Comparison of static balance and mobility between nursing home residents and community-dwelling elderly.

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ABSTRACT

Background: Postural control is considered to be a complex motor skill derived from the interaction of multiple sensorimotor processes. **Objectives:** To compare the static balance and mobility of nursing home residents with community-dwelling elderly and verify which confounders imply in a worse postural balance on nursing home residents. **Methods:** Were included elderly aged 60 and more, both sexes, living at nursing homes (NHs) and at the community. The static balance was evaluated by a force platform and the mobility by the Timed Up and Go test (TUG). The confounders available were length of institutionalization, age, gender, body mass index, number of falls and number of medication. Comparisons were made by unpaired t-tests and by the Mann-Whitney test. The risk of falls was evaluated by Fisher's Exact Test. Pearson or Spearman correlation analysis was performed to identify the independent variables with a significant relationship with the dependent variables. The simple linear regression analysis and R2 was analyzed to ascertain the coefficient of determination of the percentage variation. A value of p≤0.05 was considered significant. **Results:** 21 nursing home residents and 21 community-dwelling elderly were included. The NHs residents presented significantly higher values of COP oscillation than the community group (total displacement: p=0.0002; mean velocity: p=0.001, 95% ellipse area: p=0,04, and standard deviation in the frontal plane: p=0.01). The NHs group presented longer time to perform the TUG test than the community group (17.28±4.5 s and 13.21±3.9 s, p=0.002). Was observed that the number of medications showed a significant correlation with the TUG (r=0.52; p=0.01), and none variable showed correlation with the static balance. **Conclusion:** The results showed that the nursing home residents with a normal cognitive condition had greater center of gravity oscillation, worse mobility, and higher risk of falls than community elders. In addition, it was found that in nursing home residents, the ingestion of five or more drugs had relation with mobility.

Key-words: Elderly; Postural Balance; Nursing ome.

INTRODUCTION

Postural control is considered to be a complex motor skill derived from the interaction of multiple sensorimotor processes[1].

Studies in elderly established that many aspects of motor control are affected by aging, causing slower and less coordinated movements.[2,3] The decline in postural stability is caused by a decrease in the sensitivity of neural receptors, a decrease in the speed of the central processing systems of the brain, cognitive decline, and the decreased potential of power production in motor systems.[4] One of the complications of changes in postural control is the occurrence of falls, which, besides to be responsible for the reduction of activities of daily living, may lead to the institutionalization of the elderly.[5]

Seniors living in nursing homes (NHs) are a complex population, characterized by high prevalence of dependency in activities of daily living (ADLs), multimorbidity, and polypharmacy.[6] When compared with community-dwelling elderly, nursing home residents have fewer opportunities to independently participate in activities and tasks of daily living (e.g., domestic or recreational) that could minimize and/or alleviate the effects of aging.[7] Ikezoe et al. (2013) showed that the elderly women living in nursing homes spent 56.9% of their daytime sitting and 17.4% lying down, suggesting that this population spends a lot of time sedentary and inactive, even during the daytime[7].

Nursing home residents present a reduction in their physical abilities (muscular strength, aerobic resistance, and flexibility), which, together with a sedentary lifestyle, influence their daily function, altering their gait and balance[8]. The literature indicates that 30% of the community-dwelling elderly suffers one or more falls each year and that nursing home residents are approximately three times more likely to fall compared with their community-dwelling counterparts[9]. The intrinsic risk factors for falls are generally recognized,

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such as age, functional disabilities, chronic diseases, gait disturbances, and fear of falling[10]. Fall-related costs ranged between 0.85% and 1.5% of the total health care expenditures in developed countries[11].

The center of pressure (COP) oscillation is commonly used as an index for postural stability[12] and, in the last years, the preferred method of measuring COP has been the posturography by a force platform[13]. With this instrument, is possible evaluate the COP trajectories in the frontal plane (*X*-direction) and sagittal plane (*Y*-direction), the velocity of body oscillation and the body displacement area by the center of pressure (COP) related to the support base. From a biomechanical perspective, COP provides a first approximation to the location of the body's center of mass over the standing surface, and an increased COP fluctuation is taken as a sign of poor balance control[14]. Balance tests based on force platform registrations indicate changes in balance among older subjects in longitudinal designs and are predictive of survival among older people[15]. Poor results in force platform tests are also associated with difficulties in activities of daily living functions[16].

Some studies have examined the static balance of the community-dwelling elderly and in NHs[12,17] using a force platform, but no studies were found using this balance assessment tool, comparing these populations. So, there is a knowledge gap in comparing the static balance between these two groups of elderly people in the same study using the posturography. Understanding how the balance and mobility of nursing home residents behave is important to improve recovery techniques and postural balance training for this population.

OBJECTIVE

To compare the static balance and mobility of nursing home residents with community-dwelling elderly and verify that confounders imply in a worse postural balance on nursing home residents.

METHODS AND PROCEDURES

This was a cross-sectional study of a convenience sample, evaluated between March and December of 2016. All volunteers of community enrolled in the study were selected in the same way: primary health units, health centers, community centers and geriatric clinics. The volunteers of nursing homes were selected in two nursing homes at a city of Marília, São Paulo, Brazil. Written informed consent was obtained from all patients before enrollment. The study was approved by the Research Ethics Committee of the Faculty of Philosophy and Sciences, Universidade Estadual Paulista (UNESP), Marília, São Paulo, Brazil, and was conducted in accordance with Resolution No. 196/96 of the National Health Council (Protocol 1.591.817).

Inclusion and exclusion criteria in sample

Subjects with neurological or musculoskeletal disorders (information extracted from medical records), pain that interfered with their daily activities, with lower extremity joint replacement, orthostatic postural hypotension, and abnormal scores on the Mini-Mental State Examination according to the educational level (20 for illiterates; 25 for schooling level of 1 to 4 years; 26.5 for 5 to 8 years; 28 for 9 to 11 years; and 29 for higher levels of education),[18]. were not included. In addition, participants who were using psychoactive or vasoactive medications at the time of the evaluation were also not included. The same criteria were applied to both groups.

Balance evaluation

Center of pressure (COP) data were obtained using an AMTI® force platform (AccuSway Dual Top, Watertown, MA, USA). Data were sampled at 100 Hz and normalized by the body mass index. The subjects completed three consecutive experiments and each attempt was recorded for 30 s with open and closed eyes and were instructed to remain as still as possible, barefoot, looking forward, feet not exceeding shoulder width and arms at their sides.[19]. The parameters were processed using the AMTI's Balance Clinic® software for clinical balance, with following calculations:

-total displacement: $l_{path} = \sum_{i=2}^{n} \sqrt{(x_i - x_{i-1})^2 + (y - y_{i-1})^2}$

- X-SD (standard deviation in the frontal plane): $x_{sd} = \frac{1}{n} * \sqrt{\sum_{i=1}^{n} (X_i - x_{avg})^2}$

- Y-SD: standard deviation in the sagittal plane: $y_{sd} = \frac{1}{n} * \sqrt{\sum_{i=1}^{n} (y_i - y_{avg})^2}$

- mean velocity: $t_{unit} = \frac{l_{path}}{t}$

- 95% of ellipse area: $A = \pi * \sqrt{F * (x_{sd}^2 + y_{sd}^2 + D)} * \sqrt{F * (x_{sd}^2 + y_{sd}^2 - D)}$

Mobility was evaluated by the *Timed Up and Go* test (TUG). The TUG has been recommended as a simple fall risk screening tool, primarily to identify people warranting more detailed assessment of mobility.[20]. The test measures the time (in seconds) necessary for a person to rise from a chair with armrests, walk 3 meters at a comfortable walking speed, turn, return to the chair, and sit down. According to Trueblood et al., TUG time fewer than 9 seconds indicates low risk of falls, between 10 and 13 seconds moderate risk of falls, and 14 seconds or more indicates a high risk of future falls, with good sensitivity (75% -87%) and specificity (67% -87%) in community-dwelling older adults[21]. In a study, Alexandre et al.[22]. showed that the best predictive value for Brazilian elderly individuals was 12.47 seconds, with 73.7% sensitivity, 65.8% specificity and area under the ROC curve of 0.68 (95%CI:0.54-0.83). Thus, older people with values over 12.47s in the TUG test have a higher risk of falling.

Statistical analysis

The normality of the data was verified by the Shapiro-Wilk test. Comparisons were made by unpaired t-tests when the sample was considered normal and by the Mann-Whitney test when the sample was considered not normal. The relative risk of falls was evaluated by Fisher's Exact Test, considering values above 12.4 s for the TUG test as an increased risk of falling. Pearson or Spearman correlation analysis was performed to identify the independent variables with a significant relationship with the dependent variables. The variables that showed significant correlation were initially included in the simple linear regression analysis and R2 was analyzed to ascertain the coefficient of determination of the percentage variation. For all analyses, a value of $p < 0.05$ was considered significant.

The effect size for the variables, with probability of error of 5%, was: total displacement: 1.27 [Power (1-β err prob): 0,98]; mean velocity: 0.84 [Power (1-β err prob): 0.79]; 95% of ellipse area: 0.60 [Power (1-β err prob): 0.47]; *Timed up and Go*: 0.96 [Power (1-β err prob): 0,92].

RESULTS

Table 1 shows the characterization of the sample related to age, time of institutionalization, body mass index, and amount of medication.

Tables 2 and 3 show the mean values of the static balance variables between nursing homes residents and community with open and closed eyes, respectively.

Figure 1 shows the comparison of TUG test results between institutionalized and community-dwelling elder. The relative risk of falls based on TUG test showed that nursing home residents are 3.3 times more likely to have values greater than 12.4 s on the TUG test than community elders (p = 0.03; 95% Confidence Interval = 0.93 to 12.18), showing a higher risk of falls in this population.

Table 1: Study participants Characterization (data in mean ± standard deviation).

	Nursing Home	Community	p
N	21	21	
Gender (female)	57,1%	71,4%	
Age	75.47±7.31	72.57±7.13	ns
Time of institutionalization (years)	3.67±3.37	----	
Weight (Kg)	69.57±16.24	70.76±13.08	ns
Height (m)	1.60 ±0.08	1.57±0.09	ns
BMI (kg/m²)	26.90±5.09	28.43±4.52	ns
number of medication	5.90±3.98	2.28±1.58	<0.001
Number of falls (last 12 months)	0.61±1,0	0.42±0.7	ns

Note: Kg: kilogram, m: meters, BMI: body mass index; ns: nonsignificant

Table 2: Means and standard deviations of the center of pressure variable between institutionalized and community elderly with open eyes/firm surface.

	Nursing Home	Community	P
Mean velocity (cm/s)	2.6±0.84	1.88±0.86	0.001
X-SD (cm)	0.60±0.18	0.46±0.15	0.01
Y-SD (cm)	0.55±0.15	0.52±0.17	ns
Total displacement (cm)	77.9±25.05	52.7±12.59	0.0002
95% of ellipse area (cm²)	6.5±3.3	4.6±2.4	0.04

Note: ns: nonsignificant, X-SD: standard deviation in the frontal plane; Y-SD: standard deviation in the sagittal plane.

Table 3: Means and standard deviations of the center of pressure variable between institutionalized and community elderly with closed eyes/firm surface.

	Nursing Home	Comunity	p
Mean velocity total (cm/s)	3.50±1.6	2.28±0.9	0.0009
X-SD (cm)	0.74±0.27	0.56±0.19	0.02
Y-SD (cm)	0.63±0.17	0.57±0.15	ns
Total displacement (cm)	104.92±49.8	69.36±28.8	0.001
95% of ellipse area (cm²)	9.34±5.4	6.18±3.3	0.04

Note: ns: nonsignificant, X-SD: standard deviation in the frontal plane; Y-SD: standard deviation in the sagittal plane.
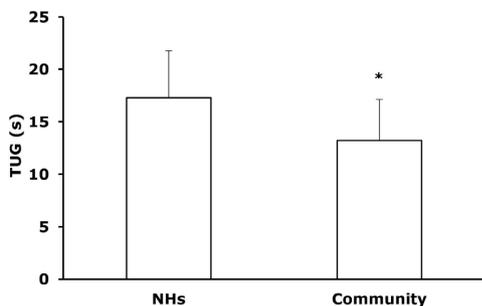
Figure 1: Comparison of TUG time between institutionalized (NHs, n = 21, 17.28 ± 4.5 s) and community elderly (n = 21, 13.21 ± 3.9 s), * Note: p = 0.002.
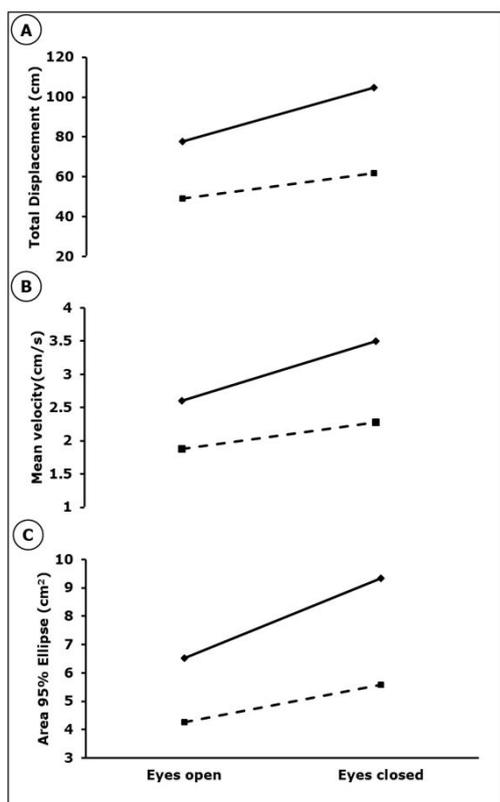
Figure 2: Influence of vision on balance in institutionalized (continuous line, n = 21) and community elderly (dashed line, n = 21). Note: A: Total displacement, p < 0.0001; B: mean velocity, p < 0.0001; C: area 95% ellipse, p = 0.005.

Table 4: Correlation indices between dependent variables and independent variables.

	Dependent variables			
	TUG (s)	TD (cm)	MV (m/s)	95% EA (cm²)
Age (years)	0.10	0.30	0.32	0.13
Gender	-0.22	-0.26	-0.27	0.07
BMI (kg/m²)	0.08	0.18	0.18	0.27
Number of medications	0.52*	0.35	0.36	0.02
Number of falls (last 12 months)	0.23	0.11	0.11	-0.28
Length of institutionalization (years)	0.08	0.02	0.03	-0.23

Note: TUG: *Timed up ad Go*, BMI: body mass index, TD: total displacement, MV: mean velocity, EA: elipse area. Note: * p = 0.01.

The Figure 2 (A, B and C) show the variables total displacement, mean velocity and 95% of ellipse area with eyes open and closed between institutionalized and community elders. A large oscillation was observed in both groups, however, older individuals of the institutions oscillated more when visual information was withdrawn.

The correlation analysis showed that of the variables age, number of medications, BMI, number of falls and time of institutionalization, only the number of medications presented a significant value with the TUG score (r = 0.52, p = 0.01), and no variables correlated with static equilibrium (Table 4). The linear regression analysis showed that the number of medications explained 27,7% of the TUG performance.

DISCUSSION

Our results showed that, in general, the NH group presented higher values in the COP oscillation than the community-dwelling elderly, indicating that this population needs a greater sway of the COP to restore body balance when compared with community elders. Generally, greater sway rises the probability of an uncontrolled crossing of stability limits[23]. Briefly, compared with the community-dwelling elderly, the nursing home residents controlled their COP more unstably in the narrow base of support.

When the vision was suppressed, was observed an increasement in the COP sway of the two groups, but again, the NHs group presented higher values than the community group. To maintain the upright stance according to environmental changes, our Central Nervous System continually changes its emphasis (i.e., weight) on visual, vestibular and somatosensory information[24]. When visual information is not available (eyes closed or in a dark environment), other sources of sensory information should be used,[4] what not was observed in the nursing home residents.

The same way, the time to perform the TUG test of the NH residents was greater than in community-dwelling elderly, suggesting a worse mobility of this population. According to Schoene et al.(2013),[20] the TUG is widely recommended as a predictor of falling risks in elderly, as it identifies balance deficit and gait. In addition, the TUG involves common everyday actions, fundamental to an independent life and is easy to apply. Despite this, it is composed of complex activities for the elderly, as it should have the muscular power of lower limbs and trunk to lift and sit without support, walk 3 meters, turn 180° and walk 3 meters again, being activities that need power, agility, and balance[25]. Therefore, lower values indicate better functional mobility, better balance, higher gait speed and, therefore, lower risk of falling, besides a greater independence in activities of daily living.

The results showed that the institutionalized elderly presented mean values above of cut-off considered normal (12.47s)[22]. indicating lower muscle power, agility and balance, showing an increased risk of falling.

The data presented corroborate the study by Yumin (2011),[26] which evaluated 122 elderly people, 60 institutionalized and 62 community residents, and found significantly higher values of TUG for institutionalized elderly compared to elderly in the community.

As part of the aging process, elderly is submitted to changes, particularly with regard to postural control and for various reasons seniors living in nursing home institutions are more vulnerable to this changes.

Table 4 shows that of all independent variables evaluated, only number of medications show a significative correlation with the TUG score. There was no significant correlation between the independent variables and the static balance. There is a lack of related work in the literature using the same variables and on the same population (nursing home residentes and community-dwelling elderly), restricting a broader discussion of the results found here.

The length of institutionalization is expected to influence the postural balance due to the lack of stimuli that these elderly people experience. To the authors' surprise, this variable did not correlate with the TUG test and with the static balance variables. The study of Batista et al.[27], also found no relationship between the length of institutionalization and Berg and TUG scores but found correlation with the ellipse area and with the mean speed of the COP in the x-axis.

Medications are an essential component of health care for many nursing home residents when are correctly administered, but harmful if not properly indicated. The number of drugs taken daily has been identified as an independent risk factor for falls. Zia et al. found that the total number of drugs was an important predictor of falls among women[28]. The study of Nakagawa et al.examined the relationship between the number of drugs taken and balance and found that older adults who take three or more drugs/day are at higher risk of falls, according to the Berg scale[29]. In the same way, our study observed the same relationship, but with the TUG test.

Some limitations have to be considered. First, due to the cross-sectional character, there is no way to correlate institutionalization with the worsening of postural balance (it is impossible to differentiate cause and effect). A longitudinal study would help to verify this relationship. Second, only elderly individuals with cognitive normality were included, both in the institutionalized and in the community group. Therefore, it is necessary to do other studies with elderly people with cognitive alterations. Third, other studies need to be carried out to evaluate the influence of other confounders on postural balance in the institutionalized population, such as the type of medication, the time that the institutionalized elderly spend sitting or lying down during the day, comorbidities and muscle strength, which were not evaluated in this study. Fourth, the visual alterations were not evaluated. In addition, it is necessary to consider the importance of other studies with a larger number of elderly people living in long-term institutions.

CONCLUSION

The results showed that the nursing home residents with a normal cognitive condition had greater center of gravity oscillation, worse mobility, and higher risk of falls than community elders. In addition, it was found that in nursing home residents, the ingestion of five or more drugs had relation with mobility.

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