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The level of physical activity as an intervening factor in the cognitive state of primary care older adults

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Abstract *This study proposed to evaluate the level of physical activity and the cognitive state of elderly users of Primary Care Facilities (UBS) of the Municipality of Maringá, State of Paraná, Brazil. This is a descriptive, cross-sectional, epidemiological study with 654 elderly men and women UBS users. A sociodemographic questionnaire, the Mini Mental State Examination (MMSE) and the short version of the International Physical Activity Questionnaire (IPAQ) were employed. Data was analyzed using the Kolmogorov-Smirnov, Chi -square, Kruskal-Wallis and Mann-Whitney "U" tests, with a significance level of p<0.05. However, they evidenced a high score in temporal orientation (Md = 5.0), spatial orientation (Md = 5.0), immediate memory (Md = 3.0), recall (Md = 3.0) and language (Md = 8.0). When comparing the mental state according to the level of physical activity of the elderly, we observed that very active/ active individuals had better attention and calculation (p = 0.036), recall (p = 0.001) and general cognitive status (p = 0.002) against irregularly active and sedentary elderly. Adequate levels of physical activity may be related to better scores of cognitive functions of elderly subjects.*

Key words *Motor activity, Cognition, Gerontology, Health promotion*

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Introduction

The aging process is accompanied by various modifications, such as changes in bodily composition (reduced muscle mass and increased body fat), lower muscle strength, flexibility, functional capacity, all associated with a decline of physical activities and cognitive performance in the elderly population[1-4]. This adverse situation observed in aging can lead to possible complications such as physical disability, development of cardiovascular and metabolic diseases, multimorbidities or frailty syndrome[4-6].

Another important factor is cognitive impairment of the elderly during aging, leading to memory deficit and declining performance of their daily activities, such as reading, logical and abstract reasoning, spatial skills and verbal abilities[7]. There are three types of cognitive changes, namely, normal cognitive aging, cognitive impairment and dementia[8,9].

Physical activity in aging improves physical fitness and cognitive function of the elderly. The regular practice of physical exercise develops positive changes, triggering angiogenesis and increased cerebral blood flow, synaptogenesis and neurogenesis[10].

Physical exercise improves cognitive performance and may increase selective attention and short-term memory. Thus, several studies evidencing that moderate or intense physical activity may be a non-pharmacological treatment for improved cognition. A study carried out in the city of Florianópolis with 875 sedentary elderly showed worse mental health and a significant increase of depressive symptoms[11].

Regular physical exercise can prevent or even reverse frequent problems found in the elderly during aging, reducing the noxious effects of cognitive decline[12-14]. However, the number of inactive elderly people who do not engage in any daily or physical activity is alarming, making physical inactivity the fourth leading cause of death in the world[15,16].

Studies on regular physical activity in the elderly and the cognitive profile of this population should be investigated because of the association between levels of physical activity that may affect the cognitive functions of the elderly[12,17-19]. Thus, this study proposed to evaluate the level of physical activity and cognitive state (Mini Mental State Examination) of elderly users of the Primary Health Facilities of the Municipality of Maringá, Paraná.

Methods

Participants

According to data obtained from the Health Secretariat of Maringá (PR), the target population consists of 42,258 elderly people (2016). The initial sample totaled 595 elderly people, adding 10% to provide for possible losses. The final sample consisted of 654 elderly men and women, considering a 95% confidence level and 4% error margin. The software used for calculations was StatDisk version 8.4.

The UBS in which the elderly are included were subdivided into four regions: East (7 UBS), with 21.8% of the elderly; North (8 UBS), with 34.5%; West (8 UBS), with 23.2%; and South (8 UBS), with 20.4% of the elderly population the city. Knowing the composition of the regions, three UBS were drawn to be evaluated in each of the regions.

After defining the size of the sample in each region and selecting the UBS, it was important to keep the proportion of the elderly population in the sample. Thus, calculations to obtain the final sample by UBS and gender were proportional to the population.

Included in the study were elderly people of both genders, aged 60 years and over, with preserved speech and hearing ability, which allowed the application of questionnaires. The Mini Mental State Examination (MMSE) was used to exclude elderly people with significant cognitive impairments. The MMSE consists of questions grouped into seven categories: temporal orientation (maximum score of 5), spatial orientation (maximum score of 5), registration of three words (maximum score of 3), attention and calculation (maximum score of 5), memory of the three words – recall (maximum score of 3), language (maximum score of 8) and visual construction ability (maximum score of 1). The higher the score in each realm, the better its cognitive state[20]. The cut-off scores used for exclusion by the MMSE were 17 for the illiterate; 22 for the elderly with 1-4 years schooling; 24 for those with 5-8 years schooling and 26 for those with 9 years or more schooling. These cut-off points were based on the criteria of Brucki et al[21]. They correspond to the mean obtained by these authors for each schooling range, minus one standard deviation. Elderly classified below the cut-off point specific to their schooling were excluded.

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Tools

A semi-structured questionnaire was used to characterize the sociodemographic and health profile of the elderly, consisting of information regarding age (60-69 years, 70-79 years, 80 years and over), gender (male, female), marital status (married or living with the partner, single, divorced, separated or widowed), ethnicity (white, black, other), monthly income in minimum wages (MW) of reference of the 2016 Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE) (R$ 880.00) (1-2 MW, 2.1-3 MW and more than 3 MW), retirement (yes/no), schooling (did not study, incomplete elementary school, complete elementary school, complete secondary school and higher education), self-perceived health status (bad, fair, good, very good) and number of medications used (none, 1-2, more than 2).

The physical activity level of the elderly was evaluated using the short version of the International Physical Activity Questionnaire (IPAQ). It consists of seven open questions and its information allows estimating the time spent per week in different realms of physical activity (walking and moderate and vigorous and physical activities) and physical inactivity (sitting position). The level of physical activity was classified as sedentary (elderly people who did not perform any physical activity for at least 10 continuous minutes during the week.), irregularly active (elderly individuals who perform physical activity, however, insufficiently to be classified as active because they do not follow the recommendations regarding frequency or duration), active (elderly people who performed at least 3 days of vigorous activity for at least 20 minutes; or 5 days or more of moderate activity or walking for at least 30 minutes; or at least 5 days and 150 minutes per week of any type of physical activity) or very active (elderly who performed vigorous activities for at least 5 days a week, 30 minutes per session; or at least 3 days a week of vigorous activity, at least 20 minutes per session, plus moderate activities or walking, for at least 5 days a week and 30 minutes per session). Sedentary behavior was assessed by means of the mean sitting time on a weekday, and on a weekend day[22].

Data collection procedures

The Research Ethics Committee of the University Center of Maringá (UNICESUMAR) approved this epidemiological cross-sectional, population-based study. Data were collected in 12 UBS over the four regions (North, South, East and West) from the 33 UBS of the municipality of Maringá that were selected by draw following authorization from CECAPS. The elderly volunteers were addressed by the researcher in charge or by the research team at the UBS, were informed about the justification, objectives and procedures to be carried out, according to human research guidelines set forth in Resolution Nº 466/12 of the National Health Council. Elderly in the UBS waiting room were approached. After these procedures, those who accepted to participate in the research signed the Informed Consent Form (ICF). Direct interview in the application of the questionnaires was chosen, due to the possible difficulty of reading, visual impairments and comprehension of questions. On average, questionnaires were answered within 15 minutes.

Data review

Data review used frequency and percentage for categorical variables. Regarding numerical variables, data normality was initially verified by means of the Kolmogorov-Smirnov test. As data did not show normal distribution, Median (Md) and Quartiles (Q1; Q3) were used to characterize results. In inferential statistics, the chi-square test was used to investigate the association between the level of physical activity, sociodemographic and health variables and prevalence of comorbidities of the elderly. In the comparison of the level of physical activity by number of associated comorbidities, the Kruskal-Wallis test followed by the Mann-Whitney "U" test were used for pairs of groups. A level of significance of $p<0.05$ was considered.

Results

There was a prevalence of female elderly (56.0%), married (61.3%), aged 60-69 years (59.2%), with a monthly income of 1-2 minimum wages (70.0%), Caucasian (81.0%) and retired (75.0%). We also observed that most elderly have incomplete elementary school education (43.0%). In relation to the health profile of primary care elderly users in the city of Maringá, we found that most have good self-perceived health (48.5%), take 1-2 medications regularly (43.9%), had no history of falls (83.7%) or almost falls in the last 6 months (79.7%) and an active/very active level of activity (60.7%).

According to findings in Table 1, the elderly do not perform vigorous physical activities and few moderate activities during the week. However, in relation to walking, the elderly showed median walking days of 3.0, as a median of 40 and 140 walking minutes per day and per week, respectively.

In relation to the mental state (Table 1), the elderly showed a high score in temporal orientation (Md = 5.0), spatial orientation (Md = 5.0), immediate memory (Md = 3.0), recall (Md = 3.0) and language (Md = 8.0), with a moderate score for attention and calculation (Md = 2.0). The elderly had a median score of 25.0 in the overall cognitive state.

When comparing the mental state according to the level of physical activity of primary care elderly users in the city of Maringá (Table 2), there was a significant difference between the groups in mental state in attention and calculation ($p = 0.036$), mental state in recall ($p = 0.001$) and in the overall cognitive state ($p = 0.002$). This finding seems to indicate that the very active/active elderly achieved a higher score in these cognitive realms compared to those with lower level of physical activity.

The following significant correlations ($p < 0.05$) were observed when analyzing the correlation between the variables of physical activity and mental state (Table 3): temporal orientation with walking days ($r = 0.13$); spatial orientation with days of vigorous activity ($r = -0.17$), minutes of vigorous activity per day ($r = -0.16$) and minutes of vigorous activity per week ($r = -0.16$); attention and calculation with walking days ($r = 0.12$), minutes of walking per day ($r = 0.16$) and minutes of walking per week ($r = 0.16$); recall with walking days ($r = 0.20$), minutes of walking per day ($r = 0.26$), minutes of walking per week ($r = 0.25$), days of vigorous activity ($r = 0.16$), minutes of vigorous activity per day ($r = 0.16$) and minutes of vigorous activity per week ($r = 0.14$); language with walking days ($r = 0.11$); overall cognitive status with walking days ($r = 0.20$), walking minutes per day ($r = 0.16$) and walking minutes per week ($r = 0.19$).

Table 1. Physical activity level and mental state of the elderly users of primary care in the city of Maringá (PR), Brazil.

Variables	Md	Q1-Q3
Physical activity		
Walking days	3.0	2.0-6.0
Min. of walking p/day	40.0	20.0-90.0
Min. of walking p/week	140.0	60.0-420.0
Days of moderate activity	1.0	0.0-3.0
Min. of moderate activity p/ day	20.0	0.0-60.0
Min. of moderate activity p/ week	30.0	0.0-180.0
Days of vigorous activity	0.0	0.0-0.0
Min. of vigorous activity p/ day	0.0	0.0-0.0
Min. of vigorous activity p/ week	0.0	0.0-0.0
Mental state		
Temporal orientation	5.0	5.0-5.0
Spatial orientation	5.0	5.0-5.0
Immediate memory	3.0	3.0-3.0
Attention and calculation	2.0	1.0-4.0
Recall (memory)	3.0	2.0-3.0
Speech	8.0	7.0-8.0
General cognitive state	25.0	23.0-27.0

Discussion

The main results of this study show that older people with higher levels of physical activity have better scores of overall cognitive status when compared with subjects who evidenced low level of physical activity and/or sedentary lifestyle.

Some variables may negatively influence cognitive functions in aging. Among these, the schooling level of the elderly in this study may have affected the results shown here, since 43% of the subjects did not have complete elementary school level education.

Despite this, good levels of physical activity and regular exercise can be a great tool to combat such cognitive dysfunctions in this population. Literature shows that adequate amounts of physical activity and physical exercises can enhance cerebral morphological aspects, such as increased brain mass in various regions of the brain, among which we highlight the hippocampus (a region responsible for learning and memory functions). In addition, improvements can be observed in biochemical mediators that can trigger changes in the brain and its cognitive functions[18,19,23,24], and the increase of some of these mediators, such as neurotrophins, can help in the maintenance, growth of neurons, thus improving the subject's neural plasticity.

An important factor for healthy aging is always maintaining good levels of physical activ-

Table 2. Comparison of the mental state according to the level of physical activity of elderly users of primary care in the city of Maringá (PR), Brazil.

Variables	Level of physical activity			P
	Very active/active	Irregularly active	Sedentary	
	Md (Q1;Q3)	Md (Q1;Q3)	Md (Q1;Q3)	
Temporal orientation	5.0 (5.0-5.0)	5.0 (5.0-5.0)	5.0 (5.0-5.0)	0.130
Spatial orientation	5.0 (5.0-5.0)	5.0 (5.0-5.0)	5.0 (5.0-5.0)	0.180
Immediate memory	3.0 (3.0-3.0)	3.0 (3.0-3.0)	3.0 (3.0-3.0)	0.853
Attention and calculation	3.0 (1.0-5.0)[a]	2.0 (0.3-4.0)	2.0 (0.5-3.0)	0.036*
Recall (memory)	3.0 (2.0-3.0)[b]	2.0 (0.3-4.0)	2.0 (0.5-3.0)	0.001*
Speech	8.0 (7.0-8.0)	8.0 (6.0-8.0)	8.0 (7.0-8.0)	0.676
General cognitive state	25.0 (23.0-28.0)[c]	24.5 (22.0-26.0)	24.0 (22.0-25.0)	0.002*

* Significant difference: $p < 0.05$ – Kruskal-Wallis test – between: a) Very active/Active and Sedentary; b) Very active/Active and Irregularly active and Sedentary; c) Very active/Active and Irregularly active and Sedentary.

Table 3. Correlation between the level of physical activity and the mental state of the elderly.

Variables	Level of physical activity							Mental state							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.		0.56*	0.77*	0.23*	0.14*	0.18*	-0.06	-0.08	-0.07	0.13*	0.07	0.08	0.12*	0.20*	0.11*	0.20*
2.			0.89*	0.26*	0.31*	0.28*	0.02	0.01	0.01	0.04	-0.07	0.10	0.16*	0.26*	-0.01	0.16*
3.				0.26*	0.26*	0.30*	0.02	0.01	0.01	0.06	-0.04	0.10	0.16*	0.25*	0.04	0.19*
4.					0.86*	0.93*	0.47*	0.47*	0.47*	0.08	-0.06	-0.02	0.05	0.16*	-0.05	0.06
5.						0.94*	0.50*	0.53*	0.53*	0.05	-0.09	-0.01	0.06	0.16*	-0.07	0.06
6.							0.51*	0.53*	0.53*	0.06	-0.08	-0.01	0.06	0.14*	-0.02	0.07
7.								0.98*	0.98*	0.02	-0.17*	-0.03	-0.02	0.04	-0.02	-0.05
8.									0.99*	0.02	-0.16*	-0.02	-0.01	0.04	-0.01	-0.04
9.										0.01	-0.16*	-0.02	-0.01	0.04	-0.01	-0.04
10.											0.20*	0.08	0.13*	0.12*	0.07	0.30*
11.												0.09	0.08	-0.06	0.16*	0.28*
12.													0.15*	0.12*	0.22*	0.27*
13.														0.06	0.27*	0.83*
14.															-0.03	0.32*
15.																0.53*
16.																

* Significant Correlation – $p < 0.05$. Note: 1. Walking days; 2. Min. of walking p/day; 3. Min. of walking p/week; 4. Days of moderate activity; 5. Min. of moderate activity p/day; 6. Min. of moderate activity p/week; 7. Days of vigorous activity; 8. Min. of vigorous activity p/day; 9. Min. of vigorous activity p/week; 10. Temporal orientation; 11. Spatial orientation; 12. Immediate memory; 13. Attention and calculation; 14. Recall (memory); 15. Speech; 16. General cognitive state.

ity, both for physical and mental health[19,25]. The World Health Organization[16] states that regular exercise has the power to prevent, minimize and/or reverse many of the problems that often accompany the aging process.

Physical exercise can influence cognitive performance and its neurological functions for several reasons: a) due to increased neurotransmitter levels and changes in brain structures (this would be evidenced in the comparison of physically active vs. sedentary individuals); b) cognitive improvement observed in individuals with mental impairment (based on comparison with healthy individuals); c) in the limited improvement obtained by elderly individuals, due to a lower mental/attentional flexibility when compared to a young group[18,25].

Based on this assumption, we must also emphasize that the action of physical exercise on cognitive function can be direct or indirect.

Mechanisms that directly act to increase the speed of cognitive processing would be an improvement in the cerebral circulation and change in the synthesis and degradation of neurotransmitters. In addition to direct mechanisms, others, such as a decrease in blood pressure, declining LDL and triglyceride levels in the blood plasma, and inhibition of platelet aggregation appear to act indirectly, improving these functions and the overall functional capacity, thus reflecting increased quality of life[26].

Epidemiological data suggest that moderately active people are less likely to be affected by mental disorders than sedentary ones, showing that participation in physical exercise programs has physical and psychological benefits, and that physically active individuals are likely to have faster cognitive processing[4,19].

It is noteworthy that other changes occur concomitantly to these neurophysiological and cognitive changes during the aging process. Among these, we can highlight those in bodily composition, which, in turn, may be closely related to worse cognitive functions[27,28]. This association, especially increased body fat and cognitive decline, is related to changes in inflammatory mediators caused by fat accumulation[29]. This increased systemic inflammation can reach central levels, causing such molecules to cross the hematopoietic barrier, which in turn, will cause inflammation in the cerebral tissue, thus ensuing tissue damage and death of neurons and, ultimately, worse cognitive functions[30].

In other words, while physical exercises and physical activity already have a positive impact on cognitive functions, adequate body weight is an ally against these aging dysfunctions.

Given the relevance of findings on the subject and due to the impact of exercise on cognition and consequently on the quality of life of the elderly, further studies are required in this field. Specifically in Brazil, where this relationship is still poorly explored, works on the subject may be relevant to the knowledge of habits related to the activities and their consequences for our population.

Conclusion

The results of this study may help professionals to prescribe physical activities and exercises, since they provide relevant information, showing that physically active elderly are more likely to sustain their cognitive functions during the aging process.

Thus, we conclude that adequate levels of physical activity (~ 150 min/week) may be related to better scores of cognitive functions of elderly subjects.

Collaborations

DV Oliveira participated in the general orientation of the study, data collection and data analysis. VB Oliveira, GA Caruzo participated in the data collection and writing of the article. AG Ferreira participated in the writing of the article. PMC Fabro and JRA Nascimento Júnior participated in the data analysis. CR Cavaglieri participated in the general orientation of the study and data analysis.

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