Article

Measuring the Prevalence, Treatment, and Associated Treatment Costs of Injury for Older Adults in India: Insights from the National Longitudinal Aging Study

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Abstract: This cross-sectional analysis of secondary data aimed to examine the injury prevalence, treatment, and associated healthcare expenditure among older adults in India. Longitudinal Aging Study India Wave 1 data for those aged 60+ years comprising sociodemographic characteristics and self-reported major injury, injury mechanism, falls and joint/bone fractures, treatment sought, and out-of-pocket expenditure (OOPE) were analyzed. Descriptive, relative risk, bivariate, and two-part regression model analyses were conducted. Fifteen percent of the 31,464 older adults surveyed had experienced a major injury, 13% a fall and 5% a bone/joint fracture. The risk of injury increased with age and income and was higher for urban residents and females. Seventy-eight percent of those who experienced injury sought medical treatment, 56% needing treatment for a serious fall and 3% undergoing surgery. Higher proportions of females than males required medical treatment for falls and injury-related surgery, yet on average, females were spending less than males for public or private hospital treatment. Injury-related OOPE increased with age and decreased with lower education. Scaling up injury prevention efforts specifically focused on older adults will be vital given the projected growth in the older adult population in India in coming years. Such efforts will prevent unnecessary health impacts and reduce health system utilization and associated individual and family economic burden.

Keywords: injury; hospitalizations; outpatient care; out-of-pocket expenditure; economic; prevention; policy; elderly

1. Introduction

Globally, injury is a significant, yet preventable, cause of premature death and disability [1]. Injuries appear in the top 10 causes of disability adjusted life years (DALYs) for all age groups and resulted in an estimated 249 million all-age DALYs globally in 2019 [2]. Injury follows a socio-economic gradient whereby the burden is greater in low- and middle-income countries [3,4]. The economic costs associated with injury, such as treatment costs or the forgone economic productivity as a result of disability, result in further economic disadvantage.

Older adults, that is, those aged 60 years and over, face increased injury risk from a range of injury mechanisms [5–7], including falls [8]. Rising injury risk can be due to a range of factors such as declining eyesight impacting licensed motor vehicle driving [9] and mobility, neurological conditions such as dementia [10], and increased frailty [11]. Given the globally aging population [12], reducing injury among older adults is vitally important. The number of people aged 60 and above in India is the second largest in the world, after China [13]. Life expectancy and population growth are such that India’s population...
aged 60 and above is expected to more than double by 2050 [14,15]. Studies such as the Longitudinal Aging Study India (LASI) provide valuable insights to inform policy and practice in light of such large predicted demographic shifts [13].

Beyond a specific focus on falls [16–20], the burden of injury, particularly as it pertains to older adults, is poorly understood across India. So, too, is the economic impact of injury. Data from selected public sector hospitals in North India identify people aged 60 years and over as the age group with the third highest out-of-pocket expenditure for injury-related hospitalization [21]; however, national data are sparse. All-age studies disaggregate economic costs of injury by age at a macro level but do not provide any further examination of variability within the older age group [22,23].

This study aimed to address gaps in knowledge by reporting the prevalence, treatment types, and overall treatment cost of unintentional injuries for older adults, aged 60 years and above, in India, across various Indian states and socio-economic groups. Our study focused on people aged 60 years and above who were more prone to injury, fall, and fracture [1] in comparison with other studies, which focus on those aged 45 years and above. We have also chosen to define older adults as 60+ years, as the midpoint of retirement age for India’s public and private sectors (between 58 and 62 years of age) [24]. The study gives an insight of the out-of-pocket expenditure (OOPE) that the respondent incurs due to injury, fall, or fracture, which is an important indicator for the health and well-being of older adults [8]. The goal of conducting this analysis is to inform policy makers in mitigating injury-related harms for older adults in India.

2. Materials and Methods

2.1. Consent to Participate and Ethics Approval

This study comprises a secondary analysis of anonymous data obtained online from the LASI data custodians. The original data collected via the LASI received ethical approval from the Indian Council of Medical Research (ICMR) Ethics Committee on 5 September 2013 (approval number LASI/12/1054). Prior to survey participation, written consent was obtained.

2.2. Data Source

LASI is an ongoing nationally representative longitudinal survey involving people aged 45 and over in India that gathers information on their health, economic, psychological, and social well-being [13]. At present, data are available only for the first wave, which took place in April 2017 to December 2018 (with injury responses covering the past 2 years [see Supplementary File S1]), comprising 72,250 adults aged 45 and above and their partners (regardless of age) from 42,949 households [25]. For this study, we focused on the responses of the 31,464 respondents aged 60 years and older.

2.3. Study Design and Sample Size

This study was a retrospective, cross-sectional analysis. The LASI adapted the multi-stage stratified area probability cluster sampling to accomplish a countrywide representative sample of older adults. The sampling design is documented in detail in the LASI Wave 1 report [25]. However, in brief, it adopted a three-stage sampling design for rural areas and four-stage sampling design for urban areas. In the rural areas, Tehsils (administrative subdivisions like subdistricts) and Talukas (administrative subdivisions of blocks that typically consist of multiple villages) were selected as the primary sampling units (PSUs). In the second stage of sampling, villages were selected from selected PSUs, and in the third stage of sampling, 35 households were selected from selected villages. In the urban areas the Tehsils and Talukas were selected as primary sampling units (PSUs) in the first stage of sampling, while urban wards were selected from selected PSUs in the second stage. In the third stage of sampling, the census enumeration block was chosen from selected wards, and in the fourth stage, 35 households were chosen from selected wards [25]. A complete listing was created of all the selected households from the selected wards/ villages.
The survey data were collected by different research agencies under the leadership of the International Institute of Population Sciences, Mumbai, India. An investigator approached the household with questions. Eligible respondents were approached for individual interviews. A multi-stage sampling plan used probability proportional to size (PPS) for the sampling to avoid the selection bias of the respondents and to ensure a more representative sample of the population. A set of questions, including age, were answered by the respondents who were aged 45 years and above.

For our current study we focused on the data of those respondents aged 60 years and above. The details of the sample design, survey questionnaires, fieldwork, data collection, and processing were published in the LASI report [25]. The sample sizes for the present study from the LASI datasets that were finally included in analyses are displayed in Figure 1.

![Figure 1](image)

**Figure 1.** Schematic figure explanation of sample abstraction from the Longitudinal Aging Study India (LASI) (2017–2018).

### 2.4. Defining Injury and Treatment Seeking Behaviour

The focus of this study was those survey respondents who indicated in the past two years that they had sustained any major injury, they had had a fall, and/or they had fractured any of their bones/joints (see Supplementary File S1 for questions). If respondents said “yes” to any of these questions, they were included in the final dataset.

We also identified those who had self-reported seeking medical treatment for their injury. For those who responded yes, respondents were asked to provide the cause of their injury from the following options: traffic injury; struck by person or object; fire, flames, burn, or electric shock; drowning; poisoning; animal attack or bite; fall; or other.

### 2.5. Economic Costs Associated with Injury

For inpatient and outpatient care, information was available for expenditure on consultation fees for doctors, medicines and diagnostic tests, medical items like blood, oxygen, etc., transportation, and expenses incurred by the attendant (see Supplementary File S2). The out-of-pocket expenditure (OOPE) was estimated as the total expenditure on these items for using inpatient and outpatient care [26–28]. The OOPE was shown in Indian Rupees (INR) and United States Dollars (USD) after conversion per the average rate for January 2018 (1 USD = INR 63.63844) (https://currencies.zone/historic/us-dollar/indian-rupee/january-2018, accessed on 18 September 2023).

### 2.6. Statistical Modeling

To achieve the study’s goals, descriptive, bivariate, and multivariable models were used. The profile of respondents who self-reported having any major injury, falling, or breaking any bones or joints—any of which constitute an injury in this study—as well as the average out-of-pocket cost for both inpatient and outpatient care, were first described using descriptive analysis. Second, bivariate analyses were performed to investigate the socioeconomic disparities in injury, as well as the out-of-pocket costs associated with injury treatment. To find statistically significant associations between outcome and predictor factors, chi square tests of association were used. When a variable’s numerous categories
were included in the chi square analysis, the recommended modified Bonferroni adjustment was applied [29].

The estimations of the variance inflation factor (VIF) showed how much the multicollinearity of the variables in the model affected the inflated variance of a regression coefficient. The variance inflation factors of all predictor variables were less than 5, indicating a mean variance inflation factor as low as 1.17 (see Table S1). This study found no multicollinearity among the predictor variables chosen to examine their independent effects on cognitive impairment using multivariate binary logistics regression analysis [30].

We then conducted a multivariable logistic regression analysis. We also conducted a two-part regression model to understand the association between socio-economic factors and OOPE due to injury. The two-part model is one of the most popular models for analyzing health care expenditure (HCE) data [31,32]. It is used when the distribution of HCE has a mass of observations at one or more specific values—say, at zero—and is skewed on the right. Therefore, the application of OLS linear regression models may yield biased and less precise estimates of means and marginal effect.

The first part of the model allowed us to explore the probability of a person experiencing HCE on injury using a logistic regression model. The second part of the model determined the value and density of positive HCE using a log-linear regression model. This therefore allowed for split investigation of the effect of covariates on health expenditure (if any expenditure was incurred for treatment) and on the positive level of expenditure (amount of expenditure that was undertaken conditional on any expenditure being undertaken), using the formula below:

Part 1: Prob (Yi > 0) x exp (βX) / (1 + exp (βX))

Part 2: E (Yi|X) = Prob (Yi > 0) E (Yi|X; Yi| > 0)

Taking into account the survey design, the SVY command was used in STATA 18.0 [33,34] for descriptive, bivariate, and multivariable models. Absolute numbers presented were unweighted, while percentages used in the analysis represented weighted data.

3. Results

3.1. Socio-Demographic Characteristics of the Respondents

In total, there were 31,464 respondents aged 60 years and above in the sample. The socio-demographic characteristics of the respondents can be found in Table 1. Out of the total sample, 52.6% (n = 16,366) were females. Two-thirds of all survey respondents lived in rural areas (70.6%). Almost half (56.5%) of the respondents had no formal education. About one-fifth of the respondents (21.7%) were from the poorest income quintile households.

<table>
<thead>
<tr>
<th>Sociodemographic Characteristics</th>
<th>Experienced Any. Major Injury</th>
<th>Experienced a Fall</th>
<th>Fractured Any Bones/Joints</th>
<th>Distribution of Total Sample</th>
</tr>
</thead>
<tbody>
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<td>Weighted</td>
<td>Unweighted</td>
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<td>75–79</td>
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<td>13.0</td>
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<td>80 or above</td>
<td>506</td>
<td>19.3</td>
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</table>

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<td>3999</td>
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<td>13.0</td>
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<td>Sociodemographic Characteristics</td>
<td>Experienced Any. Major Injury</td>
<td>Experienced a Fall</td>
<td>Fractured Any Bones/Joints</td>
<td>Distribution of Total Sample</td>
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<td>% Unweighted</td>
<td>n Unweighted</td>
<td>% Unweighted</td>
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<td>1863</td>
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<td>1335</td>
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<td>13.6</td>
</tr>
<tr>
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<td>195</td>
<td>13.3</td>
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<tr>
<td>Poorest</td>
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<td>13.8</td>
<td>634</td>
<td>11.5</td>
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<tr>
<td>Poorer</td>
<td>801</td>
<td>14.3</td>
<td>709</td>
<td>13.6</td>
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<tr>
<td>Middle</td>
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<td>628</td>
<td>11.9</td>
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<tr>
<td>Richer</td>
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<td>679</td>
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</tr>
<tr>
<td>Richest</td>
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<td><strong>Social Group</strong></td>
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<tr>
<td>Scheduled tribe</td>
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<tr>
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<tr>
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<td>442</td>
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</tr>
<tr>
<td><strong>Place of residence</strong></td>
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<td>2337</td>
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<td>933</td>
<td>10.4</td>
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<tr>
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<tr>
<td>North</td>
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<td>11.4</td>
<td>489</td>
<td>12.9</td>
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<td>8.4</td>
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<tr>
<td>East</td>
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<td>20.7</td>
<td>802</td>
<td>15.5</td>
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<tr>
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<td>West</td>
<td>630</td>
<td>15.6</td>
<td>497</td>
<td>13.8</td>
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<tr>
<td>South</td>
<td>339</td>
<td>17.1</td>
<td>249</td>
<td>9.9</td>
</tr>
</tbody>
</table>
3.2. Prevalence of Injury by Socio-Demographic Characteristics

Of the 31,464 adults aged 60 years and above who were surveyed, a total of 3999 (15.1%) reported suffering from any major injury, 3270 (12.6%) reported experiencing a fall, and 1354 (4.8%) suffered from a bone/joint fracture (Table 1). Within the 60+ years cohort, there were age differences seen in reporting any major injury ($\chi^2 = 18.514; p < 0.001$), as well as fracturing any bones/joints ($\chi^2 = 14.995; p = 0.005$). Sex differences were seen by injury type, with a statistically higher proportion of females reporting having fractured a bone/joint ($\chi^2 = 38.158; p < 0.001$) when compared with males. Proportionately, older adult rural respondents were more likely to report a major injury and a fall, when compared with urban respondents, although they were less likely to have fractured any bones or joints. The impacts of other socio-economic characteristics can be seen in Table 1.

3.3. Prevalence of Types of Injuries by Indian State

Figure 2 shows the state variation in the prevalence of different types of injuries experienced by older adults in India. States like Bihar, Assam, and Karnataka reported a higher prevalence of major injury, while states like Manipur, Meghalaya, Mizoram, and Nagaland reported a lower prevalence of major injury. State likes Orissa and Punjab reported a higher prevalence of older adults reporting falls, while Manipur, Meghalaya, Mizoram, Nagaland, Andhra Pradesh, and Jammu and Kashmir reported lower prevalence.

3.4. Risk of Injury

Odds ratio (OR) calculations showed that the probability of injury increased as people became older, with people aged 80 years and older reporting 1.2 times (OR = 1.207; 95%CI: 1.094–1.333; $p < 0.01$) higher injury risk than those aged 60–64 years. Females reported a slightly higher probability of injury when compared with males (OR = 1.217; 95%CI: 1.159–1.278; $p < 0.01$). Aside from living with children and others, the likelihood of injury was highest for older adults when they lived alone. Injury probability increased among older adults as wealth quintile increased, peaking at 1.3 times higher for those in the wealthiest quartile, compared with the poorest (OR = 1.289; 95%CI: 1.2–1.384; $p < 0.01$). Older-aged residents of urban areas have a lower probability (OR = 0.846; 95%CI: 0.804–0.891; $p < 0.01$) of injury as compared with rural residents (Table 2).
Table 2. Odds ratios (OR) for injury by sociodemographic characteristics, Longitudinal Aging Study India (LASI) (2017–2018).

<table>
<thead>
<tr>
<th>Sociodemographic Characteristics</th>
<th>Odds Ratio</th>
<th>Std. Err.</th>
<th>p-Value</th>
<th>[95% Conf Interval]</th>
<th>Significance</th>
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<td></td>
<td></td>
<td></td>
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<td>Lower</td>
<td>Upper</td>
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<td><strong>Age</strong></td>
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<td>60–64</td>
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<tr>
<td>65–69</td>
<td>1.033</td>
<td>0.038</td>
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<td>0.962</td>
<td>1.111</td>
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<td>70–74</td>
<td>1.058</td>
<td>0.045</td>
<td>0.178</td>
<td>0.975</td>
<td>1.149</td>
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<td>0.055</td>
<td>0.112</td>
<td>0.981</td>
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<td>80 or above</td>
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<td>0.061</td>
<td>0.000</td>
<td>1.094</td>
<td>1.333 ***</td>
</tr>
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<td><strong>Living Status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living with spouse</td>
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<td>0.059</td>
<td>0.023</td>
<td>0.745</td>
<td>0.979 **</td>
</tr>
<tr>
<td>Living with spouse and children</td>
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<td>0.063</td>
<td>0.444</td>
<td>0.835</td>
<td>1.082</td>
</tr>
<tr>
<td>Living with children and other relatives</td>
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<td>0.068</td>
<td>0.610</td>
<td>0.909</td>
<td>1.177</td>
</tr>
<tr>
<td>Living with others</td>
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<td>0.079</td>
<td>0.448</td>
<td>0.795</td>
<td>1.107</td>
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<td><strong>Education status</strong></td>
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</tr>
<tr>
<td>No education</td>
<td>Ref</td>
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<td>0.004</td>
<td>0.761</td>
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<td>0.546</td>
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<td>Ref</td>
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<tr>
<td>Poorer</td>
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<td>0.050</td>
<td>0.012</td>
<td>1.025</td>
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<td>Middle</td>
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<td>0.051</td>
<td>0.004</td>
<td>1.042</td>
<td>1.243 ***</td>
</tr>
<tr>
<td>Richer</td>
<td>1.267</td>
<td>0.058</td>
<td>0.000</td>
<td>1.158</td>
<td>1.386 ***</td>
</tr>
<tr>
<td>Richest</td>
<td>1.381</td>
<td>0.067</td>
<td>0.000</td>
<td>1.256</td>
<td>1.518 ***</td>
</tr>
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<td></td>
</tr>
<tr>
<td>None of them</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other backward classes</td>
<td>1.608</td>
<td>0.090</td>
<td>0.000</td>
<td>1.440</td>
<td>1.794 ***</td>
</tr>
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<td>Scheduled caste</td>
<td>1.566</td>
<td>0.081</td>
<td>0.000</td>
<td>1.415</td>
<td>1.733 ***</td>
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<td>0.084</td>
<td>0.000</td>
<td>1.356</td>
<td>1.686 ***</td>
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<td><strong>Religion</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hindu</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muslim</td>
<td>0.852</td>
<td>0.042</td>
<td>0.001</td>
<td>0.774</td>
<td>0.938 ***</td>
</tr>
<tr>
<td>Other</td>
<td>0.979</td>
<td>0.049</td>
<td>0.677</td>
<td>0.888</td>
<td>1.080</td>
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<tr>
<td><strong>Place of residence</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Rural</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>0.804</td>
<td>0.027</td>
<td>0.000</td>
<td>0.752</td>
<td>0.859 ***</td>
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</table>
### Table 2. Cont.

<table>
<thead>
<tr>
<th>Sociodemographic Characteristics</th>
<th>Odds Ratio</th>
<th>Std. Err.</th>
<th>p-Value</th>
<th>[95% Conf Interval]</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td></td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
<td>Upper</td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>Ref</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>0.872</td>
<td>0.045</td>
<td>0.007</td>
<td>0.789</td>
<td>0.964</td>
</tr>
<tr>
<td>East</td>
<td>1.841</td>
<td>0.091</td>
<td>0.000</td>
<td>1.671</td>
<td>2.028</td>
</tr>
<tr>
<td>Northeast</td>
<td>1.150</td>
<td>0.060</td>
<td>0.007</td>
<td>1.038</td>
<td>1.274</td>
</tr>
<tr>
<td>West</td>
<td>1.279</td>
<td>0.070</td>
<td>0.000</td>
<td>1.15</td>
<td>1.423</td>
</tr>
<tr>
<td>South</td>
<td>0.840</td>
<td>0.056</td>
<td>0.009</td>
<td>0.737</td>
<td>0.958</td>
</tr>
<tr>
<td>Constant</td>
<td>0.137</td>
<td>0.014</td>
<td>0.000</td>
<td>0.113</td>
<td>0.167</td>
</tr>
</tbody>
</table>

Mean dependent var 0.221 SD dependent var 0.415
Pseudo r-squared 0.028 Number of obs 30,416
Chi-square 903.655 Prob > chi2 0.000
Akaike crit. (AIC) 31,274.626 Bayesian crit. (BIC) 31,507.663

*** p < 0.01, ** p < 0.05, Ref = reference category.

### 3.5. Medical Treatment of Injury by Mechanism

As seen in Figure 1, 4619 sought outpatient treatment for their injury, while 885 required hospital treatment. Falls were the most common injury mechanism that preceded medical treatment (77.8%), followed by road traffic injuries (10.8%). Significant age-related differences existed for traffic accidents ($\chi^2 = 42.749; p < 0.001$) and falls ($\chi^2 = 54.085; p < 0.001$) (Table 3).

Table 3. Cause of injury preceding medical treatment by age group, Longitudinal Aging Study India (LASI) (2017–2018).

<table>
<thead>
<tr>
<th>Injury Mechanism</th>
<th>Total</th>
<th>60–64 Years</th>
<th>65–69 Years</th>
<th>70–74 Years</th>
<th>75–79 Years</th>
<th>80+ Years</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Traffic accident</td>
<td>463</td>
<td>10.8</td>
<td>179</td>
<td>14.7</td>
<td>155</td>
<td>11.8</td>
<td>66</td>
</tr>
<tr>
<td>Struck by person or object</td>
<td>237</td>
<td>7.2</td>
<td>93</td>
<td>8.9</td>
<td>85</td>
<td>8.2</td>
<td>42</td>
</tr>
<tr>
<td>Fire, flames, burn, electric shock</td>
<td>22</td>
<td>1.2</td>
<td>9</td>
<td>0.9</td>
<td>7</td>
<td>0.7</td>
<td>2</td>
</tr>
<tr>
<td>Drowning</td>
<td>6</td>
<td>0.2</td>
<td>3</td>
<td>0.3</td>
<td>0</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Poisoning</td>
<td>1</td>
<td>0.02</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.7</td>
<td>0</td>
</tr>
<tr>
<td>Animal attack or bite</td>
<td>197</td>
<td>4.8</td>
<td>64</td>
<td>4.6</td>
<td>57</td>
<td>6.2</td>
<td>30</td>
</tr>
<tr>
<td>Fall</td>
<td>3088</td>
<td>77.8</td>
<td>918</td>
<td>77.2</td>
<td>824</td>
<td>75.6</td>
<td>562</td>
</tr>
<tr>
<td>Others</td>
<td>29</td>
<td>0.8</td>
<td>12</td>
<td>0.5</td>
<td>7</td>
<td>0.5</td>
<td>4</td>
</tr>
</tbody>
</table>

### 3.6. Treatment for Injury

The majority (78.1%; n = 3113) of patients who self-reported experiencing a major injury received medical treatment. In almost half of all cases of falls among older adults (44.7%), medical treatment was required due to the severity of the fall, while 47.9% of older respondents had undergone surgery after fracturing bones or injuring joints. There were significant age-related differences among the 60+ years cohort analyzed in this study,
for reported fall-related surgery ($\chi^2 = 13.190; p = 0.010$). Treatment sought for injuries by sociodemographic characteristics is shown in Table 4.


<table>
<thead>
<tr>
<th>Sociodemographic Characteristics</th>
<th>Receive Medical Treatment for Injury</th>
<th>Any Falls, Seriously Enough to Need Medical Treatment?</th>
<th>Undergone Any Surgery Related to Bones or Joints?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n$ Unweighted</td>
<td>% Unweighted</td>
<td>Weighted</td>
</tr>
<tr>
<td>Total</td>
<td>3113</td>
<td>78.1</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60–64</td>
<td>972</td>
<td>77.8</td>
<td></td>
</tr>
<tr>
<td>65–69</td>
<td>893</td>
<td>88.0</td>
<td></td>
</tr>
<tr>
<td>70–74</td>
<td>531</td>
<td>77.7</td>
<td></td>
</tr>
<tr>
<td>75–79</td>
<td>329</td>
<td>78.4</td>
<td></td>
</tr>
<tr>
<td>80 or above</td>
<td>388</td>
<td>75.2</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1354</td>
<td>78.9</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1759</td>
<td>77.5</td>
<td></td>
</tr>
<tr>
<td>Living Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>170</td>
<td>70.5</td>
<td></td>
</tr>
<tr>
<td>Living with spouse</td>
<td>567</td>
<td>80.5</td>
<td></td>
</tr>
<tr>
<td>Living with spouse and children</td>
<td>1282</td>
<td>79.4</td>
<td></td>
</tr>
<tr>
<td>Living with children and relatives</td>
<td>919</td>
<td>76.2</td>
<td></td>
</tr>
<tr>
<td>Living with others</td>
<td>175</td>
<td>81.0</td>
<td></td>
</tr>
<tr>
<td>Education status</td>
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<tr>
<td>No education</td>
<td>1773</td>
<td>76.8</td>
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</tr>
<tr>
<td>Primary</td>
<td>984</td>
<td>77.5</td>
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<td>Secondary</td>
<td>281</td>
<td>88.0</td>
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</tr>
<tr>
<td>Graduate and above</td>
<td>75</td>
<td>76.3</td>
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</tr>
<tr>
<td>Wealth quintile</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Poorest</td>
<td>544</td>
<td>71.2</td>
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</tr>
<tr>
<td>Poorer</td>
<td>629</td>
<td>77.0</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>640</td>
<td>79.8</td>
<td></td>
</tr>
<tr>
<td>Richer</td>
<td>640</td>
<td>75.7</td>
<td></td>
</tr>
<tr>
<td>Richest</td>
<td>660</td>
<td>86.7</td>
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<td>Social Group</td>
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<tr>
<td>Scheduled tribe</td>
<td>285</td>
<td>72.0</td>
<td></td>
</tr>
<tr>
<td>Scheduled caste</td>
<td>595</td>
<td>78.6</td>
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<tr>
<td>Other backward caste</td>
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<td>77.3</td>
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<tr>
<td>Other caste</td>
<td>881</td>
<td>80.4</td>
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### Table 4. Cont.

<table>
<thead>
<tr>
<th>Sociodemographic Characteristics</th>
<th>Receive Medical Treatment for Injury</th>
<th>Any Falls, Seriously Enough to Need Medical Treatment?</th>
<th>Undergo Any Surgery Related to Bones or Joints?</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>n Unweighted</td>
<td>% Unweighted</td>
<td>n Unweighted</td>
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<tr>
<td>Religion</td>
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<td></td>
</tr>
<tr>
<td>Hindu</td>
<td>2473</td>
<td>78.0</td>
<td>2630</td>
</tr>
<tr>
<td>Muslim</td>
<td>355</td>
<td>77.3</td>
<td>396</td>
</tr>
<tr>
<td>Other</td>
<td>285</td>
<td>79.9</td>
<td>329</td>
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<tr>
<td>Place of residence</td>
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<tr>
<td>Rural</td>
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<td>2422</td>
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<tr>
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<td>933</td>
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</tr>
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<td>North</td>
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<tr>
<td>Central</td>
<td>594</td>
<td>72.6</td>
<td>564</td>
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<tr>
<td>East</td>
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<td>West</td>
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<td>South</td>
<td>238</td>
<td>69.7</td>
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</table>

### 3.7. Out-of-Pocket Expenditure (OOPE) for Hospitalization

Table 5 shows the mean annual injury related OOPE for hospitalization. In private health facilities the OOPE (INR 29,747; USD 467.44) was three times higher than in public health facilities (INR 10,727; USD 168.56). Expenditure in public hospitals was highest among those aged 80 years and above (INR 33,790; USD 530.96). Expenditure in private hospitals and the averaged total was highest among the 75–79 years age group. The mean OOPE increased with a rise in the wealth quintile. Expenditure was highest among males, highly educated people, and urban residents for injury-related treatment in both public and private facilities.

### Table 5. Per person out-of-pocket expenditure due to injury by sociodemographic characteristics for hospitalization (yearly) by hospital type and average, Longitudinal Aging Study India (LASI) (2017–2018).

<table>
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<tr>
<th>Background Characteristics</th>
<th>Hospitalization (Yearly)</th>
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<td>Total</td>
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<td>Age</td>
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<tr>
<td>60–64</td>
<td>5459</td>
</tr>
<tr>
<td>65–69</td>
<td>9449</td>
</tr>
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<td>70–74</td>
<td>7036</td>
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<td>75–79</td>
<td>12,432</td>
</tr>
<tr>
<td>80 or above</td>
<td>33,790</td>
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<td>Sex</td>
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<tr>
<td>Male</td>
<td>11,246</td>
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<tr>
<td>Female</td>
<td>10,351</td>
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</table>
Table 5. Cont.

<table>
<thead>
<tr>
<th>Background Characteristics</th>
<th>Hospitalization (Yearly)</th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public</td>
<td>Private</td>
<td>Average</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>INR USD</td>
<td>INR USD</td>
<td>INR USD</td>
<td>INR USD</td>
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</tr>
<tr>
<td><strong>Living Status</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>1138</td>
<td>17.88</td>
<td>19,993</td>
<td>314.17</td>
<td>15,938</td>
</tr>
<tr>
<td>Living with spouse</td>
<td>8727</td>
<td>137.13</td>
<td>30,158</td>
<td>473.90</td>
<td>23,495</td>
</tr>
<tr>
<td>Living with spouse and children</td>
<td>11,216</td>
<td>176.25</td>
<td>39,260</td>
<td>616.92</td>
<td>29,044</td>
</tr>
<tr>
<td>Living with children and other</td>
<td>13,510</td>
<td>212.29</td>
<td>16,998</td>
<td>267.10</td>
<td>15,296</td>
</tr>
<tr>
<td>Living with others</td>
<td>4930</td>
<td>77.47</td>
<td>24,791</td>
<td>389.56</td>
<td>16,129</td>
</tr>
<tr>
<td><strong>Education status</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>6385</td>
<td>100.33</td>
<td>21,860</td>
<td>343.50</td>
<td>15,308</td>
</tr>
<tr>
<td>Primary</td>
<td>14,752</td>
<td>231.81</td>
<td>28,002</td>
<td>440.02</td>
<td>23,166</td>
</tr>
<tr>
<td>Secondary</td>
<td>18,383</td>
<td>288.87</td>
<td>72,232</td>
<td>1135.04</td>
<td>58,685</td>
</tr>
<tr>
<td>Graduate and above</td>
<td>91,300</td>
<td>1434.67</td>
<td>31,110</td>
<td>488.86</td>
<td>41,085</td>
</tr>
<tr>
<td><strong>Wealth quintile</strong></td>
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<tr>
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<td>21,155</td>
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<td>17,400</td>
<td>273.42</td>
<td>18,886</td>
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<td>8841</td>
<td>138.93</td>
<td>28,432</td>
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<td>377.46</td>
<td>44,860</td>
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<tr>
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<td>3922</td>
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<td>Hindu</td>
<td>11,064</td>
<td>173.86</td>
<td>29,326</td>
<td>460.82</td>
<td>22,653</td>
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<td>7674</td>
<td>120.59</td>
<td>36,532</td>
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<td>Other</td>
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<td>201.64</td>
<td>23,581</td>
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<td>18,449</td>
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<tr>
<td>Urban</td>
<td>9503</td>
<td>149.33</td>
<td>44,193</td>
<td>694.44</td>
<td>31,365</td>
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<tr>
<td><strong>Region</strong></td>
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<tr>
<td>North</td>
<td>32,441</td>
<td>509.77</td>
<td>18,380</td>
<td>288.82</td>
<td>24,575</td>
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<tr>
<td>Central</td>
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<td>54.62</td>
<td>27,421</td>
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<td>20,571</td>
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<td>East</td>
<td>7852</td>
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<td>43,554</td>
<td>684.40</td>
<td>21,755</td>
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<tr>
<td>Northeast</td>
<td>15,963</td>
<td>250.84</td>
<td>26,853</td>
<td>421.96</td>
<td>23,306</td>
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<tr>
<td>West</td>
<td>6487</td>
<td>101.94</td>
<td>30,763</td>
<td>483.40</td>
<td>22,369</td>
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<tr>
<td>South</td>
<td>22,240</td>
<td>349.47</td>
<td>36,715</td>
<td>576.93</td>
<td>26,399</td>
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Table 5. Cont.

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<tr>
<th>Background Characteristics</th>
<th>Hospitalization (Yearly)</th>
<th>Public</th>
<th>Private</th>
<th>Average Total</th>
</tr>
</thead>
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<tr>
<td></td>
<td>INR USD</td>
<td>INR USD</td>
<td>INR USD</td>
<td></td>
</tr>
<tr>
<td>Types of Injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major injury</td>
<td>5021 78.90</td>
<td>25,632</td>
<td>402.78 17,343</td>
<td>272.52</td>
</tr>
<tr>
<td>Falls</td>
<td>6248 98.18</td>
<td>27,680</td>
<td>434.96 19,302</td>
<td>303.31</td>
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<tr>
<td>Bones and joints</td>
<td>24,962 392.25</td>
<td>38,507</td>
<td>605.09 33,499</td>
<td>526.40</td>
</tr>
</tbody>
</table>

Source: Authors’ own computation based on LASI Wave 1 survey data (April 2017 to December 2018).

3.8. Out-of-Pocket Expenditure for Outpatient Care

Table 6 provides mean monthly injury-related OOPE for outpatient care. In private health facilities the out-of-pocket expenditure (INR 1743; USD 27.39) was higher than in public health facilities (INR 1143; USD 17.96). Variations in expenditure by age group per month mirrored the trends seen in yearly expenditure displayed in Table 5, such that the oldest age group incurred the highest monthly expenditure in public hospitals, while the 75–79 years age group recorded the highest monthly expenditure in private hospitals and overall. Older adults with higher education spent much more in public facilities for treatment (INR 36,268; USD 569.91) compared with non-educated people (INR 635; USD 9.98).

Table 6. Per person out-of-pocket expenditure due to injury by sociodemographic characteristics for outpatient care (monthly) by type and average, Longitudinal Aging Study India (LASI) (2017–2018).

<table>
<thead>
<tr>
<th>Background Characteristics</th>
<th>Outpatient Care (Monthly)</th>
<th>Public</th>
<th>Private</th>
<th>Average Total</th>
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<td>INR USD</td>
<td>INR USD</td>
<td>INR USD</td>
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<tr>
<td>Total</td>
<td>1143 17.96</td>
<td>1743 27.39</td>
<td>1445 22.71</td>
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<tr>
<td>Age</td>
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<td></td>
</tr>
<tr>
<td>60–64</td>
<td>608 9.55</td>
<td>1444 22.69</td>
<td>1115 17.52</td>
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<tr>
<td>65–69</td>
<td>710 11.16</td>
<td>1842 28.94</td>
<td>1407 22.11</td>
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</tr>
<tr>
<td>70–74</td>
<td>987 15.51</td>
<td>1900 29.86</td>
<td>1544 24.26</td>
<td></td>
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<tr>
<td>75–79</td>
<td>6423 10.09</td>
<td>2003 31.47</td>
<td>2585 40.62</td>
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<tr>
<td>80 or above</td>
<td>845 13.28</td>
<td>1745 27.42</td>
<td>1340 21.06</td>
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</tr>
<tr>
<td>Sex</td>
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<td></td>
</tr>
<tr>
<td>Male</td>
<td>1745 27.42</td>
<td>1833 28.80</td>
<td>1649 25.91</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>708 11.13</td>
<td>1683 26.45</td>
<td>1307 20.54</td>
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<td>Living Status</td>
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<tr>
<td>Living alone</td>
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<td>893 14.03</td>
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<tr>
<td>Living with spouse</td>
<td>663 10.42</td>
<td>1672 26.27</td>
<td>1331 20.92</td>
<td></td>
</tr>
<tr>
<td>Living with spouse and children</td>
<td>2024 31.80</td>
<td>1628 25.58</td>
<td>1580 24.83</td>
<td></td>
</tr>
<tr>
<td>Living with children and other</td>
<td>627 9.85</td>
<td>2116 33.25</td>
<td>1574 24.73</td>
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<tr>
<td>Living with others</td>
<td>496 7.79</td>
<td>1030 16.19</td>
<td>769 12.08</td>
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</table>
Table 6. Cont.

<table>
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<th>Private</th>
<th>Average Total</th>
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<td>USD</td>
<td>INR</td>
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<tr>
<td>Primary</td>
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<td>14.90</td>
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<tr>
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<tr>
<td>Poorest</td>
<td>533</td>
<td>8.38</td>
<td>1529</td>
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<tr>
<td>Poorer</td>
<td>729</td>
<td>11.46</td>
<td>1598</td>
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<tr>
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<td>1488</td>
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<td>11.52</td>
<td>1649</td>
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<td>1258</td>
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<td>South</td>
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<td>Falls</td>
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<tr>
<td>Bones and joints</td>
<td>3498</td>
<td>54.97</td>
<td>2097</td>
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</table>

3.9. Factors Affecting Out-of-Pocket Expenditure on Injury

Regression analysis shows that the likelihood of having non-zero healthcare expenditure on injury increases with age and declines with higher education. Expenditure is greater for those seeking care at private facilities and for those who belong to higher wealth quintiles and lower for females and those living in urban areas. The second phase of the
analysis shows higher mean expenditure at private facilities, for richer quintiles, and in western and southern states and lower mean expenditure in urban areas for hospitalized care. The margin effects show the greatest increase in expenditure for the oldest age group, for lower education levels (those up to primary schooling), and among the richest quintiles. There is a decrease in expenditure for females compared with males and in urban regions compared with rural regions. The expenditure in private facilities was greater than in public facilities (Table S2). Table S3 shows factors affecting outpatient OOPE using the two-part model.

4. Discussion

This study explored the injury prevalence, treatment, and economic impact of injury-related treatment among people aged 60 years and older in India using data from Wave 1 of the LASI. This research adds to the limited evidence base regarding injury among older adults in India [22,23] by broadening the previous focus on falls [16–20] to examine other injury types and the associated economic impacts [21]. Although the reasons for previous limited research on this topic for this age group are not known, we argue that the results of this current study, which suggest India’s health system and public health policy response continues to face challenges due to injuries among older adults, may be borne out of limited research focus to date.

Findings indicate socio-demographic variability in health system utilization and OOPE for older adults in India due to preventable causes of injury such as falls and road traffic injuries. Despite males largely being overrepresented in injury statistics worldwide [1], females tend to be at higher risk of falls [8]. We posit that greater life expectancy for females compared with males in India [35], as well as the significant proportion of injuries due to falls (78%), may be driving our findings that females self-report experiencing all types of injury in slightly higher proportions than males. Regardless of sex, falls remain a significant cause of preventable injury among older adults in India, and investment in effective interventions for older adults in both urban and rural settings is needed [36]. Similar findings have been reported in Bangladesh, where fall-related injury is a significant cause of disability and where fall risk increases with age [37].

Participatory approaches have been suggested as a means of enhancing the acceptability of fall prevention initiatives among older adults in India [38]. Exploring the feasibility and acceptability of technologically based interventions to reduce fall risk, such as tele-coaching to improve physical activity, could be considered, particularly for those residing in rural areas [39]. The evaluation of such approaches would provide much needed evidence regarding the feasibility and acceptability of interventions outside of high-income countries [37,40].

After falls, road traffic injury was the second leading cause of injury-related harm among older adults in India. Road traffic injury is a significant cause of mortality and morbidity among all age groups in India, and recommendations have been made in order to reduce this risk, such as implementing evidence-based road safety interventions, implementing supportive policies with appropriate enforcement, improving road and vehicle design, and improved post-crash care [41]. However, given older adult road users’ specific vulnerability to injury and death [42], adaptation of these approaches to ensure efficacy among an aging population will be vital. Co-designed approaches may assist in ensuring the adaptation is most appropriate and relevant to older adults, and rigorous evaluation of any interventions must be conducted to further improve intervention delivery.

Regardless of the injury mechanism, there is a need for greater awareness of, and action on, primary prevention of injury-related harms among older adults in India. A review of the National Programme for Health Care of the Elderly identifies the need to improve the provision of acute care to older adults through mobile services for emergency care; however, this reflects a tertiary approach to injury prevention, with a focus on treatment rather than preventing the injurious event [43]. Within the analysis of this program there are no mentions of injury and injury-related harms among older adults in India. This repre-
sents an important gap that must be addressed through primary preventive approaches, designed alongside older adults. Many injuries occur in the home environment, providing support for home modification within any overarching injury prevention strategy for older adults [37,40,44].

Our findings indicate a socioeconomic gradient exists with respect to the risk of sustaining an injury. Education level was shown to be an important determinant of injury, with risk reducing as the level of education increased, as has been reported in other South Asian countries such as Bangladesh [37]. Those with a graduate or above level of education experienced an almost 30% lower risk of injury than those without any formal education. In addition, those from richer quintiles were shown to be more likely to seek treatment in private health facilities. These findings provide further support for addressing global agendas such as education provision, universal health care, and eradication of poverty, which have been shown to impact injury risk and vice versa [45]. Efforts to address injury among older adults in India would benefit from a specific focus on cascading risks for the rural-dwelling older adults, given their increased risk [44,46] and challenges in timely medical assistance.

Our findings indicate that people who are living alone find it more difficult to receive treatment, a finding similar to that in Bangladesh, which noted that widowed older adults had a higher risk of falls [37]. Wealth can further exacerbate this, with wealthier older adults able to better afford a higher standard of care in comparison with the poorer section of society. Additionally, similar to some other illnesses in India, injuries account for a sizable portion of out-of-pocket spending. The spending on inpatient care in comparison with outpatient care is high in case of injury in both public and private facilities as all the diagnostic testing and surgery are performed during this time, leading to high OOPE as injury requires hospitalization for the patients suffering from fall or fracture. The OOPE is higher for private facilities in cases of both hospitalization and outpatient care. These findings highlight the necessity of enhancing healthcare infrastructure and implementing universal health insurance in order to ensure patients’ speedy recovery and financial security [22]. Moreover, the prevalence and the share of OOPE is high among the more financially secure section of the country, such as males and better educated people, whereas females and people from rural areas spend less, which may equate to worse treatment and sub-optimal post-injury recovery [47].

Strengths and Limitations

The strength of our study derived from its use of national representative cross-sectional data from LASI Wave 1. The LASI survey followed the standardized study design. LASI covered all the states and union territories of India, which enhanced the generalizability to the study results. However, there were some limitations. Survey data were subject to recall and social desirability bias [48,49]. In addition, this study conducted analyses for OOPE data derived from a cross-sectional survey, and recall bias was a major limitation for expenditure data. This study did not use a standardized tool to measure injury severity [50], and as such, respondents’ assessment of whether their injury was major or not was likely to be subjective and therefore vary. Additionally, other standard measures, such as years of life lost (YLL) and years lived with a disability (YLDs), were not available in this secondary analysis. Insurance data were not included in the study, and thus, we were unable to further discuss partial or full payment for injury. This is also a topic worthy of further research. The survey did not differentiate between work-related and non-work-related injuries. Given the wide difference in age of retirement across the Indian population [24], occupational-related injury among older adults in India is a topic that requires further research. This study utilized data from Wave 1 only, which are now 6–7 years old, and as such, utilizing subsequent, and more recent, LASI waves, once available, would offer more up-to-date and meaningful longitudinal analyses. Finally, we were unable to determine if reported injuries occurred in the conduct of paid employment. The examination of occupational injury in India also represents a topic for future research.
5. Conclusions

Injury represents a significant cause of preventable harm among older adults in India. In particular, it causes OOPE for those who can least afford it. When treatment is sought, those with higher education levels and income are able to avail themselves of treatment in private facilities. We recommend greater investment in primary prevention of injury among older adults in India, as well as continued monitoring of injury-related variables in future waves of the LASI to examine longer-term trends, as well as better quantify the impact of injury on the health system in a country with a significant aging population.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/safety10030066/s1: Supplementary File S1: Relevant LASI survey questions—health event: injury/fall; Supplementary File S2: Relevant LASI survey questions—hospitalizations and out-of-pocket expenditure; Table S1: Multicollinearity evaluation results, variation inflation factor (VIF) for predictor variables; Table S2: Two-part model estimates of factors affecting health care expenditure on injury for hospitalized care; Table S3: Two-part model estimates of factors affecting the health care expenditure on injury for outpatient care.

Author Contributions: Conceptualization, J.Y. and A.E.P.; methodology, J.Y.; formal analysis, J.Y.; writing—original draft preparation, J.Y. and A.E.P.; writing—review and editing, J.Y., P.Y. and A.E.P.; data visualization, J.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Indian Council of Medical Research (LASI/12/1054; approval date 5 September 2013).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data used in this study are freely available upon request at https://www.iipsindia.ac.in/lasi (accessed date 23 July 2024).

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Conflicts of Interest: The authors declare no conflict of interest.

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