ORIGINAL ARTICLE

HOSPITALIZATIONS AND MORTALITY DUE TO FALLS IN THE ELDERLY, PIAUÍ-BRAZIL, 2014 TO 2021

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Highlights: (1) The highest number of falls was observed among women, elderly individuals aged 60–69 years, and residents in the Entre Rios health region. (2) The trend of hospitalization and mortality rates remained stationary throughout the studied years. (3) The hospitalization and mortality rates remain high in the state of Piauí. (4) Reducing hospitalizations and mortality can be achieved by expanding existing fall prevention programs and measures within the SUS primary care.

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HOSPITALIZATIONS AND MORTALITY DUE TO FALLS IN THE ELDERLY, PIAUÍ-BRAZIL, 2014 TO 2021

ABSTRACT

This study aimed to analyze the trend of hospitalizations and mortality due to falls among the elderly in Piauí between 2014 and 2021. This is an ecological, time-series study using data on hospitalizations and deaths due to falls during the period from 2014 to 2021 in Piauí. Data were collected from the Hospital Information System of the Brazilian Unified Health System (SUS). To analyze trends, the Prais-Winsten linear regression model was applied, with autocorrelation assessed using the Durbin-Watson test. A total of 16,048 hospitalizations and 516 deaths due to falls among elderly people were analyzed by sex, age group, and health region. A stationary trend in hospitalization and mortality rates was observed according to the variables used. The need to improve and expand fall prevention measures and programs for the elderly is reinforced.

Keywords: Accidental falls; Elderly; Mortality; Hospitalization; Time series studies.

INTRODUCTION

Population aging is a global reality. In 2021, there were approximately 1.1 billion elderly people in the world. Brazil follows this growth trend intensely and rapidly. In 2021, the country reached 31.3 million elderly individuals, and it is projected that by 2050, 30% of the population will be elderly[1].

The aging process is characterized by physiological changes such as reduced functional capacity, muscle weakness, and postural instability, which occur due to changes in the sensory and motor systems. Among the elderly, these changes lead to a greater tendency to fall, contributing to the increase in adverse events classified as external causes[2].

Falls in the elderly are one of the main reasons for hospitalizations in Brazil. They are highlighted as a clinical and public health issue, not only due to their morbidity and mortality and high incidence but also due to consequences such as fractures, immobilization, contusions, sprains, wounds, neurological injuries, pain, difficulties in daily activities, hospitalization, psychological and social consequences, death, as well as high care costs for public services and families[3-4,5].

Although data on hospitalization trends due to falls in the elderly in Piauí are available in the literature, there are no studies that jointly analyze hospitalizations and mortality due to

falls among the elderly[6]. Furthermore, time series studies on this topic in the state of Piauí are still scarce. Therefore, this study aims to analyze the trend of hospitalizations and mortality due to falls among the elderly in Piauí between 2014 and 2021.

METHODS

This is a descriptive ecological time series study. Data on hospitalizations were obtained from the Hospital Information System of the Unified Health System (SIH-SUS), and mortality data were sourced from the Mortality Information System (SIM), both available on the website of the Department of Informatics of SUS (DATASUS), using the International Classification of Diseases (ICD-10), chapter XX, codes W00–W19[7-8].

Population data for elderly individuals aged ≥ 60 years were obtained from the Brazilian Institute of Geography and Statistics (IBGE), with age stratified by decade (60–69, 70–79, 80 years and older), according to the estimated resident population in the health regions of Piauí[9].

Hospital morbidity and trend indicators due to falls were analyzed based on the following variables: sex (female and male); age group (60 to 69 years, 70 to 79 years, and 80 years and older); and health region (Carnaubais, Chapada das Mangabeiras, Cocais, Entre Rios, Planície Litorânea, Serra da Capivara, Tabuleiro Alto Parnaíba, Vale do Canindé, Vale do Rio Guaribas, Vale do Rio Sambito, Vale Rio Piauí/Itaueiras).

Google Sheets, part of the Google Drive suite, was used to calculate the absolute and relative values of hospitalizations, mortalities, and rates. The hospitalization rate was calculated by dividing the number of hospitalizations by the population of elderly residents × 100,000 inhabitants, stratified by sex, age group, and health region. The calculation included all hospitalizations by occurrence, stratified by sex, age group, and health region, without filtering or excluding cases of readmissions due to the same or a different fall in the same or a different year.

Mortality rates were calculated by dividing the number of deaths due to falls among the elderly in the target area in a specific year (total deaths, deaths by sex, deaths by age group, deaths by health region) by the corresponding population for that period and group (sex, age group, health region) in the same area and year, multiplied by 100,000 inhabitants.

For the temporal trend analysis, the Prais-Winsten linear regression model was applied, calculating the annual percent change (APC) and its 95% confidence intervals (95% CI), using the R software, version 4.2.0. Autocorrelation was assessed using the Durbin-Watson test.

In the linear regression, the dependent variables (Y) were the hospitalization and mortality rates due to falls among the elderly, disaggregated by sex, age group, and health region. The independent variable (X) was the year in which the data occurred. For each health region, the model used was described by the following formula:

$$log\ (y_t) = \beta_0 + \beta_1 x_t + \epsilon_t$$

Where:

- y_t represents the hospitalization and mortality rate due to falls among the elderly in year t,
- β_0 is the intercept, i.e., the expected value of $log\ (y_t)$ when $x_t = 0$,
- β_1 is the linear trend coefficient, representing the expected change in $log\ (y_t)$ for a one-unit change in x_t,
- x_t corresponds to the year of occurrence of the rate,
- ϵ_t is the error associated with year t.

Furthermore, hospitalization and mortality rates due to falls among the elderly were transformed using the natural logarithm[10]. Once the model was adjusted, the β_1 values and their respective 95% (IC95%) confidence intervals were estimated for each analysis disaggregated by sex, age group, and health region. The VPA was then calculated using the formula:

$$VPA = (10^{\beta_1} - 1) \times 100$$

The 95% confidence interval for the APC was obtained by applying the same formula, replacing β_1 with the lower and upper bounds of its 95% CI, to estimate the respective confidence intervals for the APC:

$$VPA_{inferior} = (10^{\beta_1 inferior} - 1) \times 100$$

$$VPA_{superior} = (10^{\beta_1 superior} - 1) \times 100$$

Finally, the trend in hospitalization and mortality rates was interpreted as increasing ($p < 0.05$ and a positive regression coefficient), decreasing ($p < 0.05$ and a negative regression coefficient), or stable ($p > 0.05$). A significance level of $p \leq 0.05$ was adopted.

All data were collected from a public domain database. Therefore, there was no need for submission to a Research Ethics Committee, in accordance with Resolution nº 510 of April 7, 2016, from the Brazilian National Health Council (CNS) [11].

RESULTS

In Piauí, individuals aged 60 years or older represented 11% of the population in 2014, reaching 15% in 2021. A total of 16,048 hospitalizations due to falls among the elderly were recorded during the study period (2014–2021), stratified by sex, age group, and health region. The highest number of falls occurred among women (63.2%), elderly aged 60–69 years (36.5%), and residents of the Entre Rios health region (41.3%) (Table 1).

A total of 516 deaths from falls were reported. The highest mortality was observed among elderly women (50.6%), individuals aged 80 years or older (52.5%), and residents of the Entre Rios health region (34.3%) (Table 1).

Table 1 – Number of Hospitalizations and Deaths from Falls Among the Elderly by Sex, Age Group, and Health Region. Piauí, Brazil, 2014–2021.

	Hospitalizations			Deaths (n)		
	2014	**2021**	**n (%)**	**2014**	**2021**	**n (%)**
Total	1486	2321	16048	57	84	516
Sex						
Female	915	1467	10145 (63,2)	24	51	261 (50,6)
Male	571	854	5903 (36,8)	33	33	255 (49,4)
Age Group						
60 a 69	570	792	5850 (36,5)	9	17	92 (17,8)
70 a 79	485	753	5108 (31,8)	16	39	153 (29,7)
≥ 80	431	776	5090 (31,7)	32	28	271 (52,5)
Health Region						
Carnaubais	60	133	691 (4,3)	5	4	34 (6,6)
Chapada das Mangabeiras	41	88	508 (3,2)	1	1	13 (2,5)
Cocais	101	149	1188 (7,4)	5	10	55 (10,7)
Entre Rios	624	1023	6625 (41,3)	24	24	177 (34,3)
Planície Litorânea	151	232	1344 (8,4)	4	24	69 (13,4)
Serra da Capivara	41	130	698 (4,3)	3	1	19 (3,7)
Tabuleiros do Alto Parnaíba	13	26	177 (1,1)	-	1	8 (1,6)
Vale do Canindé	59	82	679 (4,2)	1	4	25 (4,8)
Vale do Rio Guaribas	217	170	2034 (12,7)	5	7	51 (9,9)
Vale do Sambito	46	85	665 (4,1)	1	-	12 (2,3)
Vale dos Rios Piauí e Itaueiras	133	203	1439 (9,0)	8	8	53 (10,3)

Source: Ministry of Health - Hospital Information System of the Unified Health System (SIH/SUS).

Overall, the trend in the hospitalization rate remained stationary over the years studied, with an annual percentage variation of 6.4% (95%CI: -4.2;18.2). There was a higher rate among female hospitalizations (APC: 7.2%; 95%CI: 3.7;10.82), and in the health regions of Vale do Canindé (APC: 40.9%; 95%CI: 8.95;82.25); Tabuleiros do Alto Parnaíba (APC: 34.5; 95%CI: 26.78;42.6); Chapada das Mangabeiras (APC: 25.1; 95%CI: 9.54;42.85) followed by Cocais (APC: 22.9; 95%CI: 10.67;36.4) (Table 2).

Table 2 – Trend in Hospitalization Rates Due to Falls Among the Elderly in Piauí, 2014–2021.

	Hospitalization Rate*		VPA	IC95%	Valor p[a]	Trend
	2014	2021				
Total	406,7	535,5	6,4	-4,2;18,2	0,2917	Stationary
Sex						
Female	36,4	46,8	7,2	3,7;10,82	< 0,01	Increasing
Male	250,4	338,5	6,4	-5,68;19,96	0,3531	Stationary
Age Group						
60 a 69	156,3	197,0	6,4	-2,02;15,59	0,1904	Stationary
70 a 79	156,0	182,7	3,6	-5,86;14,04	0,4953	Stationary
≥ 80	132,8	173,7	4,7	-6,7;17,55	0,4629	Stationary
Health Region						
Carnaubais	118,0	179,0	10,8	-1,66;24,89	0,1429	Stationary
Chapada das Mangabeiras	16,4	30,7	25,1	9,54;42,85	0,0163	Increasing
Cocais	11,2	20,3	22,9	10,67;36,4	0,0084	Increasing
Entre Rios	27,6	34,4	2,9	-10,55;18,32	0,7046	Stationary
Planície Litorânea	170,8	236,0	3,1	-6,61;13,74	0,5702	Stationary
Serra da Capivara	41,3	53,5	-1,5	-6,89;4,15	0,6099	Stationary
Tabuleiros do Alto Parnaíba	11,2	30,0	34,5	26,78;42,6	< 0,01	Increasing
Vale do Canindé	3,6	6,0	40,9	8,95;82,25	0,0399	Increasing
Vale do Rio Guaribas	16,1	18,9	6,5	-12,98;30,32	0,5638	Stationary
Vale do Sambito	59,4	39,2	-12,0	-31,82;13,59	0,3642	Stationary
Vale dos Rios Piauí e Itaueiras	12,6	19,6	16,3	-9,73;49,91	0,2867	Stationary

VPA: Annual percentage change; CI: Confidence interval; p-value: Statistically significant (95% confidence when p≤0.05); *100 thousand inhabitants; *Durbin-Watson test.
Source: Ministry of Health - Hospital Information System of the Unified Health System (SIH/SUS).

In the general analysis of deaths, a stationary trend was observed, with an annual percentage variation of 8.6% (95%CI: -6.5; 26.1). An increasing trend in the mortality rate was observed in females (APC: 15.8%; 95%CI: 6.98; 25.32), aged between 70-79 years and residents of the Planície Litorânea health region (APC: 41.8; 95%CI: 24.15; 61.9). The

Tabuleiros do Alto Parnaíba health region was the only one that showed a decreasing trend (APC: -17; 95%CI: -28.16; -4.01) (Table 3).

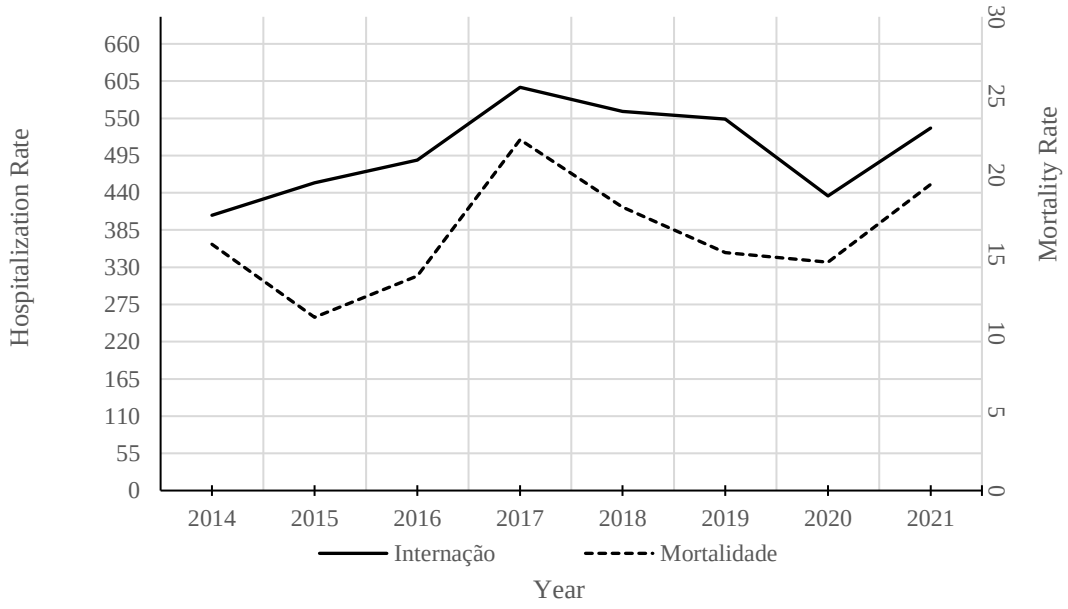
Table 3 – Trend in Mortality Rates Due to Falls Among the Elderly in Piauí, 2014–2021.

	Mortality Rate*		VPA	IC95%	p[a] Value	Trend
	2014	2021				
Total	15,6	19,4	8,6	-6,5;26,1	0,3242	Stationary
Sex						
Female	6,6	11,8	15,8	6,98;25,32	0,011	Increasing
Male	9	7,6	1,3	-21,21;30,15	0,9252	Stationary
Age Group						
60 a 69	2,5	3,9	16,5	2,09;33,01	0,064	Stationary
70 a 79	4,4	9	26,2	9,4;45,67	0,0188	Increasing
≥ 80	8,8	6,5	-6,8	-26,14;17,59	0,5743	Stationary
Health Region						
Carnaubais	1,4	0,9	-4,6	-24,45;20,45	0,7054	Stationary
Chapada das Mangabeiras	0,3	0,2	18,1	-20;74,26	0,435	Stationary
Cocais	1,4	2,3	26,4	-0,65;60,71	0,1052	Stationary
Entre Rios	6,6	5,5	-5,5	-18,43;9,48	0,4795	Stationary
Planície Litorânea	1,1	5,5	41,8	24,15;61,9	< 0,01	Increasing
Serra da Capivara	0,8	0,2	-18,9	-47,81;25,95	0,3866	Stationary
Tabuleiros do Alto Parnaíba	0,5	0,2	-17	-28,16;-4,01	0,0457	Decreasing
Vale do Canindé	0,3	0,9	36,1	-25,31;147,85	0,3532	Stationary
Vale do Rio Guaribas	1,4	1,6	-6,5	-25,85;17,96	0,5924	Stationary
Vale do Sambito	0,3	0,5	10,1	-30,71;75,02	0,6974	Stationary
Vale dos Rios Piauí e Itaueiras	2,2	1,8	14,1	-3,38;34,63	0,1711	Stationary

VPA: Annual percentage change; CI: Confidence interval; p-value: Statistically significant (95% confidence when p≤0.05); *100 thousand inhabitants; *Durbin-Watson test.
Source: Ministry of Health - Hospital Information System of the Unified Health System (SIH/SUS).

Figure 1 shows the evolution of hospitalization and mortality rates due to falls among the elderly in Piauí, between 2014 and 2021. It can be seen that the hospitalization rate shows a constant increase until 2017, when it reaches its peak, followed by a fall and a new rise in 2021. The mortality rate, on the other hand, follows a more unstable pattern, except between 2014 and 2015, when the series show opposite trajectories.

Figure 1 - Rate of hospitalizations and mortality due to falls in the elderly per 100,000 inhabitants, in Piauí, 2014 - 2021. Teresina, Piauí - 2022.



Source: Ministry of Health - Hospital Information System of the Unified Health System (SIH/SUS).

DISCUSSION

The study provides evidence on the trend of hospitalizations and mortality due to falls among the elderly in the state of Piauí, between 2014 and 2021. Overall, a steady trend was observed in the hospitalization and mortality rates based on the variables studied. The hospitalization and mortality rates were more prevalent in females.

Studies conducted in Brazil reaffirm the predominance of women in hospitalizations and deaths due to falls[12-13]. The increase in female hospitalizations may be justified by the greater demand of this sex for health services and greater adherence to self-care practices, resorting more frequently to hospital care when facing serious health problems. This practice results in a greater entry into high-complexity services, as observed by the increase in hospitalization rates between 2014 and 2021.

The number of hospitalizations was predominant in elderly people between 60 and 69 years old, while the number of deaths was more frequent in the age group ≥ 80 years old. On the other hand, the analysis of the hospitalization rate revealed a steady trend in all age groups studied, with positive variations in all of them.

The predominant number of hospitalizations in the age group between 60 and 69 years can be explained by the particularities of this group. The frequency of hospitalization triples after the age of 65, which means that in Brazil there is approximately one fall for every three people over the age of 65. It is estimated that 40% of elderly people aged 80 years or older fall at least once a year, showing that the older the person, the greater the chance of falling, triggering serious physical, functional and psychosocial impairments, which generates the risk of institutionalization and recurrent hospitalizations, reduced quality of life and death[14-15,16].

This risk is evident in the regions of Chapada das Mangabeiras, Cocais, Tabuleiros do Alto Paranaíba and Vale do Canindé, which face a common challenge: an increase in the hospitalization rates of elderly people due to falls over the period analyzed. Factors such as access to health services, quality of services, demographic profile of the population and prevalence of diseases can influence these variations. This highlights the urgency of strengthening fall prevention strategies and geriatric care in these areas, in addition to investigating the causes of this increase[17].

On the other hand, the steady trend in the hospitalization rate due to falls in Piauí when related to sex, age group and health region may be related to several factors such as greater awareness and improvement in the quality of life of the elderly, as well as expansion and access to health promotion and prevention services. Improvements in primary health care are related to the reduction of falls among the elderly, mainly due to the ability to identify risk factors,

promote education and prevention, monitor health, offer multidisciplinary interventions and ensure access to medical care[18].

Most deaths occurred among elderly women, because although women use health services more, some factors such as the use of large doses and varieties of medications, balance problems, lower lean mass and muscle strength, greater loss of bone mass due to reduced hormones, social vulnerability and comorbidities such as chronic non-communicable diseases can contribute to the increase in the number of deaths due to falls in this population[19-20].

The increasing trend of deaths among elderly people aged 70 to 79 years may be associated with factors such as age and comorbidities, since the natural aging process can cause changes in balance, mobility, flexibility and gait. In addition, with advancing age, an accumulation of comorbidities may occur, increasing the risk of falls and the prevalence of multiple consequences[16-21].

The mortality rate by health region maintained a stationary trend, increasing only in the coastal plain region and decreasing in Tabuleiros do Alto Paranaíba. This reality may be related to the possibility of improvements in the quality of care provided by health services as well as the efficiency of treatment or implementation of preventive health interventions in the regions. In addition, prevention programs can reduce the rates of falls among the elderly, the number of hospitalizations and deaths, and the demand for highly complex services[20].

The results found in this study indicate that mortality due to falls among the elderly in Piauí constitutes a public health problem and, although these rates show variations in trends with a stationary prevalence, it is important to highlight the importance of directing fall prevention measures, since in most cases, it is a preventable external cause. These primary health measures should emphasize multidisciplinary and intersectoral approaches, considering all physical and psychosocial aspects involved in the context of falls, in order to promote quality of life and active and healthy aging[22].

Regarding the annual rates of hospitalizations and mortality, these reveal a different behavior in 2015. While hospitalizations due to falls among the elderly increased, mortality rates showed a decrease. This phenomenon may indicate that, in that specific year, actions aimed at preventing and managing falls, or the quality of medical care provided after the accident, were more effective in saving lives, even in the face of an increase in hospitalizations.

In the other years, there is a direct trend between the two rates. In other words, the higher the number of hospitalizations, the higher the number of deaths. This suggests that falls with more serious complications have become increasingly lethal, a pattern that is reinforced by international literature, which highlights the role of comorbidities and progressive frailty in the elderly as aggravating factors[23].

The increase in hospitalization rates until 2017, followed by a small reduction, may be in line with improvements in preventive strategies and awareness of the risks of falls, such as physical activity and strengthening programs. However, the increase in mortality rates between 2020 and 2021 may be a reflection of weaknesses in the health system, which was overwhelmed during the pandemic, making access to fast and effective care difficult[24].

The data obtained in this study can support managers and health professionals in planning actions to prevent falls and promote the health of the elderly, as a way of dealing with this problem in the state of Piauí, since the research findings can facilitate the development of a line of care focused on this age group.

The data source used in this study may be subject to limitations. The use of SIH-SUS and SIM includes data only on hospitalizations and mortality in hospitals affiliated with SUS, not providing information on private health units, in addition to possible errors in filling out the basic document, which is the Hospital Admission Authorization (AIH) and clinical records. Furthermore, the use of secondary data may present problems in the flow of data and in its consolidation by the database used (DATASUS)[7].

Despite these limitations, these limitations do not make the study unfeasible, especially when considering the importance of secondary data, as they provide essential information on hospitalizations and mortality due to falls in the elderly, data that are fundamental to supporting professional, family, community and public interventions. In addition, the use of these data allows for a broader and more detailed analysis of large populations or regions, and can be used for studies related to trends and patterns over time, facilitating the identification of patterns and the formulation of effective policies to prevent this growing problem.

CONCLUSION

Despite the steady trend in hospitalization and mortality rates due to falls among the elderly in Piauí between 2014 and 2021, continuous monitoring is important given the high mortality rates caused by falls among the elderly.

Studies that update this information are essential, as they make it possible to contribute to the development of public health strategies and policies to maintain the safety of this population and the consequent reduction in hospitalizations and mortality.

Public policies to protect the elderly must be strengthened, prioritizing the reduction in mortality due to falls. Furthermore, it is necessary to expand existing fall prevention programs and measures in primary care in the SUS to reduce the number of hospitalizations and mortality.

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