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ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Factors associated with balance disorders of elderly living in the city of São Paulo in 2006: evidence of the Health, Well-being and Aging (SABE) Study

Fatores associados às alterações de equilíbrio em idosos residentes no município de São Paulo em 2006: evidências do Estudo Saúde, Bem-Estar e Envelhecimento (SABE)

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ABSTRACT: ***Objective***: To analyze the influence of demographic, health condition, and lifestyle factors on body balance disorders among elderly subjects living in the city of São Paulo, Brazil, in 2006. ***Methods:*** The study was developed based on information provided by the Health, Well-being, and Aging (SABE) Study. It included 60-year-old subjects, both men and women, or those over this age. The sample comprised 1,226 subjects that represented 930,639 elderly subjects. The dependent variable was the elderly's body balance disorder, which was measured using part of the Short Physical Performance Battery (SPPB). The independent variables were divided into three groups: demographic, health conditions, and lifestyle. The multiple binary logistic regression analysis was applied to estimate the association between balance disorders and demographic, health, and lifestyle variables in the elderly. ***Results:*** Age, difficulties in at least one mobility, and performance of regular physical activities showed a significant influence on the elderly's body balance ($p < 0.05$). Age was the strongest related determiner. Being aged 75–79 years and 80 years or more increased 3.77 and 5.31 times, respectively, the chances of the elderly subjects present balance disorders in comparison with the 60- to 64-years-old. ***Conclusion:*** Preventive measures that aim at reversing a body instability condition should be preconized and incorporated in the elderly's health-care schedule.

Keywords: Postural Balance. Aged. Health Of The Elderly. Epidemiologic Factors. Logistic Models. Brazil.

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**in memoriam.*

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RESUMO: ***Objetivo:*** O objetivo deste estudo foi investigar a influência dos fatores demográficos, de condições de saúde e de estilo de vida nas alterações do equilíbrio corporal dos idosos residentes no município de São Paulo em 2006. ***Métodos:*** O estudo foi desenvolvido com base em dados provenientes do Estudo Saúde, Bem-Estar e Envelhecimento (SABE). Foram selecionados todos os indivíduos com 60 anos e mais de idade, de ambos os sexos. A amostra considerada era de 1.226 indivíduos, representando 930.639 idosos. A variável dependente foi a alteração de equilíbrio corporal do idoso. Para mensurá-la utilizou-se parte do *Short Physical Performance Battery* (SPPB). As variáveis independentes foram classificadas em três grupos: demográficas, de condições de saúde e de estilo de vida. Para estimar a associação entre as alterações de equilíbrio com as variáveis demográficas, de saúde e de estilo de vida em idosos foi realizada uma análise de regressão logística binária múltipla. ***Resultados:*** Idade, dificuldades em pelo menos uma mobilidade e realização de atividade física regular exercem uma significativa influência no equilíbrio corporal dos idosos ($p < 0,05$). A idade foi o determinante mais fortemente relacionado. Ter idade entre 75 a 79 anos e 80 anos e mais aumenta em 3,77 e 5,31 vezes a chance, respectivamente, de os idosos apresentarem alterações de equilíbrio em comparação às idades de 60 a 64 anos. ***Conclusão:*** Medidas preventivas e que visam reverter um quadro de instabilidade corporal devem ser preconizadas e incorporadas na agenda de atenção à saúde dos idosos.

Palavras-chaves: Equilíbrio Postural. Idoso. Saúde Do Idoso. Fatores Epidemiológicos. Modelos Logísticos. Brasil.

INTRODUCTION

Aging is a continuous and progressive physiological phenomenon lived by people throughout their entire lives and is characterized by psychological, social, genetic, and biological changes[1].

The physiological process of aging compromises, among other body systems, the central nervous system (CNS) capacity in performing the process of vestibular, visual, and proprioceptive signals, responsible for body balance maintenance, and it also decreases the capacity of adaptive reflex modifications. These degenerative processes are responsible for the occurrence of vertigo and/or dizziness and balance disorders in the population of elderly subjects[2].

Body balance is the main factor for the subject's guidance in the environment[3], which is an automatic process that enables the subject to make movements in the environment and to endure gravity destabilization. In the body balance, the CNS needs an accurate perception of the internal position sense of body segments, one compared with the others and these in relation to the space[4].

Body balance disorder is one of the factors that limit the elderly subject's life. In the majority of cases, it cannot be attributed to a specific cause but to a compromise of the balance system as a whole. Body balance increases with aging[5,6]. Falls are the most severe consequences of balance disorder, followed by fractures, hospitalization, psychological complications, fear of new falls, loss and decrease of independence[7] and of autonomy, and mortality. There is an increase in the incidence of elderly's mortality owing to fractures from falls. According to data found by Coutinho et al.[8], the elderly people's mortality in 1 year after

hospitalization owing to fractures from falls was of 25.2% and 4% for elderly people with and without severe fracture. Falls also increase the costs with health treatment, and, thus, they create negative consequences, especially in the elderly people's quality of life.

Several aspects contribute to total or partial loss of body balance and control, such as: disorders in the vestibular system; decrease of neuromotor reactions of balance and muscular contraction[9]; decrease of muscular strength; decrease of motor coordination; visuospatial alterations[10]; proprioception alteration[11] with decrease of tactile sensitivity through atrophy of the receptors; losses of proprioceptive fibers and decrease of tendinous reflexes; hearing, cognitive alterations; depression[12]; and use of medications[13]. Elderly subjects with multimorbidity, low level of physical activities, and alcoholism show more chances of presenting balance disorders[14-16].

Knowledge of the factors associated with elderly people-related body balance disorders is very important, since it helps adopting more proper and specific preventive strategies, focused on reducing the harmful effects of some determiners. There are few studies carried out in Brazil to identify determining factors associated with balance disorders among the elderly people living in community. On the basis of this context, the aim of this study was to analyze the influence of demographic, health condition, and lifestyle factors on body balance disorders among elderly subjects living in the city of São Paulo, Brazil, in 2006.

METHODS

DATA SOURCE

The study was developed based on information provided by the Health, Well-being and Aging (SABE) Study. The SABE Study began in 2000 under the coordination of the Pan American Health Organization (PAHO) and is an epidemiological and cross-sectional study, with household approach. The objective was to analyze the varied aspects regarding health and life conditions of the elderly subjects living in the urban area of seven Latin America and Caribbean countries: Argentina, Barbados, Brazil, Chile, Cuba, Mexico, and Uruguay.

In Brazil, the SABE study involved the bordering limits of São Paulo city; 2,143 noninstitutionalized male and female subjects aged 60 years or older were interviewed in the period from January 2000 to March 2001 (named A_{00})[17].

The sampling process was conducted in two stages. The first stage included the choice of censor sectors and, the second, the selection of households within each sector. All resident subjects aged 60 years or older were interviewed in each domicile, regardless of their marital status or family bond. Owing to the population's low density, the samples of age groups of 75 years or older were extended, and to overcome the excess of mortality with regard to the female population, the male gender samples were adjusted to the same number as the female gender[17]. More details on the sampling design are available at http://www.fsp.usp.br/sabe/livrosabe/Livro_SABE.pdf[18].

In Brazil, the SABE study became longitudinal in 2006. The 2000 cohort was located and 1,115 elderly subjects were interviewed again. Losses in the period correspond to deaths (22.9%), refusals (9.6%), changes (2.5%), and institutionalizations (0.4%). This cohort was named A_{06}.

At the same moment, a new probabilistic drawing was done for entering a cohort with ages between 60 and 64 years, which included 299 subjects (cohort B_{06}). Thus, the 2006 total sample comprised the cohort A_{06}, the interviewed subjects who survived in 2000 and the new cohort B_{06}. Both databases had their weights remeasured based on the new estimations of populations, thus allowing the use of data from 60-year-old or older people in 2006.

The year of 2000 used standardized instruments for all countries. The elderly subject or eligible informer (family or caregiver) answered the questionnaire applied by previously trained interviewers. This instrument was reviewed in 2006. Some blocks were modified and other blocks incorporated. Anthropometric data were also collected in the two moments.

All subjects aged 60 years or older from both genders were chosen for this study, and they all presented anthropometry information regarding the balance test in 2006. Thus, the sample included 1,226 elderly subjects, representing 930,639 elderly subjects from the city of São Paulo, in 2006.

VARIABLES

The dependent variable was the change in the elderly's body balance. Part of the Short Physical Performance Battery (SPPB) was used to measure it[19]. According to the SPPB, balance is assessed into three positions: the participant is requested to join his/her feet and look ahead, and a point will be attributed if he/she is able to remain in the same position for 10 seconds; however, if he/she does not remain in the same position for 10 seconds or refuses to try it, no point will be attributed. Then, the test is conducted with the participant in semi-tandem position, which receives the same classification as the previous. The balance test ends with the subject staying in the tandem position. Both positions should be kept for 10 seconds. In the semi-tandem position, the subject stands with one of his/her heels leaned in the lateral of the opposite foot hallux. On the other hand, in the tandem position, the subject stands and maintains one of his/her heels heels against the toe of the other foot. If he/she is able to stay in such position for 10 seconds, he/she will receive two points; if he/she remains in the position between 3 and 9.9 seconds, he/she will receive one point; and in the case of a period lower than 3 seconds, no point will be given. Thus, the total value of the balance test will be given based on the sum of the three positions, with a variation in the classification between zero (worst performance) and four points (better performance)[19,20]. Elderly subjects with four points were classified as *without balance disorder* and, subjects between zero and three points, with balance disorder.

The independent variables were divided into three groups: demographic, health conditions, and lifestyle. The demographic variables included age (60 – 64, 65 – 69, 70 – 74, 75 – 79, and 80 years or older) and gender.

The reported health variables included presence of hypertension, diabetes, heart disease, embolism/stroke/ischemia/thrombosis, arthritis/arthrosis/rheumatism, osteoporosis, psychiatric disorders (divided into yes or no), depression (yes or no), cognitive impairment (yes or no), vertigo or dizziness (yes or no), fracture history (yes or no), vision perception (good, regular, and poor), difficulty in at least one instrumental activity of daily living (IADL; yes or no), difficulty in at least one mobility (yes or no), difficulty in at least one basic activity of daily living (BADL; yes or no), use of medications (yes or no), use of psychotropic drugs (yes or no), use of calcium blockers (yes or no), hospitalization in the last 12 months (yes or no), and body mass index (BMI; low weight, eutrophic, overweight, and obesity). Heart disease was related to heart attack, coronary disease, angina, congestive disease, or other heart issues. BMI was classified based on the recommendations proposed by the PAHO in 2002 (in kg/m^2: BMI < 23 = low weight; $23 \leq$ BMI < 28 = eutrophic; $28 \leq$ BMI < 30 = overweight; BMI ≥ 30 = obesity). Cognitive impairment was determined using the Mini-Mental State Examination (MEEM) classification according to schooling level (18 or less for illiterate subjects; 22 or less for 1 to 3 years of study; 23 or less for 4 to 7 years of study; and 27 or less for 8 years or more of study) suggested by Herrera et al.[21].

Depression was assessed using the short version of the Geriatric Depression Scale (GDS) proposed by Sheikh and Yesavage[22]. In the SABE study, this instrument was applied only in the elderly subjects who did not present cognitive impairment.

Psychotropic drugs considered were N05 class drugs (antipsychotic, anxiolytic, hypnotic, and sedatives) and N06 drugs (antidepressants); the calcium-channel blockers considered were belonging to class C08 from the Anatomical Therapeutic Chemical Code.

The lifestyle variables considered were regular physical activities (yes or no) and alcoholism (yes or no). Alcoholism was measured using the short Geriatric Version of the Michigan Examination (S-MAST-G). One point is attributed to every positive answer. The elderly subjects who obtain two or more points in the examination were classified with alcohol issues.

STATISTICAL METHOD

In order to ensure population representativeness, the weights for sample expansion were incorporated to data. Information from complex sampling research is frequently used to estimate means, ratios, and proportions. The use of sampling weights enables that nonvicious estimates are obtained to population parameters. However, the estimations of dispersion measurements are not properly found by the simple use of weights. This is the case of standard errors associated with coefficients of the variables used in the regression model. In complex sampling plans, the coefficient estimations are only influenced by weights, whereas the

estimations of dispersion measurements (variance) are influenced by both stratification and conglomeration together. Thus, in order to avoid that the conglomeration effects produce a significant impact on the estimation precision, which might result in incorrect conclusions in the analysis of hypotheses tests, the estimation process of these measures included the aspects that determine the complex sampling process of the SABE study.

Descriptive statistics was obtained for all variables belonging to the study considering the total sample. The characterization also included the demographic variables (family arrangement: lives alone and lives with someone; marital status: single, married/cohabitation, separated/divorced, and widowed) and socioeconomic variables (current occupation: works and does not work; income: without income, until one minimum wage, from one to two minimum wages, from two to three minimum wages, from three to five minimum wages, and five or more minimum wages; schooling: without schooling level, from 1 to 3 years of study, from 4 to 7 years of study, from 8 to 11 years of study, and 12 or more years of study).

Multiple binary logistic regression model was used to estimate the association between balance disorder and independent variables (demographic, health condition, and lifestyle) in elderly aged 60 years or older in 2006.

First, a simple binary logistic regression analysis was conducted. The variables that seemed statistically significant ($p < 0.25$) were chosen for the multiple binary logistic regression analysis. In the multiple analysis, all variables were simultaneously included, with a 5% significance level used as a reference. The results of the final model were interpreted as odds ratios. The analysis of residue was carried out for the final model.

Data analyses were conducted using the procedures for research of the R software, version 2.12.0.

The Research Ethics Committee of the School of Public Health, *Universidade de São Paulo*, Brazil (CONEP 315/99 and 83/06), approved the study. Participants volunteered to the study, and a signed informed consent was obtained from all of them.

RESULTS

In the sample (n = 930,639), the age varied from 60 to 90 years, and the mean age was 69.6 years and median of 69 years (SD = 7.1 years). With regard to the total amount of participants, 59.6% were female subjects. It was seen that 13.5% of the elderly people lived alone, 58.1% were married or were cohabiting, and 30% were widowed. About 28.7% of this population still worked, 19.1% did not have a schooling level, and 15.2% lived making until one minimum wage (Table 1).

The prevalence of elderly subjects with balance disorder was of 16.3%, and women showed higher ratios of damage in comparison with men (Figure 1). Table 2 presents the characteristics related to health conditions/disease and lifestyle of elderly subjects living in the city of São Paulo, Brazil, in 2006. Hypertension was the most frequent chronic

Table 1. Relative distribution of the sample according to demographic and socioeconomic characteristics, São Paulo city, Brazil, 2006.

Variables	%
Age (years)	
60–64	29.1
65–69	28.1
70–74	20.2
75–79	12.6
80 or older	10.1
Gender	
Female	59.6
Family arrangement	
Lives Alone	13.5
Marital status	
Single	4
Married/cohabitation	58.1
Separated/divorced	7.8
Widowed	30
Current occupation	
Works	28.7
Income (MW)	
No income	3
Until 1	15.2
1–2	17
2–3	10.7
3–5	9.8
5 or more	9.1
Schooling (years of study)	
None	19.3
1–3	22.3
4–7	38.7
8–11	13.2
12 or more	6.5

Source: SABE Study, 2006.
Missing data refer to categories without information. MW: minimum wage.

disease found (61.7%), followed by arthritis/arthrosis/rheumatism (31.4%), heart diseases (21.2%), osteoporosis (20.9%), diabetes (20.1%), psychiatric issues (13.6%), and embolism/stroke/ischemia/thrombosis (7.1%). About 25.9% of the elderly subjects presented cognitive impairment, 13.1% showed depressive symptoms, 16.3% reported persistent vertigo or dizziness, and 8.4% referred fracture history. With regard to vision perception, 69.5% reported good vision. It is seen that 38.2% declared having difficulties in at least one IADL and 20.0% in at least one BADL, and 86.8% showed difficulties in at least one mobility. In the sample, 90.2% used medications, and 3.3% of the elderly subjects used psychotropic drugs and 2.4% used calcium-channel blockers; 7.7% of the elderly subjects reported hospitalization in the last 12 months, respectively. As to the BMI, 24.3% presented low weight and 21.2% were obese. Around 1.5% of the elderly subjects showed positive result in the screening for alcoholism, and 18.3% reported practicing regular physical activity.

On the basis of the simple binary logistic regression analysis, the following variables were eligible for the multiple regression: age, hypertension, heart diseases, embolism/stroke/ischemia/thrombosis, depression, cognitive impairment, fracture history, vision perception, difficulty in at least one IADL, difficulty in at least one mobility, difficulty in at least one BADL, use of psychotropic drugs, hospitalization in the last 12 months, BMI, and regular physical activities.

Table 3 shows the odds ratios of the multiple binary logistic regression model regarding the elderly subjects' balance disorders. Results revealed that age, difficulties in at least one mobility, and regular physical activity performance showed a significant influence on the elderly subjects' body balance, and the associations were statistically significant at a 5% level. Age was the strongest related determiner. Ages between 75 and 79 years and 80 years or older increased 3.77 and 5.31 times, respectively, the chances of the elderly subjects presenting balance disorders compared with the reference category of 60–64 years ($p < 0.05$). Difficulties in at least one mobility worsen the elderly subjects' balance. Presence of difficulty increased 2.64 times the chance of elderly subjects presenting balance disorders with regard to the reference category ($p < 0.05$). Practice of regular physical activity seems a protective factor. The elderly subjects who usually perform physical activities decreased 66% the chances of having balance disorders ($p < 0.05$) compared with the elderly subjects who do not practice them.

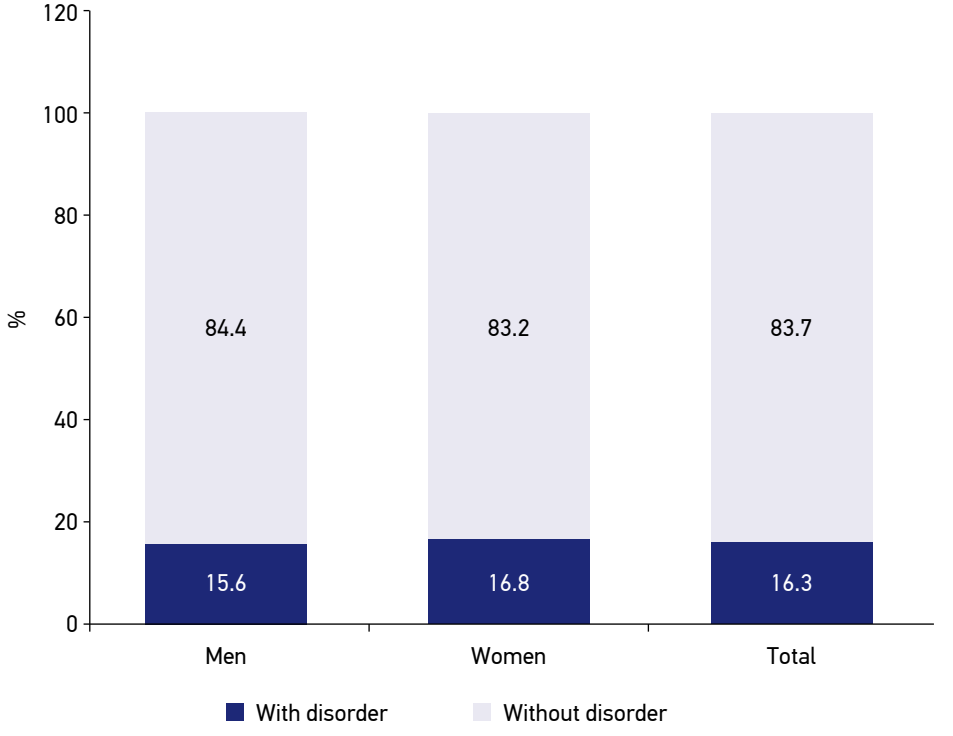
DISCUSSION

This present study found factors associated with the changes in body balance of elderly subjects living in the city of São Paulo, Brazil, in the year of 2006. Results showed that age, difficulty in at least one mobility, and regular physical activity practice present statistically significant associations with balance disorders of elderly subjects living in the city of São Paulo, in 2006.

Older age was the strongest related determiner. This study results are in agreement with those found in other investigations. According to Gahery et al.[23], age is an important factor for the risk of balance disorders and is always present among the main causes. For Iwasaki and Yamasoba[24], balance changes with aging and the strategies for its maintenance are modified throughout life.

Physiological aging comprises a series of alterations in the organic and mental functions, especially owing to the advanced age effects on the organism; thus, the body loses its capacity of maintaining homeostatic balance and all the physiological functions gradually start to decrease. This process determines the progressive loss of the subject's capacity of adapting to the environment and causes more vulnerability and higher incidence of pathological processes. These processes, in turn, result in dysfunctions in several organs and functions of the elderly subject, such as changes in the visual, vestibular, and proprioceptive systems, therefore causing posture and balance disorders[24]. Thus, as older the subject is, more vulnerable he/she becomes.

Difficulty in at least one mobility also revealed as an important determining factor of balance disorders in elderly subjects. The musculoskeletal system suffers important physiological alterations owing to senescence, such as progressive decrease of muscular mass



Source: SABE Study, 2006.

Figure 1. Relative distribution (%) of the elderly people's balance disorders according to gender, in the city of São Paulo, Brazil, 2006.

Table 2. Relative distribution of the sample according to health/disease and lifestyle characteristics, São Paulo city, Brazil, 2006.

Variables	%
Hypertension*	61.7
Diabetes*	20.1
Heart disease*	21.2
Embolism/stroke/ischemia/thrombosis*	7.1
Arthritis/arthrosis/rheumatism*	31.4
Osteoporosis*	20.9
Psychiatric disorders*	13.6
Depression**	13.1
Cognitive impairment***	25.9
Vertigo or dizziness	16.3
Fracture history	8.4
Vision perception	
Good	69.5
Regular	23.5
Poor	6.5
Difficulty in at least one IADL	38.2
Difficulty in at least one mobility	86.8
Difficulty in at least one BADL	20
Medication use	90.2
Psychotropic use	3.3
Calcium-blockers use	2.4
Hospitalization in the last 12 months	7.7
Regular physical activity	18.3
Body mass index	
Low weight	24.3
Eutrophic	42.7
Overweight	11.4
Obesity	21.2
Alcoholism screening****	1.5

Source: SABE Study, 2006.
*self-declared; **Geriatric Depression Scale; ***Mini-Mental State Examination; ****Short Michigan Examination. The percentages refer to the positive category. Missing data refer to categories without information. IADL, instrumental activities of daily living; BADL, basic activities of daily living.

Table 3. Odds ratio of the multiple binary logistic regression model for balance disorders of elderly living in the city of São Paulo, Brazil, 2006.

Variable	Odds ratio	p-value
Intercept		0.000
Age (years)		
60–64	1	
65–69	1.98	0.046
70–74	1.79	0.078
75–79	3.77	0.000
80 or older	5.31	0.000
Hypertension*	1.08	0.685
Heart disease*	1.18	0.459
Embolism/stroke/ischemia/thrombosis*	1.39	0.336
Depression*	1.18	0.574
Cognitive impairment*	1.15	0.527
Fracture history*	1.56	0.114
Vision perception		
Good	1	
Regular	0.98	0.932
Poor	1.1	0.815
Difficulty in at least one IADL*	0.98	0.489
Difficulty in at least one mobility*	2.64	0.037
Difficulty in at least one BADL*	1.16	0.813
Psychotropic use*	1.5	0.373
Hospitalization in the last 12 months*	1.04	0.914
Regular physical activity*	0.34	0.000
Body mass index		
Eutrophic	1	
Low weight	0.9	0.651
Over weight	1.64	0.113
Obesity	1.19	0.477

Source: SABE Study, 2006.
*Reference category: no. IADL, instrumental activities of daily living; BADL, basic activities of daily living.

and strength and of motor performance and flexibility, resulting in more damage to elderly subjects' functionality. In addition, elderly subjects with functional impairment are more vulnerable to alterations of balance reactions.

Through these results, it was found that regular physical activity practice was a protective factor. Previous studies pointed out that the performance of physical activities is important for improvement of balance in elderly subjects[25]. According to Ferraz et al.[26], sedentary elderly subjects were more susceptible to a higher postural oscillation. Figliolino et al.[16] found that elderly subjects who did not practice physical activities showed higher balance deficit. Sedentary subjects presented a lower functional mobility and higher balance and gait alterations.

The identification of factors associated with elderly subjects' body balance provides important elements for prevention and intervention actions. Some factors found in the results of this study and that substantially contribute to the elderly subject's body instability can be modified, such as the functional capacity and physical activity practice. Hence, it is worth emphasizing that interventions and approaches stimulating the performance of regular physical activities should continue as priorities, as physical activity seemed to be an important factor of balance alteration among elderly subjects living in the city of São Paulo. The promotion of a higher physical performance among elderly subjects causes an improvement in the muscular strength, flexibility, aerobic capacity, functional capacity, and, consequently, balance. Decrease of balance disorders works to prevent falls and their complications, thus contributing to a more active and healthy aging, and overall decreasing the health system overload. In the same way, the specific approaches focused on the existent functional limitations could result in an immediate improvement of the functional capacity, thus minimizing its consequences on the elderly subject's balance.

No population-based studies were found in the Brazilian literature that investigated the factors associated with elderly subjects' balance, which, in some part, made the comparison with other studies in Brazil more difficult. Population-based studies allow the acquisition of data inside the elderly's household, and especially in the community in which the subject lives; thus, it could reflect the reality of health conditions of the population living in that area.

Cross-sectional studies, similar to this study, present temporal direction problems between the exposures and outcomes, as these pieces of information are obtained at the same time. Therefore, cross-sectionals studies do not enable the identification of the cause of relations. Thus, future investigations with longitudinal data analyses are necessary with the aim of obtaining more explanations regarding the causality of these relations in such population.

CONCLUSIONS

In conclusion, several factors determine balance disorders among the elderly people. Special attention should be given to the identification of body balance disorders causes

and should approach the changeable disorders. Preventive measures that aim at reversing a body instability condition should be preconized and incorporated in the elderly people's health-care schedule. The intervention should always maximize physical and functional performances. Improvement of balance reactions will possibly enable the elderly subjects an increase of independence and, as a consequence, an improvement of their quality of life.

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