrants preventive action (Owen et al., 2020). Prevailing trends show that lower PA and higher SB are associated with an increased risk of depression in older people (Cunningham et al., 2020; Ramalho et al., 2018, 2021; Huang et al., 2020). This association is partly attributed to the neurochemical effects of PA on mood-boosting neurotransmitters such as serotonin and dopamine (Craft & Perna, 2004; Duclos et al., 2003; Xie et al., 2021). The integration of PA into therapeutic approaches such as cognitive behavioral therapy has shown promise in reducing

DS (Belvederi et al., 2019; Ku et al., 2018).

Nonetheless, the lack of comprehensive national research makes it difficult to develop effective interventions against depression in older people. Although the role of PA in alleviating DS is recognized, there are few data on the effects of structured PA programs, especially in rural areas of Portugal. Targeted research comparing the prevalence of DS between participants in structured PA programs and non-participants is essential. Such studies will help to develop tailored interventions to improve the mental health of older people in Portugal.

As Portugal struggles with an aging population, the prevalence of DS in older adults is increasing, further challenged by a notable lack of targeted research (Ramalho et al., 2020). Our study seeks to address this gap by exploring the complex interplay between PA, SB, and depression in older Portuguese rural dwellers. Based on two fundamental hypotheses – an inverse relationship between PA and DS and a positive relationship between persistent SB and DS – this research is central to understanding the unique Portuguese milieu. It aims to support the development of comprehensive therapeutic approaches and health policies that holistically address the well-being of the aging population.

## Method

### Participants

In this cross-sectional observational study, we focused our scientific research on a cohort of 54 community-dwelling older people aged 60 years and older. These participants were selected from the rural setting of Vouzela, a municipality in the central region of Viseu, Portugal. Using G\*Power (version 3.1.9.2) and an  $\alpha$ -error probability of 0.05, we determined a sample size of 52 to ensure statistical robustness. Recruitment took place in local community centers in Vouzela, with clear inclusion criteria: residence in the rural areas of Vouzela, age 60 or older and any gender. The exclusion criteria included end-stage disease and the presence of motor and sensory impairments that limit the ability to perform daily PA. Individuals with cognitive impairment, dementia or depression, as assessed by the Geriatric Depression Scale (GDS-27) (Pocinho et al., 2009), were also excluded. A blend of intentional and convenience sampling methods represented the demographic profile of the region while ensuring the integrity of the data.

The study aimed to examine DS in two groups that differed in their PA habits in a rural environment. For analysis purposes, participants were categorized according to their engagement in structured or self-initiated PA. The first group ( $n = 20$ ) consisted of individuals who participated in a biweekly, professionally guided exercise program that included aerobic, strength, balance, and flexibility exercises. This multicomponent program was designed to ensure both safety and adaptability for the older participants. The second group ( $n = 34$ ) consisted of individuals who exercised independently on a daily basis but did not participate in the structured, community-based program. No interventions

were carried out during the study. Stratification was only used to shed light on the associations between different PA habits and DS in the different cohorts.

Written informed consent was obtained from the participants after they had been informed about the aims of the study and the potential risks, complying with the ethical guidelines approved by the local ethics committee. This was done in accordance with the ethical standards of the Declaration of Helsinki. Data collection took place over several days in order to consider the different availabilities of the participants and thus ensure a thorough and considerate approach. The instruments were administered concurrently to ensure uniformity in data collection. This process was conducted during a single session with each participant to maintain consistency and reduce variability in responses.

### Measures

In our scientific endeavor, we used a demographic questionnaire together with two validated scales to assess the relevant variables, PA, SB and DS.

International Physical Activity Questionnaire – Short Form (IPAQ-SF): the IPAQ-SF is a widely used instrument known for its validity ( $r = .33$ ) and high reliability ( $r = .81$ ) in measuring PA and SB in the previous seven days (Craig et al., 2003). The IPAQ-SF consists of eight self-report items and quantifies the frequency and duration of PA. Weekly PA intensity is determined by algorithmically multiplying the number of days by the duration of daily activities in each specific category (Lage et al., 2021; Overdorf et al., 2016). In addition, the IPAQ-SF is used to collect data on SB, which is calculated by multiplying the minutes spent on weekdays by five and the minutes spent on weekends by two. To exclude overestimation, daily PA durations exceeding 240 minutes were capped. This ensures that the total weekly PA duration does not surpass 28 hours (Rosenberg et al., 2010).

Geriatric Depression Scale (GDS-27): The GDS was developed specifically for older people and is valued for its ease of use and practicality. It has consistently demonstrated high reliability and validity and has high sensitivity and specificity in detecting DS (Yesavage et al., 1982; Pocinho et al., 2009). The original with 30 items (Yesavage et al., 1982) includes cognitive and affective items and uses a binary response format (yes/no). The Portuguese adaptation by Pocinho and colleagues (2009), comprising 27 items, has been shown to be psychometrically robust ( $\alpha = .91$ ) and effective in diagnosing depressive disorders in the Portuguese geriatric population. Normative data for this adaptation state that scores greater than 11 on 27 indicators are indicative of depressive disorders in this population. Therefore, a GDS cut-point of 11 is used in our study to identify DS.

### Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics (version 21.0), with a pre-specified significance level of  $p < 0.05$ . Descriptive statistics, including means and

standard deviations, were calculated for normally distributed variables. For variables that were not normally distributed, the median and interquartile range were used. The distributional properties of the data set were examined using the Shapiro-Wilk test, which showed a preponderance of non-normally distributed variables ( $p$ -value < 0.05). A t-test for normally distributed data (SB) was used to determine differences between the variables. The Mann-Whitney U test was used for non-normally distributed variables as a non-parametric alternative. Correlations between variables were determined using the Spearman correlation test.

## Results

### Demographic data

The study cohort consisted of 54 participants, all aged 60 years or older and living in rural areas, with a mean age of 71.98 years ( $SD = 6.09$ ). There was a slight female majority in the sample (51.1%). In terms of marital status, 61.1% were married, 27.8% were widowed, 7.4% were single and 3.7% were divorced. Participants were categorized according to their PA habits: 63% practiced only independent PA, while the remaining 37% supplemented their independent physical activity with biweekly structured sessions under professional supervision. The mean age of participants in supervised classes was 70.45 years ( $SD = 6.004$ ), slightly younger than those who only exercised independently ( $mean\ age = 73.03$  years;  $SD = 6.053$ ).

### Physical Activity and Depressive Symptomatology

Table 1 presents descriptive statistics for the variables studied, including PA intensity – intense, moderate, and low –, SB on weekdays and weekends, and GDS scores. This analysis clarified the distribution and central tendencies of these variables and enabled a differentiated comparison between people who exercise independently and those who participate in structured exercise classes.

Table 1  
Descriptive statistics for PA, SB and GDS scores

Participant group (n = 54)	Exercising independently (n = 34)		Exercising in a class (n = 20)	
	M	SD	M	SD
Minutes per week of vigorous PA	76.76	130.08	335.75	459.99
Minutes per week of moderate PA	491.91	646.22	345.00	309.83
Minutes per week of low-intensity PA (walking)	183.24	142.45	137.25	112.66
Minutes per weekdays of SB	1228.68	625.99	960.00	590.85
Minutes per weekend days of SB	607.06	306.21	498.00	237.70
GDS score	9.88	5.63	5.45	4.80

There was a clear difference in weekly exercise duration between the cohorts: the class-attending participants exercised significantly more (335.75 minutes) than their independently exercising counterparts (76.76 minutes), as determined by a Mann-Whitney test ( $U = 160.00$ ,  $p = .001$ ). Independent exercisers reported higher levels of moderate (491.91 minutes) and low intensity PA (183.24 minutes) than class participants (345.00 minutes and 137.25

minutes, respectively). These differences, however, were not statistically significant for either moderate ( $U = 309.00$ ,  $p = .577$ ) or low PA ( $U = 262.50$ ,  $p = .162$ ). Both cohorts exercised predominantly at moderate intensity.

Different trends in self-reported SB on weekdays and weekends were observed between the groups. The group that exercised independently reported higher levels of SB on weekdays (1,228.68 minutes/week) and weekends (607.06 minutes/weekend) than the group that attended classes (960.00 minutes and 498.00 minutes, respectively). Nonetheless, the t-test analysis showed no statistically significant differences for weekdays ( $t = 1.55$ ,  $p = .126$ ) or weekends ( $t = 1.37$ ,  $p = .178$ ).

In addition, the GDS results underlined a significant association between DS and PA engagement. The mean DS score was significantly higher in independent exercisers ( $M = 9.88$ ) than in class-attending participants ( $M = 5.45$ ). A Mann-Whitney test confirmed this variance ( $U = 173.00$ ,  $p = .003$ ), indicating a possible association between participation in structured classes and lower DS scores in older adults.

Table 2 shows the correlations between the different PA habits and the severity of DS in our cohort.

Table 2.  
Spearman Rho (One-Tailed) between weekly PA and GDS

	Vigorous exercise			Moderate exercise			Low intensity (walking)		
	rs	df	p	rs	df	p	rs	df	p
Exercising independently	.153	34	.389	-.149	34	.400	-.111	34	.533
Exercising in a class	-.092	20	.698	.067	20	.780	.035	20	.884

To test the hypothesis of an inverse correlation between the level of PA and the severity of depression, we examined the relationship between weekly minutes of vigorous, moderate and low PA and GDS scores using Spearman's rank correlation coefficient. Participants were categorized based on their PA habits: independent exercisers and participants in structured classes.

Contrary to expectations, the correlations between the intensity of PA and the severity of DS were not statistically significant ( $p > 0.05$ ), which refutes the hypothesis of an inverse relationship between the amount of PA and the severity of DS, regardless of the intensity of PA.

### Sedentary Behaviour and Risk of Depressive Symptomatology

The empirical validation of our second hypothesis is presented in Table 3. This table contains the Spearman's rank correlation coefficients used to assess the potential association between SB and DS as measured by the GDS. The analysis was conducted specifically to test the hypothesis that a longer duration of SB positively correlates with DS scores.

Table 3.  
Spearman Rho (One-Tailed) between SB and GDS

	SB Weekday			SB Weekend		
	rs	df	p	rs	df	p
Exercising independently	.346	34	.045*	.017	34	.923
Exercising in a class	.002	20	.994	.064	20	.787

The relationship between SB and DS on weekdays,

weekends and total DS scores was examined using Spearman's correlation. Our results showed a significant positive correlation between increased weekday SB and increased DS scores in the independently exercising older adults ( $r = .346, p = .045$ ), indicating that prolonged SB is a potential risk factor for DS in this subgroup. However, no such association was observed in the structured PA group ( $r_s = .002, p = .994$ ). On weekends, SB did not show a significant correlation with DS in either group ( $p > .005$ ).

## Discussion

Our research adds a multifaceted perspective to the ongoing scientific debate on the associations between PA, SB and DS in the aging population of rural Portugal. This comprehensive study confirms and challenges established accounts in gerontological research. In line with previous research, our results confirm the hypothesis that structured PA is a protective factor against depression in older adults. Contrary to the widespread assumption of a negative association between the intensity of PA and the incidence of depression, our results do not indicate a significant decrease in DS in individuals with higher levels of PA.

### *Physical Activity and Depressive Symptoms*

Our study presents intriguing results that challenge the expected inverse association between PA and DS and deviate from the wealth of literature that typically touts the mood-enhancing benefits of regular PA (Babyak et al., 2000; Araque-Martínez et al., 2021; Sutapa, Pratama, & Mustapha, 2024). A distinct pattern emerged: independent exercisers had higher DS than those who participated in structured PA programs, suggesting the central role of structured, socially engaging PA in mitigating DS.

The particular characteristics of our study demographics – older, rural residents with low DS and high PA levels – may have influenced these results. This demographic deviation from commonly studied populations, which are often characterized by pre-existing depressive states and sedentary lifestyles, could explain the low impact of PA on DS (Veronese et al., 2017). Our results suggest that the correlation between PA and DS may vary depending on the presence or absence of clinically diagnosed depression.

In addition, demographic factors such as gender and marital status, which are known to influence the risk of depression, may also have played a role. Previous studies have documented a higher susceptibility to depression in older women and widowed individuals (Cheung & Mui, 2021; Girgus et al., 2017). Given the relatively even gender distribution in our cohort and the predominantly married status, these demographic nuances may have influenced our results. This underscores the importance of individual differences and the need for further research on the subtleties of PA, DS, and demographic factors in aging populations.

The rural setting of our study, which provides different motivations and opportunities for PA (Köroğlu et al., 2023), may also have attenuated the effect of PA on DS.

However, the observational nature of the study and reliance on self-report lead to potential biases that often result in an overestimation of PA levels (Healey et al., 2020). Future studies should therefore use objective methods to measure PA in order to obtain more accurate assessments.

The variety of PA that older adults engage in deserves careful examination. Recent studies emphasize the importance of the type of activity in the prevention of depression, with leisure activities such as hobbies being inversely related to depression (Smaradottir et al., 2020). The effect of PA intensity on depression also remains unclear, with different benefits found for high and moderate intensity activities in different populations (Felez-Nobrega et al., 2021; Mumba et al., 2021). Even low-intensity activities have been shown to promote mental health in older people (Harvey et al., 2018). Understanding these aspects is key to developing effective, evidence-based approaches to combat depression in older adults.

Our findings contribute to the complex narrative surrounding PA and DS. While some studies suggest an inconclusive association between intense PA and reduced DS (Nyström et al., 2019), not all intense PA interventions lead to improved mental health outcomes (Moses et al., 1989; Plante & Rodin, 1990). In line with this, Li and colleagues (2022) found no significant long-term effects of PA on DS, while Kritz-Silverstein and colleagues (2001) reported that PA may initially reduce depression scores but does not provide lasting protection against depression in non-clinically depressed older adults. These findings emphasize the differential effects of PA on mood and psychological well-being.

Finally, the association of SB and DS should also be examined. In our study, SB was significantly higher than PA, indicating a more complex relationship that may eclipse the expected correlation between PA and DS. Future research should therefore focus on the interaction of SB and PA in both the prevention and treatment of DS in older populations.

### *Sedentary Behavior and Depressive Symptoms*

Our study supports the hypothesis that prolonged SB, characterized by low-energy activities such as sitting or lying down (Tremblay et al., 2017), is associated with an increased risk of DS, especially in rural older people who abstain from structured PA. Following previous research (Diaz et al., 2017; Kim & Lee, 2019; Matthews et al., 2008), we observed that a substantial part of the day in our cohort was spent in sedentary activities, with a positive correlation between the duration of sedentary time and DS, regardless of the day of the week (Eriksson et al., 2020; Okely et al., 2019; Santos et al., 2017).

The study confirms existing findings on the prevalence of SB and at the same time emphasizes the need to distinguish between passive and mentally stimulating SB. Passive SB, such as excessive TV viewing, has been associated with increased rates of depression, while mentally stimulating activities may have a protective effect (Gianfredi et al.,

2022; Huang et al., 2020; Wang et al., 2022). This distinction calls for future research to examine different SB contexts and their long-term interaction with PA, using prospective and experimental approaches to unravel the complex relationship between SB, PA, and mental health.

The relationship between psychosocial factors, SB and aging is a burgeoning field of scientific research that is full of new and evolving insights (Chastin et al., 2015; Huang et al., 2020; Okely et al., 2019). For example, Kikuchi and colleagues (2013) reported that increased SB is related to environmental factors such as limited access to transportation. Nevertheless, the corpus examining the direct relationship between SB and DS in the aging population remains primarily observational and embryonic.

Our findings contribute to this field by showing that rural older adults maintain PA guidelines despite intensive TV viewing, possibly due to a rural lifestyle that allows for a more active life compared to urban settings (Koroğlu et al., 2023). The well-established association between reduced PA and increased risk of depression emphasizes the therapeutic potential of structured PA in mood disorders (Hallgren et al., 2020a). Furthermore, our data suggest that SB is associated with less favorable mental health outcomes in independently active older adults – a pattern not observed among participants in structured PA programs.

This leads to a central question: Could a blend of structured and self-directed PA mitigate the negative effects of SB on DS? Lucas and colleagues (2011) indicated an inverse association between PA and DS, with increased TV viewing conferring additional risk for depression, suggesting independent effects of PA and TV viewing on mental health. While our study suggests a synergy between structured PA and cognitively active SB, this area remains unexplored. The longitudinal study by Hallgren and colleagues (2020b) argues for a contextualized view of PA – occupational, transportation or recreational – and its effects on depression.

To summarize, there is a complex interplay between SB, DS and PA. Prolonged SB can reduce engagement in PA and increase social isolation, which has a negative impact on mental health. However, not all types of SB are harmful; intellectually stimulating activities with social elements can reduce the risk of DS (Hallgren et al., 2018, 2020b). The role of psychosocial factors in this interaction is evident but needs to be further explored. Biologically, a sedentary lifestyle may downregulate mood-boosting neurotransmitters and thus increase susceptibility to depression, whereas PA may restore neurotransmitter balance and improve mood (Duclos et al., 2003). The association of SB with disrupted sleep patterns and increased stress, both precursors to depression, emphasizes the need for interventions that reduce SB and increase PA to promote mental health (Ströhle, 2009; Wheeler et al., 2017).

## Conclusion

Our research provides compelling evidence that SB is

associated with an increased risk of DS, particularly in rural older people who lack structured PA. This finding underscores the need for dual strategies to promote mental health: reducing SB and promoting structured PA. Such approaches are crucial for maintaining mental health and combating depression in this population. Consequently, intervention strategies should focus on reducing physical inactivity and promoting structured PA, which are key factors for improving mental health and quality of life in rural older people.

In practice, our findings support multifaceted strategies that include both structured PA and efforts to curb prolonged SB. These could include community-based PA programs, educational campaigns that emphasize the benefits of PA, and exercise programs tailored to individual needs and abilities. Clinicians should be aware of the link between SB and depression and incorporate comprehensive physical and mental health assessments into routine care. Specially tailored interventions, such as outdoor activities that use the therapeutic qualities of nature, are critical in resource-limited rural settings.

Nevertheless, our research is not without limitations. The fact that we rely on self-reporting and do not control for confounding factors requires cautious interpretation. Furthermore, the lack of distinction between passive and cognitively active SB limits our understanding of their respective effects on DS. Future studies should combine objective measures with self-reports to expand our understanding of the role of PA and SB on mental health. Exploring the intricacies of PA and SB will enable the design of comprehensive studies with diverse samples and lead to more effective, evidence-based interventions (Ramalho & Petrica, 2023). By prioritizing interventions that improve PA and target SB, we can aim to reduce the prevalence of depression and increase well-being in rural older adults.

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