



Bidirectional association between physical activity and depression: the “Como Vai?” cohort study

Associação bidirecional entre atividade física e depressão: o “Como Vai?” estudo de coorte

AUTHORS

Bárbara Sutil da Silva¹
Debora Tornquist²
Andrea Wendt³
Andréa Dâmaso Bertoldi⁴
Elaine Tomasi⁴
Maria Cristina Gonzalez⁵
Renata Moraes Bielemann^{4,5}
Inácio Crochemore-Silva^{1,4}

1 Universidade Federal de Pelotas, Programa de Pós-graduação em Educação Física, Pelotas, Rio Grande do Sul, Brasil.

2 Universidade Federal de Santa Maria, Programa de Pós-graduação em Ciências do Movimento e Reabilitação, Santa Maria, Rio Grande do Sul, Brasil.

3 Pontifícia Universidade Católica do Paraná, Programa de Pós-Graduação em Tecnologia e Saúde, Curitiba, Paraná, Brasil.

4 Universidade Federal de Pelotas, Programa de Pós-graduação em Epidemiologia, Pelotas, Rio Grande do Sul, Brasil.

5 Universidade Federal de Pelotas, Departamento de Nutrição, Programa de Pós-graduação em Nutrição e Alimentos, Pelotas, Rio Grande do Sul, Brasil.

CORRESPONDING

Bárbara Sutil da Silva
barbarasutil89@gmail.com
Coronel Getúlio Mário Zanchi Street, n.80
D407. Santa Maria, Rio Grande do Sul,
Brazil.
Zip code: 97060-150.

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ABSTRACT

To evaluate bidirectional and longitudinal association between physical activity (PA) and depressive symptoms (DS). This is a cohort study called “Como Vai?” (How are you?), conducted by older population representative sample of the city of Pelotas-Rio Grande do Sul. The analyses used data from the first interview (2014) and follow-up (2019/20). The long version of the International Physical Activity Questionnaire (IPAQ) was applied to assess PA in the leisure, commuting and total domains. The presence of DS was measured using the Geriatric Depression Scale (GDS-10). Linear regression models were used to evaluate bidirectional associations between PA and DS. Analytical sample included 515 individuals with a mean age of 70.7 (\pm 9.2) years. Each weekly minute of total PA (β : -0.0006; 95% CI: -0.0011; -0.0001) and commuting PA (β : -0.0008; 95% CI: -0.0016; -0.0001) in 2014 predicts worse DS scores in 2019/20. At the same time, DS score in 2014 (β : -9.79; 95% CI: -18.81; -0.76) was a negative predictor of leisure-time PA in the 2019/20 follow-up adjusted for sociodemographic and other health behaviors. However, when adjusted for the respective outcomes at baseline, the associations found were not statistically significant. The present study did not find evidence of bidirectionality between PA and DS and the prospective associations lost statistical significance after adjustment for the respective outcomes at baseline. Other investigations are necessary including more periods of follow-up, objective analyses of PA to complement analyses by domains and, therefore, provide a better understanding of this complex relationship.

Keywords: Depressive symptoms; Physical activity; Older adults; Cohort study.

RESUMO

Avaliar associação bidirecional e longitudinal entre atividade física (AF) e sintomas depressivos (SD). Trata-se de um estudo de coorte denominado “Como Vai?”, conduzido com amostra representativa da população idosa da cidade de Pelotas-Rio Grande do Sul. As análises utilizaram dados do *baseline* (2014) e um acompanhamento (2019/20). Foi aplicado a versão longa do Questionário Internacional de Atividade Física (IPAQ) para avaliar a AF nos domínios de lazer, deslocamento e total. A presença de SD foi medida através da Escala de Depressão Geriátrica (GDS-10). Modelos de regressão linear foram usados para avaliar associações bidirecionais entre AF e SD. Amostra analítica incluiu 515 indivíduos com média de idade de 70,7 (\pm 9,2) anos. A cada minuto semanal de AF total (β : -0,0006; IC 95%: -0,0011; -0,0001) e AF deslocamento (β : -0,0008; IC 95%: -0,0016; -0,0001) em 2014 prediz piores escores de SD em 2019/20. Ao mesmo tempo, escore de SD em 2014 (β : -9,79; IC 95%: -18,81; -0,76) foi preditor de menor prática da AF lazer no seguimento 2019/20, ajustado para aspectos sociodemográficos e outros comportamentos de saúde. Entretanto, quando ajustado para os respectivos desfechos no baseline, as associações encontradas não se mantiveram estatisticamente significativas. O presente estudo não encontrou evidências de bidirecionalidade entre AF e SD e as associações prospectivas perderam a significância estatística após ajuste para os respectivos desfechos no baseline. São necessárias outras investigações incluindo mais pontos no tempo, análises objetivas da AF para complementar as análises por domínios e, com isso dar um melhor entendimento a essa relação complexa.

Palavras-chave: Sintomas depressivos; Atividade física; Idosos; Estudo de coorte.

Introduction

Depression is currently one of the mental disorders with the greatest impact on public health, affecting around 300 million people worldwide, accounting for 4.3% of the global burden of disease, and being one

of the biggest causes of disability and mortality^{1,2}. Depression is a disabling mental disorder that affects mood and pleasure, damaging the individual’s cognitive and behavioral aspects².

Physical activity (PA) has been consolidating itself

as an important ally in the treatment and prevention of depression and its symptoms³ even at volumes and levels below those recommended^{4,5}. There is a growing body of evidence that PA is prospectively associated with a lower risk of depressive mood and the emergence of depression over time, showing its protective relationship^{6,7}. However, it is also possible that depressive symptoms (DS), such as lack of energy, low motivation, and anhedonia³, may inhibit involvement in PA⁸. This premise was confirmed by Moghaddam et al.⁹, who showed that more aggravated symptoms of the disease reduce the regular practice of PA⁹, suggesting a bidirectional relationship between PA and depressive symptoms (DS)^{10,11}.

In terms of the bidirectional association of depression with PA, one of the first systematic reviews carried out on the topic observed that in eight out of the eleven studies reviewed, depression was a significant risk factor for a decrease in the level of physical exercise⁹. On the other hand, an investigation carried out with older adults did not observe this bidirectional association in their analyses. Early DS were not associated with the rate of change in leisure-time PA over eleven years, suggesting that depression does not inhibit PA later in adulthood⁸. Furthermore, Vossen et al.¹² observed that the relationship between these associations might be even more complex in older adults, as sufficient PA at the beginning of the study did not lead to a greater reduction in DS after two years, which differed from younger adults¹².

In addition to variations in context and type of study, these inconsistencies in the associations between PA and depression may be specifically linked to the way PA is measured and classified⁶. Choi et al.⁶, in a longitudinal study involving adults and older people, showed an association of DS and objectively measured PA (including all domains), but they did not find this association when assessed by self-report (moderate and vigorous PA)⁶. In contrast, Steinmo et al.¹³, when investigating this bidirectional association in a cohort that followed adults until early old age, reported that PA (measured by self-report) and mental health have a longitudinal and bidirectional association from middle age to early old age. These findings show us the complexity of the relationship between PA and mental health¹³.

It is worth noting that among the studies that seek to analyze these bidirectional associations, few have explored different contexts of PA, especially in older

adults⁸. In this sense, robust investigations that analyze in detail the relationship between depression and measured PA, looking at the type of PA (e.g. leisure-commuting), with a longitudinal design and population-based samples are necessary¹⁴. Therefore, the objective of the study was to evaluate the bidirectional and longitudinal association between leisure-time and commuting PA with DS in a cohort of older people. Based on the aforementioned evidence and the study population under evaluation, our hypothesis was that PA in both leisure-time and commuting may have a bidirectional relationship with DS.

Methods

Study design

This study is based on a project called as “COMO VAI?” (HOW ARE YOU?) - Master’s Consortium Oriented for the Appreciation of Older Adults Care, which aims to monitor the lifestyle habits of the older population to identify factors related to the health-disease-disability-mortality process of older adults. Data collection began in 2014 and new follow-ups were carried out in 2016/17, 2019/20 and 2021/22, through home and telephone interviews. A complete description of the “COMO VAI?” and its methods can be found in previous publications^{15,16} and other digital websites (<https://wp.ufpel.edu.br/comovai/>). All procedures were approved by the Research Ethics Committee of the Federal University of Pelotas through protocol (201324538513.1.0000.5317).

Population and sample

All individuals aged 60 or over living in the urban area of the city of Pelotas-Rio Grande do Sul/Brazil, were eligible for the research. Residents were considered to be those people whose domicile (selected for the study) was their usual place of residence on the date of the interview, and who could be present or temporarily absent for a period not exceeding 12 months. Older adults with verbal communication inability, cognitive or mental incapacity to respond to the questionnaire, or those who were institutionalized were not included in the sample.

The study sampling process was carried out in two stages. Conglomerates were selected using data from the 2010 Census¹⁷. The number of 469 census tracts were considered, which were ordered by the average income of the head of the family, to carry out a draw. This strategy ensured the inclusion of different

neighborhoods in the city with different economic situations. Estimating 0.43 older adults/household, to find the 1,649 individuals aged 60 or over, it would be necessary to include 3,745 households, of the 107,152 existing ones, in the urban area of the city of Pelotas-Rio Grande do Sul. Thus, it was defined that 31 households would be systematically selected per tract to enable the identification of at least 12 older adults in them, which implied the inclusion of 133 systematically selected census tracts. The households in the selected tracts were listed and drawn at random in the locations themselves.

Starting from the baseline study, the participants of the study have been monitored through permanent records of their contacts and family members. In the 2019 follow-up, which is the focus of this study along with the baseline, the interviews were carried out in person at home. Mortality was assessed in two ways, with family contact data and with the Mortality Information System (Sistema de Informação de Mortalidade - SIM) (Death Registration Service - DRS). In all data collections, the questionnaires were applied by trained interviewers.

Collection instruments

The Geriatric Depression Scale (GDS)¹⁸, abbreviated Brazilian version¹⁹ was used to measure DS at each follow-up. This tracking instrument contains 10 items with “yes or no” answers and refers to a recall period of seven days before the interview. One point was assigned to each answer, the sum of which resulted in a score ranging between 0 and 10. In addition to the main use of the variable as a continuous score, to describe the prevalence of symptoms among the elderly, it was defined that scores ≥ 5 were indicative of the presence of depressive episode. This instrument with this cutoff point was chosen because it presents good sensitivity and specificity indicators: 80.5% and 78.3%, respectively, according to the ICD-10 criteria for Major Depressive Episode; and 84.8% and 67.7%, respectively, according to the DSM-IV criteria for Major Depressive Disorder¹⁹. Older adults who were unable to answer the questionnaire with or without help, either due to inability to communicate verbally and/or cognitive and/or mental incapacity, were excluded from the study.

The long version of the International Physical Activity Questionnaire (IPAQ) was applied in the leisure-time and commuting domains in each follow-up

to measure PA. The questionnaire collected PA frequency, duration, and intensity in leisure-time and commuting domains, expressed in minutes per week of PA, using the last seven days as a recall period²⁰. The weekly minutes of PA and the classification of ≥ 150 active and < 150 insufficiently active were adopted²¹. However, for our analyses, we will present the variables continuously. The exclusion criteria for this instrument were individuals who did not have the mental capacity to respond to the questionnaire and/or physical disability. Bedridden and disabled older adults were also excluded from this evaluation.

Potential correlates and confounding factors

Based on the literature, sociodemographic correlates consistent with the association between PA and depression were selected^{1,8,10,13}. The following were included as study covariates: gender (male; female); age (60-64; 65-69; 70-74; 75-79; ≥ 80 years); family income in real (in quintiles); current work status (no; yes); marital status (with/without partner); self-reported skin color/race by the older adult (white; non-white); smoking (no; yes; ex-smoker) and alcohol use (no; yes). Furthermore, additional adjustments were made for the outcome (DS and PA) status on the baseline.

Statistics analysis

Sociodemographic characteristics, occurrence of DS, and prevalence of active older adults in the Cohort sample were described using absolute and relative frequencies. The normality of PA variables and DS scores was assessed through a visual inspection of histograms, and medians and interquartile ranges were described for nonparametric variables at each follow-up.

Crude and adjusted associations between leisure-time, commuting, and total PA, and DS were performed by linear regression models using Stata software, version 15.0. Bidirectional analyses were performed with PA modeled as exposure and later as the outcome. Bootstrap procedures (1000 resampling) were adopted to obtain greater reliability of the 95% confidence intervals. The adjusted analyses included two models, with the regression coefficients and their respective confidence intervals: model 1 included gender, age, skin color/race, education, income, employment status, marital status, smoking, and alcohol consumption; model 2 included all variables from Model 1 and the outcome in the baseline (PA in each domain or DS). All analyses adopted an alpha of 5%.

Results

Figure 1 presents the flow diagram of baseline and follow-up data availability, reaching 515 participants in the analytical sample. Until the 2019 follow-up, 204 deaths were identified.

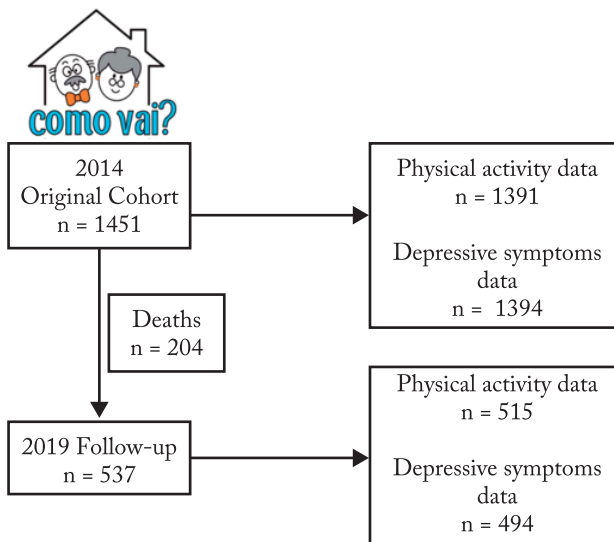


Figure 1 – Flow diagram of follow-ups, physical activity data, and depression symptoms data in the “Como Vai?” Cohort, southern Brazil.

Table 1 describes the sample characteristics, where 63% of respondents were female, and 27.3% of the older adults were between 60 and 64 years old in 2014. Whereas in 2019, the age group of 70 to 74 comprised 34.1% of the sample. The prevalence of episode depressive in the cohort sample was 15.2% in 2014 and 17.6% in 2019. In 2014, 18.5% of older adults reached 150 minutes of PA in the leisure-time domain, 24.8% in the commuting domain, and 41.9% for total PA. In 2019, these prevalences were 24.9%, 17.3%, and 38.6%, respectively.

Table 2 describes the medians of total PA, leisure-time and commuting PA and DS scores for the participants. The median of total PA in 2014 was 120 minutes with interquartile ranges of (20 – 270). The participants had a median of 2 DS in both follow-ups with an interquartile range of (1-3) and (1-4), respectively.

Table 3 shows bidirectional longitudinal associations between PA and DS. The adjusted analyses for sociodemographic and other health behaviors (model 1) showed that minutes of commuting PA performed in 2014 were negative predictors of the DS scale score in 2019 (β : -0.0008 95% CI: -0.0016; -0.0001), as well as total PA (β : -0.0006; 95% CI: -0.0011; -0.0001). These associations were no longer statistically signif-

Table 1 – Characteristics of participants from the “Como Vai?” Cohort, southern Brazil.

	2014 Original cohort (n = 1,453)	2019 Follow-up (n = 537)
	% (95% CI)	% (95% CI)
Gender		
Male	37.0 (34.6; 39.5)	33.6 (29.5; 37.9)
Female	63.0 (60.5; 65.4)	66.4 (62.1; 70.5)
Age		
60-64	27.3 (25.0; 29.6)	0.5 (0.1; 1.4)
65-69	25.0 (22.9; 27.3)	14.4 (12.0; 17.3)
70-74	18.7 (16.7; 20.8)	34.1 (30.6; 37.8)
75-79	13.1 (11.5; 15.0)	23.3 (20.2; 26.7)
≥80	15.9 (14.1; 17.9)	27.7 (24.4; 31.2)
Skin color/race		
White	83.7 (81.7; 85.5)	80.7 (76.9; 84.0)
Not white	16.3 (14.5; 18.3)	19.3 (16.0; 23.1)
Income (quintiles)		
1 (poorest)	20.1 (18.0; 22.3)	22.6 (19.0; 26.7)
2	20.7 (18.6; 22.9)	20.0 (16.6; 23.9)
3	19.6 (17.6; 21.9)	20.0 (16.6; 23.9)
4	19.8 (17.8; 22.0)	16.5 (13.4; 20.2)
5 (wealthiest)	19.8 (17.8; 22.0)	20.9 (17.4; 24.8)
Leisure physical activity		
<150 minutes/week	81.5 (79.3; 83.4)	75.1 (71.2; 78.7)
≥150 minutes/week	18.5 (16.6; 20.7)	24.9 (21.3; 28.8)
Commuting at physical activity		
<150 minutes/week	75.2 (72.9; 77.4)	82.7 (79.1; 85.7)
≥150 minutes/week	24.8 (22.6; 27.1)	17.3 (14.3; 20.1)
Total physical activity		
<150 minutes/week	58.1 (53.6; 62.5)	61.4 (56.9; 65.6)
≥150 minutes/week	41.9 (37.5; 46.4)	38.6 (34.4; 43.1)
Depressive episodes		
No	84.8 (82.8; 86.6)	82.4 (78.8; 85.5)
Yes	15.2 (13.4; 17.2)	17.6 (14.5; 21.2)

% (95% CI) = percentual (95% confidence interval). Depressive episodes (Geriatric Depression Scale – GDS-10): defined that scores ≥ 5 = presence of depressive episode.

icant after adjustment for DS in the baseline (model 2). In addition, leisure-time PA in 2014 was associated with lower DS scores in the crude analysis (β : -0.0008; 95% CI: -0.0016; -0.0001). However, this association was not maintained after adjustments.

When we assessed the association between DS and PA indicators, a negative association with leisure-time PA in 2019 was observed (β : -9.79; 95% CI: -18.81; -0.76) after adjustment for sociodemographic variables and other health behaviors (model 1), but it did not re-

main associated after adjustment for both outcomes in the baseline (model 2). No associations were identified considering commuting and total PA.

Table 2 – Description of physical activity and depression symptoms score at 2014 and 2019 of older adult participants in the Como Vai? Cohort, southern Brazil.

	2014	2019
	Median [II]	Median [II]
Leisure physical activity	0 [0 - 79]	0 [0 - 150]
Commuting physical activity	60 [0 - 150]	40 [0 - 120]
Total physical activity	120 [20 - 270]	90 [0 - 280]
Depression symptoms	2 [1 - 3]	2 [1 - 4]

Median [II] = Median [Interquartile Interval]

Discussion

We evaluated the longitudinal bidirectional association between leisure-time PA, commuting PA and total PA with DS in a population-based cohort of older adults in southern Brazil. In one of the analysis models, with adjustments for sociodemographic aspects, it was observed that weekly minutes of commuting PA and total PA were negative predictors of worse DS scores in subsequent follow-up; at the same time, higher DS scores were predictors of lower leisure-time PA in later follow-up. When we additionally adjusted these analyses for the respective outcome variables measured at baseline, the associations did not remain statistically significant. In other words, the effect of commuting PA and total PA could have been confounded by the DS levels already existing in the baseline. Likewise, the effect of DS on lower levels of leisure-time PA could have been

confounded by previous levels of PA in this domain.

Some studies that found an association between PA and DS did not consider baseline adjustment for the outcome in their analyses^{9,22}. However, due to potential bidirectionality, that is, the fact that these factors affect the risk of depression or the level of PA, this analytical approach should be considered⁸. Furthermore, some recent investigations of bidirectional association analysis^{1,6,23} have not clearly addressed which outcomes were adjusted for at baseline, which might modify the interpretation of the real effect of associations.

In fact, the disappearance of the associations found in this study highlights the possibility that neither PA impacts DS longitudinally, nor the opposite, but that there is confusion due to the outcome already established at the time of baseline. Thus, the loss of association from the inclusion of PA in the baseline as a covariate, for example, can demonstrate the influence of PA levels in the first moment and that, in this way, the linear reduction in PA in the second moment can be impacted due to PA levels already reduced at baseline. Therefore, the effects of these associations or the lack of them may partly have component causes, as they are factors that tend to vary over time. Furthermore, recent investigations suggest that lower PA in people with depression may reflect a trait rather than a state characteristic, i.e., it may be a characteristic of the individual's personality¹².

In this context, few studies explored the bidirectional investigation of DS and leisure-time PA²³, especially in older adults, which consider that aggravated DS can lead to a reduction in the practice of leisure-time PA⁸. Our results did not demonstrate that DS has a neg-

Table 3 – Bidirectional longitudinal associations between leisure, commuting, and total PA and depressive symptoms in older adults people from the *Como Vai?* Cohort, southern Brazil.

	Crude β (95% CI)*	p-value	Model 1 Adjusted β (95% CI)**	p-value	Model 2 Adjusted β (95% CI)***	p-value
	Leisure physical activity at 2014 → Depressive symptoms at 2019	-0.0008 (-0.0016; -0.0001)	0.023	-0.0006 (-0.0013; 0.0001)	0.059	-0.0002 (-0.0008; 0.0005)
Commuting physical activity at 2014 → Depressive symptoms at 2019	-0.0013 (-0.0021; -0.0005)	0.001	-0.0008 (-0.0016; -0.0001)	0.045	-0.0004 (-0.0013; 0.0006)	0.463
Total physical activity at 2014 → Depressive symptoms at 2019	-0.0008 (-0.0013; -0.0003)	0.003	-0.0006 (-0.0011; -0.0001)	0.031	-0.0002 (-0.0007; 0.0003)	0.460
Depressive symptoms at 2014 → Leisure physical activity at 2019	-18.87 (-28.25; -9.48)	<0.001	-9.79 (-18.81; -0.76)	0.034	-6.11 (-14.95; 2.73)	0.175
Depressive symptoms at 2014 → Commuting physical activity at 2019	-13.24 (-23.20; -3.27)	0.009	-5.03 (-13.37; 3.31)	0.238	-5.08 (-13.68; 3.53)	0.248
Depressive symptoms at 2014 → Total physical activity at 2019	-32.34 (-49.22; -15.45)	<0.001	-15.22 (-31.97; 1.54)	0.075	-9.43 (-25.68; 6.82)	0.255

β (95%CI) = Linear regression coefficient (95% confidence interval). * no Adjustment. **Model 1: Adjusted for gender, age, skin color, schooling, income quintiles, employment status, marital status, smoking, and alcohol. ***Model 2: Adjusted for gender, age, skin color, schooling, income quintiles, employment status, marital status, smoking, alcohol and outcome in baseline (symptoms depressive or physical activity).

ative impact on the practice of leisure-time PA after adjustment. A similar investigation, which excluded in its analysis participants with previous DS and who were physically inactive at the beginning of the study, showed that lower risks of DS were associated with the practice of PA. However, they did not observe an inverse association⁸. In contrast, a longitudinal investigation, but with adolescents, observed that higher depressive symptom scores were associated with a decrease in PA over time²³. It is worth noting that this investigation does not clearly address which covariates were adjusted at baseline for bidirectional association analysis. Furthermore, differences in age groups include other independent variables, which makes comparability between investigations difficult.

Another PA domain explored in our investigation was commuting PA. The way older people and adults transport themselves is the subject of recent investigations, suggesting that the environment may be fundamental to this promotion, bringing important impacts to mental health^{24,25}. Our results regarding commuting PA and DS are not comparable with the national health survey in Brazil, as this is a cross-sectional investigation, but it is worth addressing some results found in this investigation. Although this research was carried out with a cross-sectional design and with adults in general (not specifically with older adults), the association of the four domains of PA with DS was evaluated. The authors observed that commuting PA was associated with lower DS among adults²⁶. In the same direction, Coker et al.²⁷, in a cross-sectional analysis with 261,121 adults, observed that the practice of commuting PA is associated with a lower prevalence and severity of DS²⁷.

The results found in our analyses are similar to some studies that investigate the possible bidirectional association between PA and DS in longitudinal studies^{6,8}. Both investigations^{6,8} found no bidirectional association. For the bidirectional association analyses, Ku et al.⁸ added the exclusion of participants with previous DS at the beginning of the study in their third analytical model. The results found in this model suggest that greater PA at baseline was associated with a slower increase in DS among older adults who had not yet become depressed. However, in the subsequent model, when analyzing DS as exposure and PA as outcome, excluding participants who were physically inactive at the beginning of the study, no significant association was found.

Finally, our investigation found the importance of bidirectional association research clearly addressing in its studies which outcomes (PA and/or DS) are being adjusted at baseline. This approach was enlightening in our investigation and allowed us to conduct the discussion of the topic without bringing about a misinterpretation in relation to both outcomes investigated.

These inconsistencies in the associations may be linked to the way of measuring and classifying PA as reported by Choi et al.⁶, and to the differences in adjustment variables that are often not well detailed in publications. The same authors observed only one direction in the associations, in this case, the protection of PA for depression measured objectively, however, they did not find an association when they assessed PA by self-report. Another investigation that found bidirectionality assessed mental health as a whole and adjusted for baseline PA and other covariates¹³. However, this study assessed PA through the total weekly hours of PA converting into standardized Metabolic Equivalent of Task (MET) values, which are multiples of the basal metabolic rate, that differs from our investigation¹³. Apparently, it may be necessary to evaluate PA by domains concomitantly with other objective measures, such as accelerometry¹⁰, as this can be an efficient indicator to detect greater effects and thus a more detailed description of PA and its relationship with DS.

Despite the inconsistencies in the association being explored, it is evident that increasing the support network for the older population in cities in the interior of Brazil and providing social support for the practice of PA with access to safe environments, and green and blue spaces, are essential to minimize DS, as reported by World Health Organization²⁴. It is worth noting that sometimes inland cities do not have the same infrastructure favorable to the practice of PA found in metropolitan regions. Furthermore, it is necessary for urban planning and its adaptation to consider the needs of municipalities with civil society participation in decision-making²⁸, which is sometimes not considered in government actions. There is a field with a range of opportunities for intersectoral actions to support the mobility of older adults²⁵, where the environment is considered as a favorable determinant of physical and mental health.

Furthermore, it is worth highlighting that, like the Brazilian population in general, the cohort under study has low PA levels²¹, which imply health problems. Although our findings do not indicate bidirectionality between PA and DS, public policies for people with

depression should consider it, as the positive impact of PA in reducing DS is well established^{3,4}. On the other hand, it is known that the worsening of symptoms can result in harm to both the mental and physical health²⁹. In practice, given the mental health scenario in the country with high rates of depression diagnosis³⁰ along with difficulty in accessing specialized treatment, it is relevant to discuss the monitoring of DS as well as counseling and guidance regarding PA performance when approaching older adults in routine consultations in primary care. This approach could signal possible worsening in terms of physical and mental health, making evident the importance for physical education professionals to be included in primary care³¹.

As far as we know, our study is one of the pioneers to present results of bidirectional and longitudinal association analyses between PA in different domains and DS in a cohort of older adults. The design of a population-based prospective cohort in a middle-income country and the sample size are strengths of our study. Furthermore, we show results of associations by PA domains where we use analysis models adjusted for sociodemographic aspects and, additionally, we adjust for the respective outcomes at baseline.

We point out as a limitation the fact that PA information is self-reported and, therefore, vulnerable to memory bias and social desirability. Although there are limitations in the use of self-reported PA measures, the instrument used in this study is validated, being applied in other follow-up studies, and important for differentiating domains of practice. Another limiting point is that our last follow-up analysis (2019/20) had to be interrupted due to the start of the Covid-19 pandemic, and as a result it was not possible to monitor all older adults, but approximately 60% of the estimated interview target was reached. Furthermore, the adjustments and sample loss during follow-up resulted in a reduction in sample, which could lead to a lack of statistical power, as suggested by the small magnitude of the effects found.

No bidirectional association was found between PA by domains and DS in the older adults' cohort studied, and when we additionally adjusted the analyses for both outcomes at baseline, the associations did not remain. These results show how complex the relationship between PA and DS is. Therefore, further longitudinal investigations are necessary to address more time points and other ways of measuring PA, objectively and subjectively, complementing the analysis by domains. Bringing

a better understanding of these relationships is seeking more clarity in the field of mental health and, thus, also showing how PA can be essential for healthy aging.

Conflict of Interest

The authors declare no conflict of interest.

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Authors' contributions

Silva BS: Conceptualization; Methodology; Formal analysis; Investigation; Resources; Data curation; Supervision; Project administration; Visualization; Writing – original draft; Writing – review & editing; Approval of the final version. Tornquist D: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data curation; Visualization; Writing – review & editing; Approval of the final version. Wendt A: Conceptualization; Methodology; Validation; Formal analysis; Investigation; Data curation; Writing – review & editing; Approval of the final version. Bertoldi AD: Conceptualization; Methodology; Software; Investigation; Supervision; Writing – review & editing; Approval of the final version. Tomasi E: Conceptualization; Methodology; Software; Investigation; Supervision; Writing – review & editing; Approval of the final version. Gonzalez MC: Conceptualization; Methodology; Software; Investigation; Supervision; Writing – review & editing; Approval of the final version. Bielemann RM: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data curation; Supervision; Project administration; Visualization; Funding acquisition; Writing – original draft; Writing – review & editing; Approval of the final version. Crochemore-Silva I: Conceptualization; Methodology; Formal analysis; Investigation; Supervision; Visualization; Writing – review & editing; Approval of the final version.

Declaration regarding the use of artificial intelligence tools in the article writing process

The manuscript did not use artificial intelligence tools for its preparation.

Availability of research data and other materials

The contents are already available

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