

## The Effect of falls on Medical Costs among Elderly Inpatient; A Case-Study in Iran

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### ABSTRACT

**Objective:** Falls are the main cause of injuries and death among the elderly and lead to using medical services. This study aimed to assess the effect of falls on medical costs among elderly inpatients.

**Methods:** This retrospective cross-sectional study was done in a public hospital (heart center) in Qazvin, Iran. In this study, 79 medical records of the elderly who had experienced in-hospital falls and 79 medical records in control group with similar characteristics who had not experienced in-hospital falls during 2016-2019. The data, including the elderly age, sex, fall characteristics, and all hospital costs related to falls were gathered from hospital accident forms, medical records, nursing reports, and official data banks. The overall costs of services provided for fallen elderly were compared with the control group. The data were analyzed by SPSS software, version 22, using Chi-square and paired sample t-test.  $P < 0.05$  was considered statistically significant.

**Results:** Total cost of all services provided for the elderly during their hospitalization was 106.596\$ (base year: 2019,  $\$1=42500$  IRR), of this amount 8.600\$ (8.06%) was related to the services due to in-hospital falls. The highest costs were related to treatment services (40%), diagnostic services (33%), visits (21%) and consultation (6%). The difference between the case and control groups was 7.310\$. The elderly falls significantly increased medical costs by 8.06% ( $P \leq 0.01$ ).

**Conclusions:** Even falls that do not lead to serious injuries waste medical services and increase hospital costs by making changes in treatment methods and increasing the length of hospital stay.

**Keywords:** Elderly; fall; Cost; Medical services

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### Introduction

Aging would become a major global and national challenge for the healthcare system in future decades. Falls are among the most common and serious causes of disability, hospitalization, and death among the elderly leading to personal and social problems, reduced quality of life, and need for care, and impose health and medical costs (1,4). According to the National Health Service (NHS), falls are among the 28 accidents that should never occur in hospitals (5). The percentage of people over the age of 60 years will increase from 12% in 2015 to 22% (1.2 billion) in 2050 worldwide (6). An increasing number of falls was also seen in Iran's elderly population (from 3.8% in 1966 to 6.1% in 2012) (7).

About 28% - 35% of the elderly (almost about one third of those over the age of 65 years) fall each year. For individuals over the age of 70, this percentage increases to about 32%-42%, and further increases for those over the age of 80. About 30-50% of the elderly residing in nursing homes fall once and about 40% of them experience recurrent falls, and more than 50% of inpatients comprise individuals over the age of 65 years (8). Falls are the results of interactions between biological, behavioral, environmental, social, and economical factors (8). In a study in Iran, 46.9% of the elderly had fallen three times, 33.8% twice and 9.4% once (9).

Although it seems impossible to fall in hospitals, in addition to physicians and healthcare workers (10), falls are very common among inpatients. According to the patients fall index (a tool for assessing care quality and calculating financial burden on the country's medical health system), 3.7 to 7 falls occur among every 1000 patients per day which is equal to 6-14% of hospital admissions (11-13).

In hospital falls comprise 26% (324000 cases) of accidents that endanger people's lives yielding an annual cost of two billion pounds (14).

Many factors increase the occurrence of falls, such as depression, cognitive, situational, visual, and musculoskeletal impairments, use of motor-aid instruments, history of previous fall, medical

conditions, such as cardiovascular diseases, infection, Parkinson's disease, stroke, osteoarthritis, depression, use of medication, female sex, and old age (15,16).

The simultaneous existence of several risk factors would further increase this possibility (17).

Falls worsen public health conditions because of physical complications, such as hematoma, bruise, hemorrhage, fracture, and death, and also mental problems, such as post-fall syndrome characterized by dependence, confusion, immobility, depression, and limited daily activity (18,8,11,13). Ten to 15% of falls lead to severe injury, 5-10% causes various types of fracture, and 30% lead to death (19,20,11). In 2002, more than 12900 elderly lost their lives due to falls (20). In addition to the abovementioned consequences, the long-term effects and costs of falls among inpatients not only affect the elderly, but also place a considerable burden on hospitals and the healthcare system (21,15). It consumes medical services and as a result increases medical costs (22,23). These costs include hospitalization and treatment services, surgical procedures, radiographs, diagnostic services, and rehabilitation measures (11,17).

Various studies have been done to calculate the financial burden of falls in the elderly worldwide. The NHS has estimated the treatment and hospitalization costs of falls more than 630 million pounds which is equal to 87% of all treatment costs (5).

In Finland and Australia, the average health system cost per one fall injury episode was 3611 US\$ and 1049 US\$ (24). Moreover, studies in America have shown that this number was 11 million dollars in 2010 (25).

Cost estimates are necessary for making a correct decision for resource allocation and prioritizing healthcare decisions (26).

The comparison of international studies is difficult due to differences in healthcare systems, different populations, and use of different research designs, data collection, and cost estimates. Despite these challenges, researchers agree that considering the increasing trend of the elderly

population throughout the world, the financial burden imposed on the health system and treating these patients is on the rise (21).

Considering the importance of this issue and lack of studies assessing fall costs in Iranian elderly, we aimed to assess the effects of falls among elderly inpatients on medical costs in one of the hospitals in Qazvin, Iran, from March 2016 to February 2019.

### Materials and Methods

In this cross-sectional study, all 115 records of people who had experienced in-hospital falls and never events were gathered from hospital accident forms from March 2016 to February 2019 in Booali hospital in Qazvin, The inclusion criteria were: age over 60 years, experiencing fall in sitting, standing and lying position (falling off the bed), medical procedures were performed for these fallen elderly, and Availability of complete costs

and payment information during hospitalization. Among the elderly entered the study, those with the mentioned characteristics were excluded from the study: age less than 60 years (8 cases), lack of cooperation (two cases), no medical action taken and only nurse examination performed (5 cases), death (because of no control for comparison, 5 cases), other never events than fall (19 cases). By omitting the above mentioned cases, the sample consisted of 79 elderly who had experienced at least one type of fall and one medical procedure has been performed for them. With the permission of hospital authorities and removing the names of those in the case group for confidentiality, data were gathered from hospital accident forms, medical records, daily reports of nursing stations and official data banks. During the assessment the demographic and payment information was gathered from fallen elderly's record. Table 1 show the information from patients' record.

**Table 1.** Information extracted from fallen elderly's records

#### Patient information

- Age and sex
- Mode of admission
- Patient's state of consciousness upon admission
- Final diagnosis of illness
- Admitted ward
- Received medication 24hours before the accident
- Mental state and consciousness 24 hours before the accident

#### Details of fall

- Type of fall
- Method of diagnosis
- Day and hour of fall
- Place of fall
- Preventive measures taken before the fall
- Measures taken during the first minutes after the fall
- Type and severity of injury
- Medical procedures done after the fall with respect to revisits, specialist consultation, diagnostic procedures, and treatment actions

#### Cost information

- Type of insurance
- Cost of provided services (revisits, specialist consultation, diagnostic procedures, and treatment actions)
- Total costs

Some factors that affect falls, such as the elderly's musculoskeletal power, the effect of education on the patients' and their families' knowledge, and the nurses' level of awareness

(15,17,22,27,28), could not be assessed; since the patient, his/her family, and the nurse in charge at the time of fall were not available. The type and severity of trauma were categorized as follows

after being visited again: 1) Minor injury: inflammation, itching, pain, minor bleeding, 2) Moderate injury: bleeding that requires bandage, bruise needing stitches, trauma to the head and forehead, 3) Major injury: splinting, a variety of fractures leading to plaster, severe trauma to the skull and heart attack.

All provided services, cost of each service, and total paid expenses were extracted from the records. The provided services due to falls were separated from other services and classified into four categories, including visit, counseling, diagnosis, and treatment. After subtracting costs related to falls, each person's bill was prepared based on the final diagnosis and categorized into the main groups (cardiovascular, nervous, and infectious) for different types of disease. This method insured suitable categorization and data integrity. Moreover, a suitable control was found for each patient matched with respect to final diagnosis of the disease, age, sex, provided services, and total costs. The control group had not

experienced any falls or accidents. The required data for comparison were extracted from the records of the elderly in the control group.

The data were analyzed by SPSS software, version 22 using Chi-square and paired sample t-tests.  $P < 0.05$  was considered as statistically significant. Moreover, all costs were converted based on the CPI index provided by Iran's National Statistics Center for the year 2019.

**Results**

The research findings were divided into three sections, including patient information, details of falls, and cost information.

*Patient information: demographic and characteristics of the elderly who had fallen*

As shown in Table 2, the mean age of the elderly was 73.85 years and falls were 1.32% more prevalent in women ( $P < 0.044$ ). The highest rate of falls was observed in the elderly patients with cardiovascular diseases (43/79: 54.44%) and in the cardiology ward (22/79:27.85%).

**Table 2.** Demographic characteristics of elderly patients who had fallen and circumstances of falls: Base-year: 2019

| Patients' characteristics                              | Inpatients Who Fell<br>(N=79) n (%) | p*           |
|--|-------------------------------------|--------------|
| <b>Age (mean age)</b>                                  | 73.85                               |              |
| <b>Sex</b>   |                                     | $\leq 0.044$ |
| • Female   | 45 (56.96%)                         |              |
| • Male   | 34 (43.03%)                         |              |
| <b>Mode of admission</b>                               |                                     | $\leq 0.001$ |
| • Ambulance  | 12 (15.18%)                         |              |
| • In person  | 67 (84.82%)                         |              |
| <b>Patient's state of consciousness upon admission</b> |                                     | $\leq 0.004$ |
| • Conscious  | 54 (68.35%)                         |              |
| • Semi-conscious                                       | 16 (20.25%)                         |              |
| • Unconscious  | 9 (11.4%)                           |              |
| <b>Final diagnosis of illness</b>                      |                                     | $\leq 0.047$ |
| <b><u>Cardiovascular disease</u></b>                   | <b>43 (54.42%)</b>                  |              |
| • Cardiac disorders                                    | 19 (24.05%)                         |              |
| • Hypertension   | 11 (13.93%)                         |              |
| • Stroke   | 8 (10.12%)                          |              |
| • Asthma   | 5 (6.32%)                           |              |
| <b><u>Neurological diseases</u></b>                    | <b>19 (24.05)</b>                   |              |
| • Limb numbness  | 11 (13.93%)                         |              |
| • Convulsion   | 8 (10.12%)                          |              |
| <b><u>Infectious disease</u></b>                       | <b>17 (21.53%)</b>                  |              |
| • Fever and shivering                                  | 11 (13.93%)                         |              |
| • Nausea and poisoning                                 | 6 (7.6%)                            |              |

| Patients' characteristics   | Inpatients Who Fell<br>(N=79) n (%) | p*      |
|---|-------------------------------------|---------|
| <b>Inpatient ward</b>   |                                     | ≤0.048  |
| • Internal  | 18 (22.79%)                         |         |
| • Surgery   | 5 (6.33%)                           |         |
| • Neurology   | 13 (16.45%)                         |         |
| • Cardiology  | 22 (27.85%)                         |         |
| • CCU, ICU  | 8 (10.12%)                          |         |
| • Infectious  | 13 (16.46%)                         |         |
| <b>Received medication 24 hours before the accident</b>                     |                                     | ≤0.006  |
| • Receiving medication effective on level of consciousness**                | 62 (78.47%)                         |         |
| • Not receiving medication effective on level of consciousness              | 11 (13.93%)                         |         |
| • Unclear   | 6 (7.6%)                            |         |
| <b>Mental state and consciousness 24 hours before the accident</b>          |                                     | ≤0.009  |
| • Conscious   | 29 (36.7%)                          |         |
| • Semi-conscious  | 50 (63.3%)                          |         |
| <b>Type of fall</b>   |                                     | ≤0.513  |
| • Same level falls  | 40 (50.63%)                         |         |
| • Fall from elevation   | 39 (63.49%)                         |         |
| <b>Method of diagnosis</b>  |                                     | ≤0.014  |
| • Reported by nurse/nurse aide/ward personnel                               | 47 (59.49%)                         |         |
| • Reported by patient companion   | 20 (25.31%)                         |         |
| • Reported by patient (self-report)   | 12 (15.18%)                         |         |
| <b>Day of fall</b>  |                                     | ≤0.009  |
| • 1-4 days after admission  | 58 (73.41%)                         |         |
| • 5-10 days after admission   | 21 (18.98%)                         |         |
| • 11 days or more after admission   | 6 (7.59%)                           |         |
| <b>Hour of fall</b>   |                                     | ≤0.034  |
| • From 7 AM to 6:59 PM  | 31 (39.24%)                         |         |
| • From 7 PM to 6:59 AM  | 48 (60.75%)                         |         |
| <b>Place of fall</b>  |                                     | ≤0.007  |
| • Patient's room  | 54 (68.35%)                         |         |
| • Bathroom or restroom  | 9 (11.39%)                          |         |
| • Hallway or yard of hospital   | 12 (15.18%)                         |         |
| • Other places (laboratory and radiology ward)                              | 4 (5.06%)                           |         |
| <b>Reason of fall</b>   |                                     | ≤0.0019 |
| • Sleeping/turnover on bed  | 7 (8.86%)                           |         |
| • Sitting on/getting of the bed/ movements                                  | 41 (51.9%)                          |         |
| • Confusion/fainting  | 11 (1.92%)                          |         |
| • Loss of balance/slipping/slippage   | 20 (25.31%)                         |         |
| <b>Preventive measures taken before the fall</b>                            |                                     | ≤0.009  |
| • Training patient/companion  | 62 (78.48)                          |         |
| • Using bedside sleeper   | 79 (100)                            |         |
| • Maximize sleep environment (light, fences, etc.)                          | 51 (64.55)                          |         |
| • Alarm   | -                                   |         |
| • Drug monitoring   | 16 (20.25)                          |         |
| • Sleep and rest supervision policy   | 56 (70.88)                          |         |
| <b>Measures taken during the first minutes after the fall</b>               |                                     | ≤0.006  |
| • Keep the patient immobilized and ask for a house call doctor immediately. | 53 (63.29%)                         |         |
| • Transfer patient to visit a doctor in less than 2 hours after fall.       | 26 (36.7%)                          |         |
| <b>Type of injury</b>   |                                     | ≤0.002  |
| • Upper limbs injured (head, neck, shoulder)                                | 36 (45.57%)                         |         |
| • Middle limbs injured (hand/abdomen/chest/uterus)                          | 16 (20.25%)                         |         |
| • Lower limbs injured (pelvis, leg)   | 27 (34.18%)                         |         |

| Patients' characteristics                     | Inpatients Who Fell (N=79) n (%) | p*     |
|---|----------------------------------|--------|
| <b>Severity of injury</b>                     |                                  | ≤0.247 |
| • Mild  | 32 (40.5%)                       |        |
| • Moderate                                    | 24 (30.39%)                      |        |
| • Severe                                      | 23 (29.11%)                      |        |
| <b>Medical procedures done after the fall</b> |                                  | ≤0.121 |
| • Re-visit                                    | 79 (100%)                        |        |
| • Specialist consultation                     | 41 (51.9%)                       |        |
| • Diagnostic procedures                       | 70 (88.6%)                       |        |
| • Treatment actions                           | 79 (100%)                        |        |

\* P≤ 0.05 considered statistically significant.

\*\* These medicines, such as sedatives, painkillers, sleeping drugs, insulin, hypotensive drugs, etc. have side effects, such as decreased consciousness, dizziness, drowsiness, loss of balance, rapid hypotension, and etc.

**Description of falls**

Table 2 reveals the rate of reporting falls by the ward personnel and those accompanying the patients was 5.5% more than the self-reports. Most falls occurred 3.2 days after admission from 7 P.M to 7 A.M (60.75%, n=48). With respect to the place of falls, the patient’s room was the most prevalent place (68.35%, n=54) and the bed was the most important factor contributing to falls, so that 60.76% of the falls were due to “fall from bed” during sleep or when awake.

Of the 48 (60.76%) cases of bed fall, 5 elderly (10.41%) fell during sleep, 27 (56.25%) while getting off the bed (for going to the rest room of getting on a wheelchair, etc.), 12 (25%) while trying to sit on the bed, 2 (4.17%) when trying to turnover on the bed, and 2 (4.17%) when trying to take something off the bedside. Use of bedside (n=79, 100%), training (n=62, 78.48%), and monitoring the patient during sleep and rest (n=56, 70.88%) were the most prevalent preventive measures.

The highest rate of trauma was head injury, hematoma, bruises requiring stitches, forehead fracture, trauma to the shoulder and clavicle (n=36, 45.57%), injury to the lower limbs, including fracture of the thumbs and pelvis, knee injury (n=27, 34.18%) and injury to the upper limbs, such as fracture of the fingers, injury to the wrist, elbow, and chest (n=16, 20.25%). 29.11% (n=23) of these traumas were severe and led to splinting, plastering, and surgery. In 24 (30.39%) of the patients, injuries led to hemorrhage and stitching.

Minor bruises and inflammation were seen in 32 (40.5%) patients. In 41 (51.9%) patients, consultations were done with a neurologist, orthopedic surgeon, ophthalmologist, and internal specialist. Diagnostic methods (CT scan, radiography, Sonography, EEG, and ECG) were taken for 70 (88.6%) patients and some underwent more than one diagnostic method (Table 3).

**Table 3.** Type and number of diagnostic procedures

| Type of diagnostic procedures | N (%)               | p      |
|-------------------------------|---------------------|--------|
| Diagnostic procedures         | <b>423 (100%)</b>   |        |
| <b>CT Scan</b>                | <b>132 (31.22%)</b> | ≤0.048 |
| • Spiral brain                | 38 (28.78%)         |        |
| • Lung and mediastinum        | 17 (12.88%)         |        |
| • Abdomen and pelvis          | 34 (25.76%)         |        |
| • 3D face and body scan       | 12 (9.1%)           |        |
| • Limbs                       | 28 (21.21%)         |        |
| • Others                      | 3 (2.27%)           |        |
| <b>Radiography</b>            | <b>169 (39.96%)</b> | ≤0.032 |
| • Chest                       | 35 (20.71%)         |        |
| • Pelvis                      | 44 (26.3%)          |        |
| • Skull                       | 29 (17.16%)         |        |
| • Shoulder                    | 11 (6.5%)           |        |
| • Limbs (hands/legs)          | 36 (21.31%)         |        |
| • Others                      | 14 (8.29%)          |        |
| <b>Sonography</b>             | <b>90 (21.27%)</b>  | ≤0.018 |
| • Abdomen and pelvis          | 29 (32.22%)         |        |
| • Neck                        | 14 (15.55%)         |        |
| • Abdomen                     | 9 (10%)             |        |
| • Liquid in pylorus           | 12 (13.33%)         |        |
| • Pelvis                      | 15 (16.66%)         |        |
| • Uterus and ovaries          | 7 (7.8%)            |        |
| • Others                      | 4 (4.44%)           |        |
| Electrocardiogram (ECG)       | <b>18 (4.25%)</b>   |        |
| Electroencephalogram (EEG)    | <b>14 (3.3%)</b>    |        |

Minor and major treatment measures were taken for all patients. The most prevalent and cheapest treatment approach was prescribing medication and serums and minor wound healing based on the location and severity of injury. Forty seven (59.5%) patients received more than one type of treatment. The most expensive and least prevalent treatment was surgery which accounted for 77% of the healthcare service costs. Hip fracture surgery was the most prevalent surgery (n=5/9, 55.5%) (Table 4).

#### Cost information

The cost information extracted from the patients' medical records is shown in Table 6. The cost of medical services provided to the elderly due to fall-related injuries is 8.06% of the total treatment costs of the elderly during the hospitalization period. Moreover, 72.53% of the

provided services due to falls were related to diagnosis and treatment. As shown in Table 5, the highest amount was related to treatment services 3.409 US\$ (39.63%) and the lowest related to consultation 599 US\$ (6.96%).

Table 6 shows the characteristics of the control group, which were matched with the case group.

**Table 4.** Type and number of treatment actions

| Type of treatment actions                    | N(%)       |
|--|------------|
| Take medicine/ointment /serum                | 79 (100)   |
| Compression/ Superficial Treatment of wounds | 9 (11.39)  |
| Bandage                                      | 23 (29.11) |
| Stitches and gauze                           | 24 (30.37) |
| Splinting                                    | 11 (13.92) |
| Plastering                                   | 14 (17.72) |
| Surgery                                      | 9 (11.39)  |
| Physiotherapy                                | 35 (44.3)  |

**Table 5.** The financial information of case group invoice: base year: 2019

| Patients characteristics              | Inpatients who had fallen (N=97)<br>n(%) | p      |
|---------------------------------------|--|--------|
| Type of insurance                     |  | ≤0.011 |
| • Health services                     | 28 (35.44)                               |        |
| • Social security                     | 47 (59.5)                                |        |
| • Others                              | 4 (5.06)                                 |        |
| Cost of provided services due to fall | 8.600\$ (365,461,250 IRR, 8.06)          | ≤0.041 |
| • Visits                              | 1.764\$ (74,968,630 IRR, 20.51)          |        |
| • Specialist consultation             | 599\$ (25,463,020 IRR, 6.96)             |        |
| • Diagnostic procedures               | 2.828\$ (120,175,850 IRR, 32.9)          |        |
| • Treatment actions                   | 3.409 (144,853,750 IRR, 39.63)           |        |
| Total costs (including fall costs)    | 106.596\$ (4,530,304,580 IRR)            |        |
| Total costs if no fall occurred       | 97.996\$ (4,164,843,230 IRR)             |        |
| Costs of fall                         | 8.600\$ (365,461,250 IRR)                |        |

To assess the effects of falls on medical costs and to compare case and control groups, independent t test was used. Initially, the fall-related costs were subtracted from the total hospital expenses of the elderly and then the total costs of both groups were compared, which showed no significant difference between the two groups ( $P>0.05$ , Table 7).

Then, t-test was performed again for the total cost of the case group (including the cost of fall-related services) as well as the control group. As shown in Table 7, the mean difference between the two groups in case of falls and receiving related services was 7.310 US\$ (310,651,500 IRR) which showed that falls significantly increased medical service costs in the hospital ( $P\leq 0.01$ , CI:0.99).

**Table 6.** Characteristics of elderly who did not fall (control group): base year: 2019

| Characteristics               | N=79<br>n(%)                        | P-value |
|-------------------------------|-------------------------------------|---------|
| Age (mean)                    | 74.01                               |         |
| Sex                           |                                     | ≤0.043  |
| • Male                        | 32(40.5)                            |         |
| • Female                      | 47(59.49)                           |         |
| Type of disease               |                                     | ≤0.038  |
| <b>Cardiovascular disease</b> | <b>43 (54.44)</b>                   |         |
| • Heart disorders             | 20 (25.32)                          |         |
| • Hypertension                | 10 (12.66)                          |         |
| • Stroke                      | 10 (12.66)                          |         |
| • Asthma                      | 3 (3.8)                             |         |
| <b>Neurological disease</b>   | <b>19 (24.05)</b>                   |         |
| • Limb numbness               | 10 (12.65)                          |         |
| • Convulsion                  | 9 (11.4)                            |         |
| <b>Infectious disease</b>     | <b>17 (21.51)</b>                   |         |
| • Fever and shivering         | 11 (13.92)                          |         |
| • Nausea and poisoning        | 6 (7.6)                             |         |
| <b>Total cost paid</b>        | <b>99.286\$ (4,219,653,080 IRR)</b> |         |

**Table 7.** The comparison between the total costs base year: 2019

|   | The comparison between the total cost of the case group (excluding the cost of services provided due to falls) and the control group |   | The comparison between the total cost of the case group (including the cost of services provided after falls) and the control group |                           |
|---|--|---|---|---------------------------|
| F   | 3.663  |   | 2.345   |                           |
| P-Value                                   | 0.473  |   | 0.473   |                           |
| T   | 4.48   | 4.48  | 3.26  | 3.26                      |
| Degrees of freedom                        | 26   | 26  | 26  | 26                        |
| p-value                                   | 0.138  | 0.138   | 0.001   | 0.001                     |
| Mean difference                           | 5480975  | 5480975                                       | 310651500   | 310651500                 |
| Standard error difference                 | 7.168  | 7.168   | 4.082   | 4.082                     |
| 95% confidence interval of the difference |  |   |   |                           |
| Upper                                     | 6.162  | 6.197   | 3.107   | 3.223                     |
| Lower                                     | 9.163  | 9.144   | 5.132   | 5.024                     |
| Case                                      | Fall cases   | 4164843230 IRR (97996\$)                      | fall cases  | 4530304580 IRR (106596\$) |
| Mean                                      | Control  | Cases had not fallen 4219653080 IRR (99286\$) | Cases had not fallen  | 4219653080 IRR (99286\$)  |

\* P≤0.01 considered statistically significant.

**Discussion**

Elderly’s falls are among the serious and common hospital complications (13). These falls impose a considerable financial burden on hospitals each year and leave a negative effect on the limited resources of counties’ healthcare system due to the services they consume, length of stay (LOS) and costs (15,23). The results of the study showed that increasing rates of falls in the hospital, especially among the female elderly and

those with chronic diseases, would increase the cost of medical services.

The World Health Organization (WHO) states that “age over 60 years” and “female gender” are two biological factors that increase the possibility of falls (8). Many studies have shown that falls are more prevalent in elderly women (4-17-20-22-30). Hartholt found that women fall 2-3 times (58%) more than men (22). It was found that 56.96% of the falls were related to women and 43 % related to



men, showing 1.32% increase in the rate of falls in women. According to the WHO reports, the rate of life-threatening falls increased with age in both sexes and the highest rate was seen in individuals over 85 years. Moreover, falls leading to death were more prevalent in men while falls occurred more in women (8).

A study in 2015 showed that, about 64% of admitted elderly experienced falls, 54% of which led to death (35). In the present study, 79.74% of personal referrals in the elderly led to falls and 89.86% of the falls led to severe injury. This rate would increase as the number of elderly increases in the society. Osteoporosis, especially in women leads to lower ability to maintain balance and increased incidence of severe fatal falls. Stevens studied the effect of underlying diseases in increasing the risk of falls (20). Studies have shown the effect of cardiovascular disease on the risk of falls in the elderly (15,36,37). The chance of falling increases with a history of myocardial infarction (18). In the current study, the highest number of falls and fall-related costs were due to cardiovascular diseases, so that the elderly with such diseases comprised 54.42% of the falls and 64% of the fall-related costs (5.505 US\$). This could be attributed to the use of heart medications that cause a sudden decrease in blood pressure, blurred vision and loss of balance. Sudden change of mood (from supine to standing) could also be effective in causing falls.

Neurological diseases, such as stroke (89%), Parkinson's disease (77%), epilepsy (57%), headache (28%), delusion (60%), multiple sclerosis, and migraine increase the rate of falls (16,38,39). Another study also showed that Parkinson's disease, syncope, and other neurological diseases increased the possibility of falls by 62%, 57%, and 48% in the elderly, respectively. Stroke, Parkinson's disease, chronic pain, dizziness, loss of balance, and weak eye sight increase the risk of falling (19). It was also found that elderly patients with neurological diseases comprised 24.05% of falls with a cost of 1.729 US\$ (20.10%). Most of these falls were due to taking certain medicine, sudden neurological

attacks, and related cognitive and environmental disorders leading to lack of balance and falling.

Some studies have shown that the elderly with a history of infectious disease (influenza, pneumonia, etc.) have a higher chance of falling (22). In the present study, the elderly with a history of infectious disease comprised 21.53% of falls with a cost of 1.366 US\$ (15.89%). Considering the wide range of infectious diseases that affect different body organs and have various complications, should be carefully monitored in patients with a history of fall. Infectious diseases present with symptoms, such as fever, diarrhea, dizziness, and the side effects of medications (dizziness, low muscle power, etc.) contribute to increase the risk of falling.

Most falls occur at night (13,40) which is in line with the present study in which 60.75% of falls occurred during 7 PM to 7 AM ( $P \leq 0.034$ ). Visual disorders increase the chance of falls and people with these disorders are more vulnerable in the dark and when tired. Other causes of falls in these hours include consumption of several drugs and their effect on the brain and level of consciousness, being unfamiliar to the environment and existence of physical obstacles, frequent visits to the toilet during the night, the incorrect culture of not requesting help due to shame, and lack of supervision on the nurses' behalf.

Most falls were in room and due to falling from the bed (13). A study showed that 51% of the falls result from sitting and getting out of bed leading to minor (95%) and major (5%) injuries (41). Other studies have also indicated that the bed is an important factor leading to falls (13,42-44). It was found that 60.76% of the falls were related to the bed and 68.35% occurred in patients' rooms. Given the elderly spend most of the time in their room, prolonged rest reduces their muscle strength leading to imbalance. Falling off the bed could be due to wearing tight or loose clothing (and in our country wearing veils during rest), fear of sleeping on the bed, location of the bed, and its height. Some falls were the result of dislocation of the bedside, not being able to lower it, and attempting to get of the bed while the bedside is still up. It is

necessary to add physiotherapy to the daily preventive programs of patients at risk to increase their muscle power and help them gain balance. Moreover, the correct method of using the bedside should be simple and clearly explained.

In this study, 91.13% of the patients had fallen when they were conscious or semi-conscious which was consistent with another study (13). However, two other studies did not find such results (45,46). The contradictory findings could be attributed to chance and it seems that conscious patients reported more falls or they were more aware of their injuries and described injuries better. Ten-20% of falls lead to serious injury and fracture (20) and 20-30% of falls lead to hip and head trauma (18). Moreover, hip fracture is the most prevalent trauma and comprises 70% of the costs (24). In the present study, the most prevalent injury was head injury and fractures and surgeries comprised more than 77% of medical costs.

With respect to the costs of falls in the elderly, many studies have been done. The difference between the costs mentioned in different studies is related to the different healthcare systems, different participation plans of insurance companies, different types of injuries, and treatment plans, the advanced technologies available in some countries, different sample sizes, different data collection and analysis methods, which complicate comparison (21,26,35). What all studies have in common is that fall-related costs impose a considerable financial burden on the hospitals and healthcare systems of all countries. This amount would further increase as the number of the elderly increases (15,21,22). The cost of falls in the elderly has been studied extensively in America. In America and England the cost of fatal and non-fatal falls adds up to 23.3 and 1.6 billion dollars, respectively, each year. The mean cost of falls is 3.476 dollars per person and it can increase to 10.749 dollars in falls leading to injury and 26.483 dollars for those requiring admission (41). In 1997, 9% of the American elderly fell yielding a cost of 6.2 million dollars (2.039 dollars per person) and this amount increased to 7.8 million dollars in 2022 (2.591 dollars per person) (17). In 2000, 10300 fatal falls and 2.6 million non-fatal falls leading to

injury occurred in America (42% in hospitals and 50% at home). The cost of fatal and non-fatal falls has been estimated to be 0.2 and 19 billion dollars, respectively, 63% of which were for admission services and hospital stay (12 billion dollars), 21% for visits and consultation (4 billion dollars) and 16% for treatment services. In 2010, the cost of falls in healthcare centers of America was 11 million dollars (25). In 2012, 616.5 million dollars was spent for fatal falls and 30.3 billion dollars for non-fatal falls; which increased to 637.5 million and 31.3 billion dollars in 2015 (20,21,34). Twelve percent of American elderly reported falling in 2015 which means 80 million falls (37.2 falls for every 100 person) and 9.9 million led to injury (4.38 per 100 person) (25). In 2015, fatal and non-fatal falls cost 50 billion dollars in America (15). In the same year, treatment costs (surgery, radiography, etc.) for patients who had fallen was 4200 dollars more than costs for patients who had not fallen (11). In England, the cost of falls (treatment, admission, and litigation) comprised 87% of total treatment costs (2.3 billion pounds (5). Annually, more than 2 billion pounds are spent on fall-related injuries. Hospital falls comprise 26% of accidents (324000 cases) (14). In Finland and Australia, the mean cost of each injury due to falls is 1.049 to 3.611 dollars. The mean admission costs for each fall leading to injury in the hospital is 6.646 to 14.483 dollars (24). In 2001 and 2002, falls cost 498 million dollars. The mean financial burden on the healthcare system was 6500 dollars for each fall (47). In 2006 and 2007, 507000 falls occurred in the New South Wales leading to 143000 medical procedures and a cost of 558.5 million dollars. Eighteen percent of costs were related to admission and 84.5% related to medical services (26). In Australia, of the 27026 admitted patients, 966 experienced falls and 313 were injured. These rate increased hospitals stay for up to eight days and imposed 6669 dollars on hospitals (23). Fall-related costs have been estimated to be 43.8 billion dollars in 2020 (37).

### *Limitations*

The most important limitation of the study is that it was a single-center study. Also, cost

calculations were difficult due to price fluctuations and inflation. Due to lack of information, the effect of falls on the LOS could not be considered. Moreover, assessing primary and secondary state of consciousness could differ based on the nurse's knowledge and experience. The effect of factors, such as physical characteristics, BMI, muscular strength, history of previous fall, severity of illness, amount of care, and insurance support could not be assessed. Lack of similar national studies for comparison was also a big challenge.

### Conclusion

The results of this study showed that even falls that do not lead to serious injury, waste medical services and leave negative effects on hospital resources and the healthcare system and increase hospital costs by 8.06%. This increase in costs could be due to changes in treatment methods and increase the LOS. It indicates the necessity of existence and implementation of fall prevention programs in hospitals, emphasizing supervision,

control, and training. This is not only necessary for reducing fall-related injuries, but also for reducing hospital costs. Intervention strategies reduce falls and as a result decrease the cost of health services.

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### Author's contribution

All authors contributed to this project and article equally. All authors read and approved the final manuscript.

### Conflict of Interest

No potential conflict of interest was reported by the authors.

### References

1. Salminen MJ, Vahlberg TJ, Salonoja MT, Aarnio PT, Kivelä SL. Effect of a risk-based multifactorial fall prevention program on the incidence of falls. *Journal of the American Geriatrics Society*. 2009 Apr;57(4):612-9.
2. Tromp AM, Pluijm SM, Smit JH, Deeg DJ, Bouter LM, Lips PT. Fall-risk screening test: a prospective study on predictors for falls in community-dwelling elderly. *Journal of clinical epidemiology*. 2001 Aug 1;54(8):837-44.
3. Stevens JA, Ballesteros MF, Mack KA, Rudd RA, DeCaro E, Adler G. Gender differences in seeking care for falls in the aged Medicare population. *American journal of preventive medicine*. 2012 Jul 1;43(1):59-62.
4. Azadi A, Bastami M, Mmalek M. Effect of Fall-Preventive Program on Fear of Falling, Falling Frequency, and Quality of Life in the Elderly Living in Nursing Homes. *Iranian Journal of Nursing Research*. 2017 Oct 10;12(4):68-75.
5. NHS Improvement. The incidence and costs of inpatient falls in hospitals. London: NHS Improvement; 2017. Available from: [https://improvement.nhs.uk/documents/1471/Falls\\_report\\_July2017.v2.pdf](https://improvement.nhs.uk/documents/1471/Falls_report_July2017.v2.pdf).
6. Worapanwisit T, Prabpai S, Rosenberg E. Correlates of falls among community-dwelling elderly in Thailand. *Journal of aging research*. 2018 May 24;2018.
7. Statistical Center of Iran. Population and Housing Censuses. Tehran: Statistical Center of Iran. Available from: <https://www.amar.org.ir/english/Population-and-Housing-Censuses>
8. World Health Organization. WHO global report on falls prevention in older age. Geneva: World Health Organization; 2008. Available from: <https://apps.who.int/iris/handle/10665/43811>
9. Najafi Ghezlcheh T, Ariapour S, Jafari Oori M. Epidemiology and relationship of fall and fear of falling in the elderly residing at Kamrani nursing home, Tehran, Iran. *Iranian Journal of Ageing*. 2016 Jan 10;10(4):152-61.
10. King T. Helping baccalaureate nursing students care for the wellbeing of older adults. *International journal of nursing education scholarship*. 2005 Jun 29;2(1).
11. Fields J, Alturkistani T, Kumar N, Kanuri A, Salem DN, Munn S, Blazey-Martin D. Prevalence and cost of imaging in inpatient falls: the rising cost of falling. *ClinicoEconomics and outcomes research: CEOR*. 2015;7:281.

12. Currie L. Fall and injury prevention. 2008. In: Patient Safety and Quality: An Evidence-Based Handbook for Nurses (Internet). Rockville, Maryland: Agency for Healthcare Research and Quality (US). Available from: <https://www.ncbi.nlm.nih.gov/books/NBK2653/>.
13. Hitcho EB, Krauss MJ, Birge S, Claiborne Dunagan W, Fischer I, Johnson S, Nast PA, Costantinou E, Fraser VJ. Characteristics and circumstances of falls in a hospital setting: a prospective analysis. *Journal of general internal medicine*. 2004 Jul;19(7):732-9.
14. Tian Y, Thompson J, Buck D, et al. Exploring the System-Wide Costs of Falls in Older People in Torbay. London: The King's Fund; 2013.
15. Florence CS, Bergen G, Atherly A, Burns E, Stevens J, Drake C. Medical costs of fatal and nonfatal falls in older adults. *Journal of the American Geriatrics Society*. 2018 Apr;66(4):693-8.
16. Homann B, Plaschg A, Grundner M, Haubenhofner A, Griedl T, Ivanic G, Hofer E, Fazekas F, Homann CN. The impact of neurological disorders on the risk for falls in the community dwelling elderly: a case-controlled study. *BMJ open*. 2013 Nov 1;3(11).
17. Carroll NV, Slattum PW, Cox FM. The cost of falls among the community-dwelling elderly. *Journal of Managed Care Pharmacy*. 2005 May;11(4):307-16.
18. Wu S, Keeler EB, Rubenstein LZ, Maglione MA, Shekelle PG. A cost-effectiveness analysis of a proposed national falls prevention program. *Clinics in geriatric medicine*. 2010 Nov 1;26(4):751-66.
19. Stolze H, Klebe S, Zechlin C, Baecker C, Friege L, Deuschl G. Falls in frequent neurological diseases. *Journal of neurology*. 2004 Jan 1;251(1):79-84.
20. Stevens JA, Corso PS, Finkelstein EA, Miller TR. The costs of fatal and non-fatal falls among older adults. *Injury prevention*. 2006 Oct 1;12(5):290-5.
21. Alekna V, Stukas R, Tamulaitytė-Morozovienė I, Šurkienė G, Tamulaitienė M. Self-reported consequences and healthcare costs of falls among elderly women. *Medicina*. 2015 Feb;51(1):57-62.
22. Hartholt KA, Polinder S, Van der Cammen TJ, Panneman MJ, Van der Velde N, Van Lieshout EM, Patka P, Van Beeck EF. Costs of falls in an ageing population: a nationwide study from the Netherlands (2007–2009). *Injury*. 2012 Jul 1;43(7):1199-203.
23. Morello RT, Barker AL, Watts JJ, Haines T, Zavarsek SS, Hill KD, Brand C, Sherrington C, Wolfe R, Bohensky MA, Stoelwinder JU. The extra resource burden of in-hospital falls: a cost of falls study. *Medical journal of Australia*. 2015 Nov;203(9):367.
24. Fu D. Health service impacts and costs of falls in older age. Geneva: World Health Organization. Available from: <http://www.who.int/entity/ageing/projects/4%20Health%20service%20impacts%20and%20costs%20of%20falls2.pdf>.
25. Verma SK, Willetts JL, Corns HL, Marucci-Wellman HR, Lombardi DA, Courtney TK. Falls and fall-related injuries among community-dwelling adults in the United States. *PLoS one*. 2016 Mar 15;11(3):e0150939.
26. Watson WL, Clapperton AJ, Mitchell RJ. The cost of fall-related injuries among older people in NSW, 2006–07. *New South Wales public health bulletin*. 2011 Jun 23;22(4):55-9.
27. Paliwal Y, Slattum PW, Ratliff SM. Chronic health conditions as a risk factor for falls among the community-dwelling US older adults: a zero-inflated regression modeling approach. *BioMed research international*. 2017 Mar 28;2017.
28. Kelsey JL, Berry SD, Procter-Gray E, Quach L, Nguyen US, Li W, Kiel DP, Lipsitz LA, Hannan MT. Indoor and outdoor falls in older adults are different: the maintenance of balance, independent living, intellect, and Zest in the Elderly of Boston Study. *Journal of the American Geriatrics Society*. 2010 Nov;58(11):2135-41.
29. Torkaman Gholami J, Mohamadi Shahbolaghi F, Norouzi K. The Relationship between Fear of falling and Activity Limitations among Seniors of Ghaem Shahr City in 2013. *Iranian Journal of Rehabilitation Research*. 2015 Oct 10;2(1):45-52.
30. Iran SCo. Population and Housing Census Results Year 2016: Institute for Scientific Research; 2016. Available from: <http://www.sci.org>
31. Chang NT, Chi LY, Yang NP, Chou P. The impact of falls and fear of falling on health-related quality of life in Taiwanese elderly. *Journal of community health nursing*. 2010 Apr 28;27(2):84-95.
32. Scuffham P, Chaplin S, Legood R. Incidence and costs of unintentional falls in older people in the United Kingdom. *Journal of Epidemiology & Community Health*. 2003 Sep 1;57(9):740-4.

33. Araújo E, Martins K, Lima R, et al. Concern with falls in elderly people attended in an Integral Attention Center. *Rev Eletr Enf.* 2016;18:e1186.
34. Burns ER, Stevens JA, Lee R. The direct costs of fatal and non-fatal falls among older adults—United States. *Journal of safety research.* 2016 Sep 1;58:99-103.
35. Haddad YK, Bergen G, Florence C. Estimating the economic burden related to older adult falls by state. *Journal of public health management and practice: JPHMP.* 2019 Mar;25(2):E17.
36. Carey BJ, Potter JF. Cardiovascular causes of falls. *Age and ageing.* 2001 Nov 1;30(suppl\_4):19-24..
37. Dykes PC, Adelman J, Adkison L, et al. Preventing falls in hospitalized patients Silver Spring, Maryland: *American Nurse*; 2018. Available from: <https://www.myamericannurse.com/preventing-falls-hospitalized-patients/>
38. Syrjälä P, Luukinen H, Pyhtinen J, Tolonen U. Neurological diseases and accidental falls of the aged. *Journal of neurology.* 2003 Sep 1;250(9):1063-9.
39. Miertová M, Bóriková I, Tomagová M, Žiaková K. Risk factors of falling in patients with neurological diseases. *Kontakt.* 2018 Sep 1;20(3):e217-22.
40. Amirian Z, Jalali R. Assessment of hospitalized patients fall out of bed in hospitals of Kermanshah University of Medical Sciences. *Journal of Clinical Research in Paramedical Sciences.* 2014;(3):130-134.
41. Davis JC, Robertson MC, Ashe MC, Liu-Ambrose T, Khan KM, Marra CA. International comparison of cost of falls in older adults living in the community: a systematic review. *Osteoporosis international.* 2010 Aug 1;21(8):1295-306.
42. Lane AJ. Evaluation of the fall prevention program in an acute care setting. *Orthopaedic Nursing.* 1999 Nov 1;18(6):37.
43. Morse JM, Prowse MD, Morrow N, et al. A retrospective analysis of patient falls. *Can J Public Health.* 76 (1985): 116-118.
44. Lund C, Sheafor ML. Is your patient about to fall?. *Journal of Gerontological Nursing.* 1985 Apr 1;11(4):37-41.
45. Hendrich AL, Bender PS, Nyhuis A. Validation of the Hendrich II Fall Risk Model: a large concurrent case/control study of hospitalized patients. *Applied Nursing Research.* 2003 Feb 1;16(1):9-21.
46. Biderman A, Cwikel J, Fried AV, Galinsky D. Depression and falls among community dwelling elderly people: a search for common risk factors. *Journal of epidemiology & community health.* 2002 Aug 1;56(8):631-6.
47. Steinberg M, Cartwright C, Peel N, Williams G. A sustainable programme to prevent falls and near falls in community dwelling older people: results of a randomised trial. *Journal of Epidemiology & Community Health.* 2000 Mar 1;54(3):227-32.