


Intrinsic risk factors for falls among institutionalized older adults

Fatores de risco intrínsecos para quedas entre idosos institucionalizados

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ABSTRACT

Objective: The objective of the study is to investigate the intrinsic risk factors for falls among older adults admitted at Long Term Institutions (ILP). **Methods:** Twenty older adults with a mean age of 79 years (between 60-100 years) of two ILP of the countryside of Minas Gerais/Brazil were evaluated. Tinetti and Barthel scales were applied to assess body balance and functional independence, respectively. The Downton scale for the analysis of the risk of falls, esthesiometry, dynamometry and manual muscle strength test to estimate, respectively, the sensitivity of the hands and feet, the hand grip strength and the strength of the muscles of the lower limbs. The data was analyzed with t-student test, Pearson's correlation test, and analysis of variance (ANOVA-one way). The significance level was 5% for all analysis. **Results:** The overall mean score on the Downton scale was 4.68 ($p<0.05$), balance was 14.57 points ($p<0.05$), Barthel scale was 72.36 points ($p<0.05$), handgrip strength was 2.73 kg/m² (± 3.64), and the mean strength in the lower limbs was 3.7 kg/m² ($p<0.05$). **Conclusion:** Older adults have a high risk of falls and the parameters most compromised and responsible for this risk are polypharmacy, lack of balance, muscle weakness, loss of sensitivity, and functional dependence.

Keywords: Accidental Falls, Risk Factors, Homes for the Aged, Activities of Daily Living, Aged

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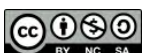
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RESUMO

Objetivo: Investigar os fatores de risco intrínsecos para queda entre idosos de duas Instituições de Longa Permanência (ILP) no interior de Minas Gerais/Brasil. **Métodos:** Foram avaliados 20 idosos com idade média de 79 anos (entre 60-100 anos). Foram aplicadas as escalas de Tinetti e Barthel para avaliação do equilíbrio corporal e independência funcional, respectivamente. A escala de Downton para análise do risco de quedas; a estesiometria, a dinamometria e o teste manual de força muscular para estimar respectivamente, a sensibilidade das mãos e pés, a força de preensão palmar e a força dos músculos de membros inferiores. A análise estatística utilizada foi o teste t-student, o teste de correlação de Pearson, a análise de variância (ANOVA-one way), considerando nível de significância de 5%. **Resultados:** A média geral do escore da escala de Downton foi de 4,68 ($p<0,05$); a do equilíbrio corporal foi de 14,57 pontos ($p<0,05$), a escala de Barthel foi de 72,36 pontos ($p<0,05$); a força de preensão palmar foi de 2,73 kg/m² ($\pm 3,64$) e a média de força em membros inferiores foi de 3,7 kg/m² ($p<0,05$). **Conclusão:** Conclui-se que os idosos avaliados apresentam alto risco de quedas sendo os parâmetros mais comprometidos e responsáveis por este risco, a polifarmácia, desequilíbrio, fraqueza muscular, perda de sensibilidade e dependência funcional.

Palavras-chaves: Acidentes por Quedas, Fatores de Risco, Instituição de Longa Permanência para Idosos, Atividades Cotidianas, Idoso

INTRODUCTION

Human aging studies can be considered a milestone in advancing quality of life as it allows for assessing social indicators. Characterized as individuals aged 60 years or older, the older adult population is expected to increase from 962 million in 2017 to approximately 1.4 billion in 2030 worldwide, according to the United Nations (UN).¹ The Brazilian Institute of Geography and Statistics (IBGE) assures there were 30.2 million older adults in 2017. It estimates that the population aged 65 or over will correspond to a quarter of the Brazilian population, suggesting that this population portion should be better investigated.^{2,3}

Biologically, the human body has a natural decline in its physiological, metabolic, and physical functions over time,^{4,5} generating a series of consequences associated with increased dependence, decreased muscle mass, physical resistance and mobility, reduced bone mass, and a greater propensity for chronic illnesses.⁴ In this context, older adults have more significant chances for falls, and, according to the 2008 Guidelines of the Brazilian Society of Geriatrics and Gerontology (SBGG, *Sociedade Brasileira de Geriatria e Gerontologia*), approximately 5% of falls trigger fractures, the most common being in the humerus, distal radius, femur, and ribs.⁵

According to World Health Organization (WHO), about one-third of older adults fall at least once a year, and a large proportion of these accidents cause emergency service visits.⁶ Another study indicates that about 31% of older adults were hospitalized after falling.⁷ Therefore, preventing falls by identifying risk factors for falls can reduce costs to the public health systems since there is a tendency to increase the number of falls due to the growth of the aged population in the world. These accidents can also lead to post-fall syndromes, such as loss of autonomy, confusion, dependence, depression, immobilization, and restrictions to Basic Activities of Daily Living (BADL).⁶ Some complications that may arise from falls are increased dependence on BADLs, hospitalizations, fractures, and fear of falling, which may increase mortality risk.⁸

Falls risk factors can be classified as intrinsic or extrinsic. Intrinsic factors are associated with physiological changes due to aging, comorbidities, psychological or mental impairment, and pharmacological adverse reactions.⁹

The risk for falls, as described by the Brazilian Health Ministry (*Ministério da Saúde, MS*), are advanced age,^{9,11} female sex,¹² decreased balance, immobility, previous falls, low physical fitness, slow gait and short steps, upper and lower limbs muscle weakness, cognitive capability reduction, presence of Parkinson's disease, polypharmacy, and the use of hypnotic and anxiolytic sedatives.⁹

Older adults with functional-clinical vulnerability are more susceptible to falls and may be hospitalized after falling. Among these aged vulnerable populations, the most common risk factors for falls are impaired mental status, the presence of depression, urinary incontinence, postural and postprandial hypotension, dizziness, vision, hearing and balance problems, muscle weakness or lower limbs disabilities, incapacity to perform basic and instrumental activities of daily living, use of assistive technology for walking, gait abnormalities, use of psychotropic, cardiac, anti-inflammatory, and analgesic medications, and the physical restriction or restraint.¹³ Over time, their hospitalization has been increasingly studied as the population is consistently aging, and

the risk factors for falls have changed. Other variables have modified functionality, independence, and the risk of falls among institutionalized elderlies. The Coronavirus (SARS-CoV-2) pandemic, also called COVID-19, has impacted functional aspects of institutionalized aged people. Therefore, the relevance of this study lies in identifying the intrinsic risk factors that mainly affect older adult patients in Long Term Institutions, based in the surrounding cities of *Campo das Vertentes*, in the countryside of Minas Gerais State (MG), Brazil.

OBJECTIVE

The objective of this study was to describe the intrinsic risk factors for falls of institutionalized older adults in two cities in the region of *Campo das Vertentes*, in the countryside of Minas Gerais State (MG), Brazil.

METHODS

This article is an original report of a quantitative, cross-sectional study conducted between April 2021 and June 2022 in two Long Term Institutions (LTI I and LTI II), homes for 24 and 50 elderly, respectively. These institutions are located in the region of *Campo das Vertentes, Minas Gerais (MG)*, Brazil. Eleven patients from ILP I and nine from ILP II were included, a total of 20 participants. The study was approved by the Ethics Committee Board of the Federal University of *São João del-Rei* (registration number CAAE: 36901220.3.0000.5151), and their legal representative signed all the Informed Consent Form (ICF).

Participants who met the inclusion criteria were institutionalized subjects aged 60 or older who voluntarily agreed to participate in the study. Those who were bedridden, with severe psychiatric condition hindering their cooperation with the study procedures or their capacity to undertake the assessments, with mental or physical conditions that interfered in the evaluation, or with a previous history of COVID-19 infection, or who were diagnosed with Sars-Cov-2 during the assessments were excluded from the study.

The assessments were applied on alternate days so that the participants would not feel upset, and two trained evaluators carried out each test. The tests and scales were applied blindly, so no evaluator knew the results of the other tests.

In the first meeting with the participants, the evaluators assessed the lower limbs muscle strength. The measurements were conducted in the hip flexors and extensors, thigh abductors, knee extensors and flexors, ankle dorsiflexors and ankle plantar flexors.

These muscle groups were evaluated on a scale of 0 to 5. The scores were classified as 0 (absence of muscle contraction), 1 (muscle contraction, without joint movement), 2 (absence of active movements against gravity), 3 (contraction against gravity), 4 (movement against slight resistance), and 5 (movement against strong resistance).¹⁴ On the second day, the evaluators rated the participants with the Barthel index scale, the Downton scale for risk of falls, and the Tinetti balance scale.

The Barthel Index assesses the degree of independence for activities of daily life (ADLs). This scale evaluates the domains of feeding, transfer (from one chair to another), self-hygiene, mobility (going in and out of the bathroom, walking on a flat surface, climbing stairs), dressing, and bowel and bladder control. The

scale score ranges from 0 to 100 in increments of 5 points, grading the patient as entirely dependent to completely independent.¹⁵

The Downton fall risk index quantifies the risk of falling based on five items and their corresponding sub-items. The analyzed parameters consider previous falls (history of falls during institutionalization), use of medications, sensory deficits, mental state, and gait capacity and type. For each positive answer, one point is added to the total. Parameters such as the use of medications and sensory deficits can be reported with more than one point in each item since the answer is multiple. The higher the score, the greater the risk of falls.¹⁶

The Tinetti scale assesses balance and gait abnormalities within 16 different situations, including sitting or standing balance with eyes closed, gait initiation and length of steps, and several other circumstances.¹⁷ The first nine items rate static balance, and the remaining seven assess dynamic balance (gait test). The static and dynamic balance total 16 and 12 points, respectively, adding a total score of 28 points. The risk of falling prediction is graded according to the final score, such that high, moderate, and low risk of falling are 0 to 19, 19 to 24, and 24 to 28 points, respectively.¹⁶

Finally, in the third meeting, esthesiometry and handgrip dynamometry tests were applied. Esthesiometry was performed on upper and lower limbs with nylon monofilaments of different diameters of standardized pressure. These monofilaments are classified according to their color. Green and blue correspond to normal sensitivity, violet to difficulty in discriminating shape and temperature, red to a slight loss of protective sensation, orange to loss of protective sensation for the foot, and magenta for the presence of sensitivity to deep pressure and pain. In addition, if there is no response regardless of the filament color, it can be considered a total loss of sensitivity.¹⁸

Handgrip strength was measured with a manual dynamometer (Saehan). The instrument consists of a cylinder, on which the participant was instructed to grip and press until their peak strength. This equipment quantifies the force exerted in kg/m² (N).^{19,20}

Data analysis initiated with the data description as means and standard deviations of the variables. The comparison between both long-term institutions was performed using the unpaired t-student test. Pearson's correlation test was performed to compare the data of the analyzed variables.

One-way analysis of variance (ANOVA) and Turkey's post-test were chosen to compare the means between the age groups of the participants. All data were analyzed considering mean and standard deviation values and a significance level of 5%. The statistical pack used was GraphPad Prism 9.3.

RESULTS

The 20 participants included were 13 women and seven men. They had a mean age of 79, ranging from 60 to 100. Table 1 presents their characteristics according to the facility where they were institutionalized.

Data on the risk of falls showed a general average of 4.68. The average of both Institutions were 3.82 and 5.88 in the LTI I and LTI II, respectively, a statistically significant difference ($p=0.01$, Figure 1). No significant differences were observed regarding the comparisons by age group ($p=0.2623$, Table 2).

Table 1. Participants characteristics per institution

Institution	Women (N)	Men (N)	Mean age, years (Minimum - Maximum)
LTI I	7	4	79 (60-89)
LTI II	6	3	80 (71-100)

LTI I: Long Term Institution I; LTI II: Long Term Institution II

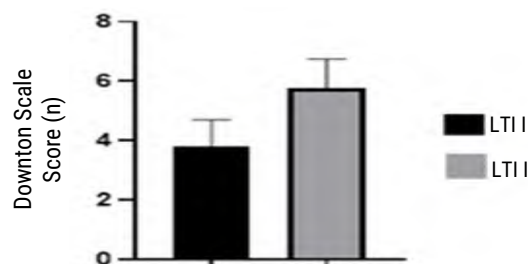


Figure 1. The mean score for the Downton scale risk factor for falls of LTI I and LTI II.

Table 2. The mean score for risk factors for falls mean, according to age group

Institution	Presenile	Senile	Elderly
ILP I	3.5	3.89	0
ILP II	4.75	6.67	7

LTI I: Long Term Institution I; LTI II: Long Term Institution II

The balance analysis resulted in an average score of 14.57, where the means were 15.81 and 12.87 for ILP I and ILP II, respectively. Table 3 presents the balance data according to age groups. The statistical comparison between the means found in ILP I and ILP II showed significant differences ($p=0.7574$). There were also no significant differences between the means of balance score, regardless of the age group ($r=0.0093$; $p=0.9273$).

Table 3. Mean scores of balance assessment

Age group (years)	Balance scale score (n)
60-74 (presenile)	14.3
75-90 (senile)	14.41
>90 (elderly)	18

The Pearson's correlation test between body balance and the incidence of falls scale showed that the association between both variables is statistically significant ($r=-0.5399$; $p=0.017$) (Figure 2).



Figure 2. Pearson correlation test between Downton risk of falls scale and Tinetti balance scale $p < 0,05$

The global mean score of the analysis of functional independence was 72.36. The partial mean scores found in ILP I and ILP II were 77.72 and 65 points, respectively, with no significant differences between both institutions ($p = 0.4838$, Figure 3). Comparing age groups, the mean scores were 80.83, 68.75, and 65 points for participants aged 60-74, 75-90, and above 90, respectively.

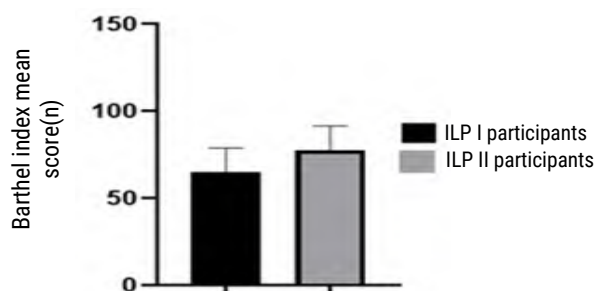


Figure 3. Barthel index mean score for functional Independence assessment

The association test between the participants' body balance and functional independence conducted with the Pearson correlation test evidenced a significant correlation between the variables ($p < 0.001$, Figure 4). Regarding sensitivity, 7 points were tested on the right and left upper limbs and 11 points on the right and left lower limbs of 13 participants. The total sites tested were 91 and 143 on the upper and lower limbs, respectively. These data are presented in Table 2.

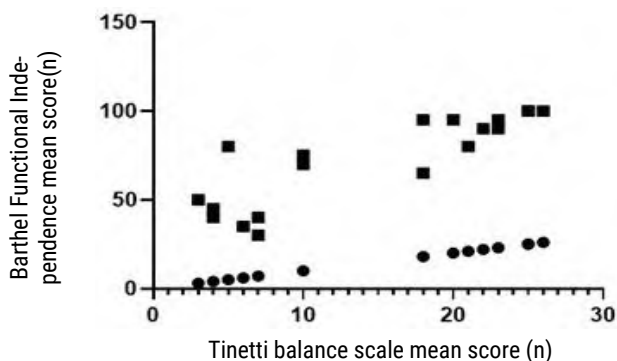


Figure 4. Pearson correlation test between Barthel index score and Tinetti balance score.

Table 4. Percentage of responders to monofilament types on Upper and lower limbs

Monofilament	Right hand	Left hand	Right foot	Left foot
Green	1.09% (1 site)	-	-	-
Blue	21.98% (20 sites)	26.37% (24 sites)	2.09% (3 sites)	0.7% (1 site)
Purple	30.77% (28 sites)	25.27% (23 sites)	6.99% (10 sites)	5.59% (8 sites)
Red	13.18% (12 sites)	9.89% (9 sites)	6.29% (9 sites)	6.29% (9 sites)
Orange	5.49% (5 sites)	10.99% (10 sites)	27.47% (35 sites)	29.37% (42 sites)
Pink	8.79% (8 sites)	13.18% (12 sites)	18.88% (27 sites)	16.78% (24 sites)
Non-responders	9.89% (9 sites)	6.59% (6 sites)	10.49% (15 sites)	10.49% (15 sites)

The hand grip strength results did not show significant differences between institutions ($p = 0.5557$, $R = 0.02737$). The Pearson correlation test did not evidence associations between handgrip strength and balance ($r = 0.2055$; $p = 0.4809$). Grip strength results are shown in Table 5.

Table 5. Mean values of handgrip strength

Institution	Handgrip strength Right hand (Kg.m/s ²)	Handgrip strength Left hand (Kg.m/s ²)	Global handgrip strength (Kg.m/s ²)
ILP I	3 kg.m/s ²	1.19 kg.m/s ²	-
ILP II	2.25 kg.m/s ²	5 kg.m/s ²	-
Global	2.8 kg.m/s ²	2.67 kg.m/s ²	2.73 kg.m/s ²

LTI I: Long Term Institution I; LTI II: Long Term Institution II

The results on muscle strength in the lower limbs showed a mean of 3.7 points. Regarding the institutions, the participants had 4 and 3.4 points in ILP I and ILP II, respectively. Separating by age groups, it was observed that the means were 3.9, 3.6, and 3.1 points for participants aged 60-74, 75-90, and above 90, respectively.

No associations were observed when performing the Pearson correlation test between the average lower limb muscle strength and balance ($r = 0.2571$; $p = 0.2880$). It is possible to observe the average values of strength among the muscle groups of lower

limbs of participants who perform body movements (Table 6).

Table 6. Mean values of muscle strength of lower limbs

Movements	General (kg.m/s ²)	Women (kg.m/s ²)	Men (kg.m/s ²)
Right hip flexion	4.1	3.8	4.7
Left hip flexion	3.75	3.8	3.7
Right hip abduction	4.4	4.3	4.6
Left hip abduction	4.25	4.3	4.1
Right hip adduction	4.25	4.2	4.4
Left hip adduction	4.05	4.2	3.8
Right hip extension	2.9	3.2	2.4
Left hip extension	2.6	2.8	2.3
Right knee extension	4.3	4.2	4.6
Left knee extension	3.85	3.8	3.8
Right knee flexion	3.8	3.6	4.1
Left knee flexion	3.55	3.7	3.3
Right ankle dorsiflexion	3.15	3.4	2.7
Left ankle dorsiflexion	3.15	3.5	2.6
Right ankle plantar flexion	3.25	3.2	3.3
Left ankle plantar flexion	3.15	3.1	3.1

DISCUSSION

Data from the present study demonstrated a high incidence of falls, severe imbalance, high levels of functional dependence, loss of sensitivity, especially in the lower limbs, significant muscle weakness of upper and lower limbs, regardless of the institution the participants were admitted, even though the participants of ILP II presented worse results.

The results showed high rates of falls among the participants, as the general average of the scale was 4.68. According to Rosendahl et al.²¹, a score greater than or equal to 3.0 on the Downton scale indicates a high risk of falls. The most relevant parameter for this high score was polypharmacy, however, even if the Downton scale proposes the classification of the medications, it does

not specify all medications used by the participants.

The participants in ILP II had about 54% higher risk of falling than those in ILP I. The assessment of previous falls considered only those that occurred in the institution since, except for ILP II, there was no reliable background information before their institutionalization. The participants do not always have a preserved mental state or remember the events of falls. Regarding the number of falls during their institutionalization, three had fallen in the institution without hospitalization after the events. One of these participants had fallen twice in the previous year, confirming the strong association between the chances of falling again in the year following the first fall. Unlike ILP I, in ILP II, all falls are reported. Therefore, access to this information is faster, facilitating its assessment and notification.

The averages of the Downton scale score increase with age. This finding was observed with the classification of presenile, senile, and elderly, in which a lower average was seen in the first group with a progressive increase until the last one. In ILP I, there are no elderly participants, but the averages between the presenile and senile were different. The same event was seen in ILP II, where an elderly participant was included, allowing for a progression of means between groups, with the elderly comprising the highest average.

In assessing the risk of falls, worse rates were observed among women than men. It can be explained by the general balance data found between women and men. In Pearson's correlation test, a correlation was found between falls and balance, agreeing with other publications that discuss balance changes as having a greater propensity for falls.^{22,23}

Data on the high rates of falls among the evaluated participants demonstrate that it is necessary to understand the triggering factors of these falls. In this context, the assessment of body balance is an important parameter. The present study identified that the participants generally had a low balance index (14.57 points), representing a severe lack of balance. It is known that aging causes changes such as decreased muscle flexibility, reduction of agility, coordination, joint mobility, and, especially, balance.²³

In a study by Bayo et al.²⁴, they mentioned a high rate of institutionalized aged people who have body balance changes, which is associated with the increased incidence of falls. The authors emphasize the importance of prevention for such accidents.²⁴

In the present study, it was possible to identify a mild to moderate reduction in sensitivity in the hands and a severe reduction in the feet. In other words, there was a prevalence of response to filaments of intermediate thickness (blue and purple) in the hands, whereas the response in the feet was prevalent with monofilaments of greater thickness (orange and pink). In some cases, no response was observed. A study conducted by Agostini et al.¹⁸ concluded that the decrease in plantar sensitivity is an important factor in the loss of dynamic balance, consequently increasing the risk of falls among aged patients with Diabetes. Such analysis allowed us to assure that individuals with concomitant balance alterations and sensitivity are more vulnerable to falls, such as the participants of the present study.

Balance is strictly associated with functional independence, as older adults with worse balance tend to be more dependent. In the present study, Pearson's correlation test showed correlations between these two variables. The functional independence index showed high dependence rates among the participants, regardless of the institution, even though ILP I had better results than

ILP II. It is known that the greater risk of falls is also associated with muscle weakness.²⁵ In this context, the handgrip strength assessments of the participants resulted in an average of 2.73 kg/m², indicating muscle weakness.

According to a study by Amaral et al.²⁶, the reference mean handgrip strength for the right hand is 21.1 kg/m² for people of 60 to 69 years old, 19.5 kg/m² for 70 to 79, and 16.4 kg/m² for 80 years or older. Regarding the left hand, the reference values are 20.4 kg/m², 17.8 kg/m², and 15.2 kg/m², respectively. This muscle strength reduction is associated with a greater risk of imbalance and, consequently, of falls, once, considering that the hand is one of the main human instruments of movement, mobilization, gripping, and precision, the decrease in grip strength may indicate an increase in the difficulty that the aged person can support and protect themselves from possible accidents.²⁷

The muscle strength of the lower limbs is also an essential parameter in assessing risk factors for falls, as it indicates possibilities of motor control during walking. Therefore, the assessment of muscle strength of lower limbs resulted in a mean strength of 3.7. In comparison, the participants included in the ILP I and ILP II had an overall mean of 4 and 3.4, respectively.

It is also relevant to emphasize that in a detailed assessment of muscle strength, the muscle groups with the lowest means were hip extensors, ankle dorsiflexors and plantar flexors, and knee flexors. These muscle groups are precisely those responsible for the gait.¹⁸ The knee flexor muscles are relevant in the swing phase of gait, the ankle dorsiflexor muscles are essential in the heel strike phase, or initial phase of gait, and the hip extensor muscles are essential to the initial and support phases of gait. In other words, these muscles are crucial stabilizers and propulsors during walking. Therefore, the poor result obtained in the evaluation, even within the normal range of motion against gravity, may be responsible for the risk of falls in this population, especially when associated with the other variables analyzed in this study.

The progressive loss of muscle mass with limited muscle function or strength is prevalent among aged subjects, called sarcopenia, a geriatric syndrome associated with increased morbidity and mortality.²⁸ In this context, our findings demonstrate a reduction in muscle strength due to a lack of physical activity and body movement. Such characteristics may cause senile immobility syndrome.

Studies show that sarcopenia is commonly associated with functional dependence, comorbidities, and cachexia and is highly prevalent among institutionalized elderlies. Moreover, it is essential for older adults to undertake a resistance training routine within the institution since these exercises may increase muscle mass, strength, and balance, reducing the risk of falls.²⁹

Therefore, some measures to prevent and treat sarcopenia in the elderly are needed in these settings, such that multidisciplinary treatments should be delivered, with nutrition, physiotherapy, and psychology interventions aiming to treat the aged person entirely.

The data evidenced that balance, functional independence, handgrip strength, lower limbs muscle strength, medication administration, number of previous falls, and visual and hearing changes are critical parameters for assessing the risk of falls among older adults.

The study also showed that at the ILPI, these data were better compared to the ILPII. This finding caused the researchers to consider the impacts social isolation during the COVID-19 pandemic

may have imposed on institutionalized elderlies who had physical activity programs suspended during the evaluation period.

Therefore, prevention strategies should be emphasized for this population, reviewing medication use and proposing rehabilitation of motor and sensory functions and body balance. Such strategies should improve the quality of life, preventing falls and even death among this population.

CONCLUSION

Older adults have a high risk of falls, and the most compromised and responsible parameters are polypharmacy, reduced balance, muscle weakness, loss of sensitivity, and a high level of functional dependence.

The data in this study evidenced a strong correlation between balance, functional dependence, and a higher risk of falls among aged adults. The need for multidisciplinary intervention to prevent the risk factors and improve the quality of life of this population was also observed.

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AUTHOR CONTRIBUTION

Ferreira MJR, Rodrigues JA, Rezende AES, Pereira ACMS, Lemos LR, Cunha LA, Belo MSFOM: data collection, data analysis, and manuscript editing; Damázio LCM: research, data collection, and data analysis tutoring, manuscript writing correction.

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