ORIGINAL RESEARCH

Elders suffering recurrent injurious falls: causal analysis from a rural tribal community in the eastern part of India

AUTHORS

Arista Lahiri[1] MD, Senior Resident *

Sweety Suman Jha[2] MBBS, Junior Resident

Arup Chakraborty[3] MD, Associate Professor

CORRESPONDENCE

*Dr Arista Lahiri alpublications2016@gmail.com

AFFILIATIONS

[1] Department of Community Medicine, College of Medicine & Sagore Dutta Hospital, 578 B. T. Road, Kamarhati, Kolkata 700058, India

[2] Department of Preventive and Social Medicine, All India Institute of Hygiene and Public Health, 110, C.R. Avenue, Kolkata 700073, India

[3] Department of Community Medicine, Medical College & Hospital, 88, College Street, Kolkata 700073, India

ABSTRACT:

Introduction: Falls among the elderly are prevalent but preventable. There is a knowledge gap regarding the factors causing recurrent injurious falls among the elderly, especially in tribal areas. The aim of the present study was to find out the incidence of injurious falls among elderly participants and measure the effect of selected predictors on recurrent injurious falls.
Methods: A longitudinal observational study was conducted among 536 community-dwelling elderly individuals residing in 16 tribal dominated villages under two community development blocks of North 24-Parganas, West Bengal, India from December 2017 to January 2019. Participants were followed up for 1 year. The predictors of recurrent injurious falls were assessed through Prentice, Williams and Peterson Gap Time hazard model.
Results: The mean age of the participants at the baseline was

69.16 (±2.95) years. The majority were male (55.60%), with sedentary physical activity (49.63%). At baseline, history of injurious fall in the preceding 1 year was present in 37.69% of participants. At baseline, 53.17% had malnutrition and 54.29% were dependent on caregivers for activities of daily living. During the follow-up period there were 153 episodes of injurious falls. The incidence of fall was 29.88 episodes per 100 person-years. History of fall had a hazard ratio of 2.33 (95% confidence interval (CI): 1.01–5.38). The hazard ratios for malnutrition, impaired

balance and faster walking speed respectively were 1.20 (95%CI: 1.01–3.60), 5.96 (95%CI: 3.52–6.34) and 3.23 (95%CI: 2.12–5.26), and were statistically significant.

Conclusion: Physical status indicators such as nutritional status, balance and walking speed appeared to be key factors contributing to recurrent injurious falls. Proper nutrition, and regular check-up and rehabilitative measures, are needed to reduce recurrent falls.

FULL ARTICLE:

Introduction

The population is ageing at an increased pace, and it is now predicted that people aged 60 years or older (ie elderly) will outnumber the children aged less than 5 years in the near future. Around 80% of these older people are expected to be living in low- and middle-income countries by the middle of this century[1]. In recent years, India has focussed on strengthening the health system to support healthy ageing through the National Programme for Health Care of the Elderly (NPHCE)[2,3]. While in the Indian context, health of the elderly largely remains a problem of access and affordability nested in the context of complex social dynamics, the exacting burden of non-communicable diseases including lifestyle diseases and disabilities thereof should not be undermined[3,4]. The geriatric population is vulnerable, as they mostly exhibit poor healthcare seeking behavior, ultimately leading to poor quality of life and avoidable death[1]. The tribal areas, being marginalized and practicing their own indigenous customs, facing the challenge of accessibility and affordability of health care, require special consideration while dealing with issues affecting the health of the elderly.

Fall is one of the important factors leading to what is now termed as 'geriatric syndrome'[1]. Around 10% of these fall victims require medical care[5]. In recent years, there has been an increase in published researches focussing on falls among the elderly in India[6-12]. Despite this impetus, only few studies have approached the issue in a longitudinal manner, and attempts to find out factors behind recurrence of the episodes of injurious falls is a rarity. Some studies have focussed on the rural community, but the elderly population from tribal areas was not studied[6,8,10]. According to current knowledge, this topic is less studied in the Indian context, and research on this issue is lacking in the eastern part of India. Doing the study in a tribal population is unique because they are the vulnerable population, and lack of data makes it difficult to formulate an informed policy framework. Earlier studies conducted in different socio-economic contexts revealed several risk factors associated with recurrent fall-related injuries such as age, sex, physical inactivity, living situation, psychosomatic conditions, sensory and mobility-related issues. But whether and to what extent these factors are applicable for the tribal elderly has not been explored, and an estimate of the magnitude of the issue among this underprivileged population is not available.

When discussing health of the geriatric population, prevention of injurious falls is a very important cost-effective strategy[6,13]. In the same continuum, recurrent injurious falls, if prevented, will result in effective reduction of social and economic stress. Fall episodes can be prevented by active intervention after identifying the risk factors. A longitudinal design of study yields evidence of temporality in the relationship of risk factors with occurrence of falls. By identifying such key intervention areas of health promotion to prevent recurrent falls, the evidence from this study will aid policymakers to improve the relevant health programs to a more robust level. The current study therefore aimed to find out the incidence of injurious falls among elderly participants from tribal areas of West Bengal, India. It also measured the effects of selected predictors on recurrent injurious falls among this population.

Methods

Study design and participants

A prospective observational study was conducted in 16 tribal dominated villages under two selected community development blocks of North 24-Parganas district[14-16],West Bengal, India from December 2017 to January 2019. Home-dwelling elderly participants (aged ≥ 60 years), who were residing permanently (≥10 years) in a selected village and living with at least an adult person, were included in the study after obtaining written informed consent for participation. Only ambulatory elderly individuals were selected. However, those with diagnosed cardiometabolic or musculoskeletal diseases, cognitive impairments, or neurological or psychiatric diseases were excluded. Those having bony fracture or associated diseases attributed to non-fall events were also excluded. After recruitment the participants were followed up for 1 year through four quarterly contacts. A minimum of one follow-up at the third month was considered mandatory for inclusion in the final analysis.

Sampling and recruitment

Participants were selected from the villages using probability proportional to size technique. The sample size was calculated using the power cox program in Stata v14.2 software (StataCorp LLC, https://www.stata.com/stata14)[17,18]. At 95% level of confidence and 90% power, taking the average detectable hazard

ratio to be 0.25, 20% attrition and 30% prevalence of recurrence, the estimated sample size was 254[10,13]. Adjusting for a design effect of 2, the sample size was estimated at 508. Inflating for an estimated partial- or non-response of 10%, the target sample size was 559. A total of 548 participants were recruited in the study. The scheme of the study is presented in Figure 1.

Table 1: Baseline characteristics of participants according to follow-up

Baseline characteristic		Participants followed up until ...						p-value[†]
		3 months (n=536)		6 months (n=506)		9 months (n=496)		
		n	%	n	%	n	%	
Age	'Young old' (60–69 years)	308	57.46	286	56.52	282	56.85	0.953
	'Old old' (70–79 years)	228	42.54	220	43.48	214	43.15	
Sex	Male	298	55.60	268	52.96	258	52.02	0.486
	Female	238	44.40	238	47.04	238	47.98	
History of fall in past year	Present	202	37.69	202	39.92	202	40.73	0.582
	Absent	334	62.31	304	60.08	294	59.27	
Status as per Katz' Activities of Daily Living scale	Dependent (score 1–4)	291	54.29	281	55.53	279	56.25	0.814
	Independent (score 5–6)	245	45.71	225	44.47	217	43.75	
Nutritional status (as per Mini-Nutritional Assessment tool)	Malnutrition	285	53.17	280	55.34	278	56.05	0.916
	At risk of malnutrition	118	22.01	107	21.15	102	20.56	
	Normal nutritional status	133	24.81	119	23.52	116	23.39	
Physical activity level	Sedentary	266	49.63	266	52.57	266	53.63	0.132
	Moderate	149	27.80	149	29.45	149	30.04	
	Heavy	121	22.57	91	17.98	81	16.33	
Walking speed	Slow mover	253	47.20	250	49.41	250	50.40	0.881
	Normal mover	217	40.49	197	38.93	187	37.70	
	Fast mover	66	12.31	59	11.66	59	11.90	
Balance	Impaired	225	41.98	218	43.08	216	43.55	0.871
	Maintained	311	58.02	288	56.92	280	56.45	
Visual disturbance	Present	292	54.48	275	54.35	271	54.64	0.996
	Absent	244	45.52	231	45.65	225	45.36	
Use of FRIDs	User of any FRIDs	211	39.37	203	40.12	199	40.12	0.959
	BZD user	173	32.28	170	33.60	169	34.07	0.816
	TCA user	56	10.45	69	13.64	51	10.28	0.167
Alcohol use	Chronic user	283	52.80	274	54.15	271	54.64	0.827
	Irregular or no use	253	47.20	232	45.85	225	45.36	
Tobacco use	Chronic user	305	56.90	288	56.92	280	56.45	0.986
	Irregular or no use	231	43.10	218	43.08	216	43.55	

[†] Differences in categories tested with χ^2. P-values are unadjusted and are obtained from χ^2 tests.
BZD, benzodiazepine. FRID, fall risk increasing drug. TCA, tricyclic antidepressant.
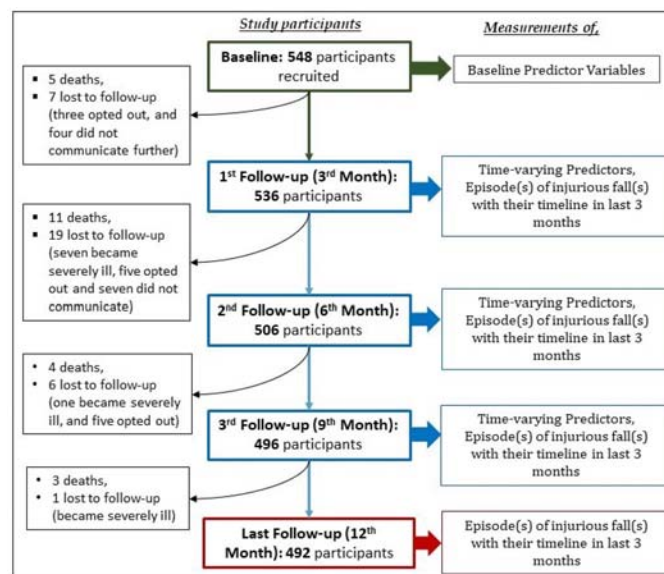

Figure 1: Scheme of recruitment participants and follow-ups.

Study variables and data collection

Interview for data collection was done with the help of a pre-designed, pre-tested schedule. After recruitment and baseline data collection, follow-ups were done at the completion of the third, sixth, ninth and twelfth months. The variables measured during these follow-ups are shown in Figure 1. Sociodemographic information (eg age, gender, religion, type of family and level of

education) were self-reported by the respondent with or without aid of a caregiver. Use of alcohol and tobacco products were considered. Those who currently used any tobacco product were considered current users of tobacco[19]. Use of alcohol was categorized as 'chronic users' (at least one drink per week over past one year) or 'irregular or non-users'[13]. Physical activity was categorized as sedentary, moderate or vigorous based on daily activities of the respondents[20].

The nutritional status of the elderly participants was screened with the help of the Mini Nutritional Assessment – Short Form (MNA-SF) tool. The MNA-SF tool classified the respondents into normal nutrition, at risk of malnutrition and malnutrition, based on dietary history, history of involuntary weight loss, mobility, psychological stress, neuropsychological problems and body mass index[21-23]. Independence in performing daily activities was assessed by the Katz index of independence in Activities of Daily Living (ADL) scale. The ADL scale considers bathing, dressing, toileting, transferring, continence and feeding as the basic activities and notes dependence in each activity, yielding a highest score of 6, which implies independence[24,25]. Data regarding use of fall-risk-increasing drugs (FRIDs) including psychotropic medication were collected from each respondent and triangulated with the response of their caregiver[26,27]. Balance was measured by testing the ability to stand on one leg[13,28,29]. Walking speed was classified into 'fast movers', 'normal movers' and 'slow movers' according to standard measurements[13]. Self-reported visual disturbance, being a validated measure, was also noted[30].

Injurious fall was defined as an episode of fall leading to bodily injury and receiving professional medical care[31]. History of injurious fall in the past year was elicited from each participant and/or the caregiver at the time of recruitment. Episodes of injurious falls and durations of hospital stays, if any, during the study period were noted during subsequent follow-up visits. Occurrence of more than one episode of fall for the same individual during the follow-up period was considered as a recurrent fall.

Statistical analysis

The data collected were entered online in real-time mode during follow-up visits using predesigned Google forms. The entered data were available for analysis through automatically generated Google sheets. Statistical analysis was done using Stata v14.2. Participants were categorized into two age groups: 60–69 years ('young old'), and 70–79 years ('old old')[32]. Those scoring 4 or less in ADL were considered dependent. When modelling recurrent falls, physical activity levels of moderate and vigorous were classed as non-sedentary, while slow and normal walking speed were combined into a 'slower' category.

The outcome (recurrent injurious falls) had two components: time until occurrence of the first fall and effect of different predictors on recurrent falls. Due to the recurrent nature of the event, the population at risk at the beginning of each quarter were those completing follow-up in the previous quarter, irrespective of their status of sustaining a fall. Therefore, the survival time analysis for

time until an episode was done separately for each quarter. It was conceptualized that not only an episode of injury has an effect on a subsequent event, but also the time of hospitalization, if any, following injury served as a time gap during the period of follow-up. Therefore, effects of the fall predictor variables were assessed using the Prentice, Williams and Peterson Gap Time (PWP-GT) model, considering the Cox proportional hazard model was inappropriate to model recurrent events[33-36]. The regression model was developed with history of a fall in the previous year, age at recruitment and gender as time-independent variables. Nutritional status, dependence, physical activity, use of FRIDs, visual disturbance, addiction status (alcohol and tobacco), balance and walking speed were time-varying variables (variables interacting with the follow-up time). The effects of the predictors were reported in terms of adjusted hazard ratio (aHR) and its 95% confidence interval (95%CI). P-value <0.05 was considered statistically significant.

Ethics approval

Ethics clearance was obtained from the institutional ethics committee of Medical College and Hospital, Kolkata (ref. no. MC/Kol/IEC/Non-Spon/569/05-2017). Written informed consent was obtained from the participants while recruiting in the study. No incentive was provided to the participating families.

Results

Baseline information of study participants

Among the total recruited participants, 536 geriatric participants who completed a follow-up after 3 months post-recruitment were included for analysis. A total of 506 participants were followed up until 6 months and of them 496 were followed up until 9 months and 489 until 12 months (ie 1 year of observation). The baseline characteristics of the study participants and along the phases of follow-up are shown in Table 1. The mean age of the participants at the start of follow-up period was 69.16 (±2.95) years, with the eldest participant aged 78 years. The majority (57.46%) were 'young old' (60–69 years) at the time of recruitment. Around 55.60% were male and 49.63% had a sedentary level of physical activity. It was observed that most of the participants were Hindu, belonging to Scheduled Tribes, currently married and residing in a joint family. Most of the participants were chronic users of alcohol and tobacco products. Around 37.69% had a history of injurious fall in the preceding year. At the time of recruitment, 53.17% had malnutrition according to the MNA-SF tool. At the sixth month (ie second follow-up) the proportion of malnutrition was 55.34% because a higher proportion of participants with normal nutritional status were lost to follow-up. A similar trend led to a malnourished proportion of 56.05% at the third follow-up (ninth month). According to Katz' ADL scale, the mean score was 3.75 (±1.99). More than half of the participants (54.29%) were dependent on caregivers for ADL. Although 47.20% had a slow walking speed, 58.02% did not have impairment of balance. Visual disturbance was reported by 54.48% participants. Use of psychotropic medications was not found to be a prevalent practice.

Episodes of injurious falls

During the 1-year follow-up period there were 153 reported episodes of injurious falls in the study group. No individuals suffered more than one episode of injurious fall during any follow-up quarter. Figure 2A depicts the proportion of individuals reporting an episode, while Figure 2B shows the proportion of episodes in each quarter of follow-up. The highest proportion of individuals suffering injurious falls was reported during the first 3 months (9.51%), while the next 3 months (3.73%) had the lowest reported proportion. Out of the total episodes of fall, 33.33% occurred during the first 3 months, and in the subsequent quarters the proportions were 13.07%, 29.41% and 24.18% respectively. Excluding the days of hospitalization following an episode, the incidence of fall calculated was 29.88 episodes per 100 person-years.
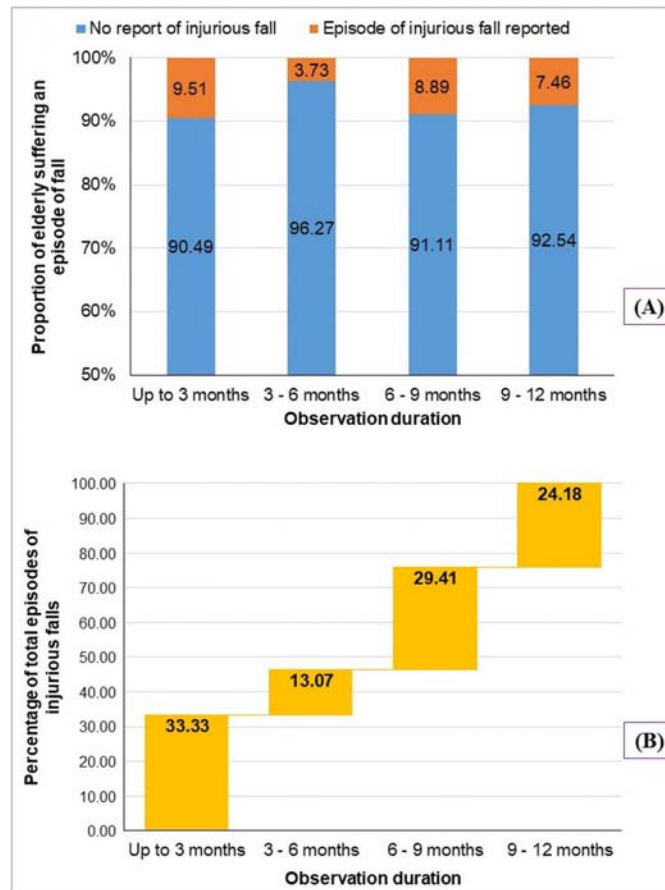

Figure 2: Episodes of injurious falls as per observation quarter. (A) Proportion of elderly individuals reporting episodes of injurious falls; (B) Proportion of quarterly injurious falls out of total reported episodes of falls.

Predictors of injurious fall

Figure 3 represents the survival curves for sustaining an episode of injurious fall during each quarter. In the first 3 months the mean duration for occurrence of an episode was 2.85 (95%CI: 2.81–2.89) months. For those who were followed until 6 months, the mean duration of sustaining a fall in the second quarter of follow-up was 5.96 (95%CI: 5.94–5.98) months. For those followed up until 9 months and 12 months, the mean durations of sustaining an episode in the third and fourth quarters were 8.85 (95%CI: 8.80–8.89) and 11.89 (95%CI: 11.85–11.93).

The predictors of recurrent fall among the geriatric study participants are shown in Table 2. Having a history of fall in the previous year at the time of recruitment was found to have a 133% higher chance of sustaining recurrent episodes of injurious fall (aHR: 2.33; 95%CI: 1.01–5.38). When adjusted for time, compared to normal nutritional status those at risk of malnutrition had a 53% higher chance (aHR: 1.53; 95%CI: 2.54–9.23) and those having malnutrition had a 20% higher chance (aHR: 1.20; 95%CI: 1.01–3.60) of suffering recurrent falls. Those having an impaired balance had a hazard ratio of 5.96 (95%CI: 3.52–6.34) as compared to those maintained balance. The hazard ratio observed for a faster walking speed was 3.23 (95%CI: 2.12–5.26). The effects of use of psychoactive medication, physical activity or addiction were not found to be statistically significant. Although visual disturbance showed a 13% higher chance of sustaining recurrent falls, this effect was not statistically significant. While considering the effect of dependency, it was observed that the dependent elderly had 99% less chance of sustaining recurrent injurious falls (aHR: 0.01; 95%CI: 0.00–0.03), implying dependency regarding daily living activities to be a protective factor.

Table 2: Predictors of recurrent injurious fall among study participants

Predictor of recurrent fall[†]	aHR	95%CI of aHR		p-value
		Lower limit	Upper limit	
Age group				
'Old old' (70–79 years)	0.99	0.72	1.37	0.967
Sex				
Female	0.98	0.71	1.36	0.920
Injurious fall in past year				
Episode of fall present	2.33	1.01	5.38	0.047
Activities of daily living				
Dependent	0.01	0.00	0.03	0.000
Nutritional status				
At risk of malnutrition	1.53	2.54	9.23	0.000
Malnutrition	1.20	1.01	3.60	0.000
Balance				
Impaired	5.96	3.52	6.34	0.000
Walking speed				
Fast	3.23	2.12	5.26	0.000
FRIDs				
User	0.93	0.68	1.27	0.640
Physical activity				
Non-sedentary	0.41	0.05	3.51	0.416
Visual disturbance				
Present	1.13	0.78	1.66	0.516
Alcohol consumption				
Current user	1.38	0.71	2.69	0.347
Tobacco consumption				
Current user	1.08	0.72	1.63	0.707

[†] Hazard ratio for the reference categories was taken as 1. This overall model was statistically significant at $p(\chi^2)<0.001$.
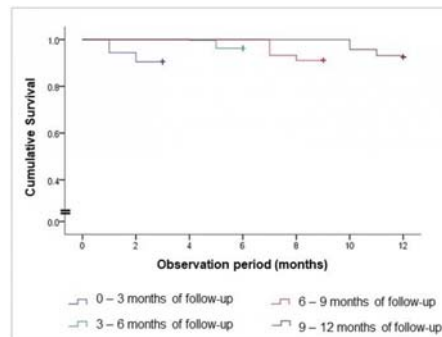aHR, adjusted hazard ratio. CI, confidence interval. FRID, fall risk increasing drug.

Figure 3: Survival curve for incidence of injurious fall per observation period.

Discussion

Findings in light of previous literature

The current article reports a 29.88 per 100 person-years incidence for an episode of injurious fall among the elderly. This is comparable to the prevalence of around 20–30% reported in several studies[5,10,13,37]. A previous fall was found to put an elderly individual at risk of an injurious recurrence. In their cross-sectional study, Chacko et al reported age to be a significant correlate of falls[10]. But in the present study the effect of age was not statistically significant. This may be due to the fact that the age range of the studied population was less dispersed.

Sirohi et al, in their cross-sectional survey in rural Haryana in India, demonstrated functional disability and visual impairment as significant correlates of falls[6]. However, the present study showed visual impairment to be a risk factor for recurrent falls, but dependency (functional disability) to be a protective factor. The

effect of visual impairment was, however, not statistically significant. A possible explanation could be that dependency restricts mobility of the elderly, and the dependent elder is most of the time aided by a caregiver, reducing the probability of sustaining injury. The tribal communities are known to take care of their elders. It may be a factor in dependent individuals being protected from the risk of recurrent falls. Visual impairment, on the other hand, acted as a probable confounder in view of dependence. This explains visual impairment not being statistically significant with dependency as a predictor. The effects of addictions, physical activity and use of FRIDs were not significant statistically. This can be reasoned by their interactions amongst themselves and with the other significant predictor variables.

Most of the cross-sectional surveys report prevalence of fall to be significantly higher among women[6,7,10]. However, in the present article the hazard of incurring recurrent fall was statistically not significant for women. The present study included participants who

lived with at least one caregiver. Also, the majority of the participants belonged to a joint family. These imply the participants were expected to receive better social and family support, explaining the contrasting finding. Nutritional abnormality, balance impairment, gait disorder and addiction habits were found to be important correlates of falls as per another cross-sectional study from south India[7]. In consonance, the present study established abnormal nutritional status, impaired balance and faster walking speed to be risk factors for recurrent falls. But effect of physical activity was not found to be statistically significant. In the present study, more than half of the participants were found to be malnourished. Such a high burden of malnutrition itself requires a separate thrust. Those having poor nutritional status were at substantial risk of sustaining injurious fall episodes recurrently.

Strengths and limitations

The majority of the studies dealing with the correlates of falls in the elderly in an Indian context have considered comorbidities as the chief contributors[8,10]. However, in the present research, several of the comorbidities were set as exclusion criteria, allowing the study of the biophysiological effect of different factors itself. But the current study did not screen the participants continuously to identify and exclude several cardiometabolic morbidities during the course of the study, due to logistic constraints. This is a limitation to the study despite the rigorous attempts to exclude participants with diagnosed morbidities. The importance of considering injurious falls over simple fall events is in minimizing the recall bias associated with reporting of events of interest. Moreover, from a clinical and public health point of view it is important to prevent injuries. Considering the design and analytical technique used in this study, perhaps it is one of the few studies in the Indian context measuring the risk of recurrence of injurious falls, using a statistically robust method. The use of the PWP-GT model accounts for the alteration in risk when hospitalized, thus providing a more accurate estimate of risk situations for recurrent falls among the elderly when residing in the community. While most studies report the prevalence of falls, the current article reports the incidence, by virtue of its longitudinal design.

Implications of findings

The high burden of malnutrition provides actionable evidence from a public health point of view for rigorous nutritional improvement programs for the disadvantaged elderly. The effect of addiction habits on recurrent falls was not significant

statistically. However, the proportions of chronic alcohol or tobacco users were around 50–60%. This warrants serious behavior change communication, as the ill-effects of such prevalent addiction practices extend beyond episodes of fall-related injuries. The study recommends that the revealed risk factors, particularly prevalence of elderly malnutrition, lack of awareness and attitude regarding healthy dietary practices, high alcohol and tobacco addiction, lack of health care and rehabilitative facilities to address the balance or gait problems, should be adequately addressed while developing the program for health care for the elderly in India. There is strong advocacy of developing a separate program focussing on nutrition of the elderly, and development of a de-addiction framework. Along with the clinical care made available, the NPHCE may require assistance with these components, or maybe a merged approach is required. The proportions of fallers were higher during the first and third quarter of follow-up. This can be conceptually correlated with the abundance of rainfall during these periods, resulting in accidental falls often leading to serious injuries. Therefore, an environmental effect requires further in-depth assessment.

Conclusion

Intensive care to those having a history of an episode of fall is probably the best way to prevent recurrence. Provision of proper nutrition, by means of economic development, ease of accessibility and awareness generation regarding healthy dietary practices, is an important cornerstone in prevention of recurrent injurious falls. Although addiction did not have any significant effect, the proportion of alcohol and tobacco use was found to be high in the tribal-dominated villages studied. Measures should be taken to curb these behavioral factors. Regular check-up and rehabilitative measures to aid individuals with balance or gait problems are also required. Moreover, a positive and constructive attitude should be garnered to improve the health of the elderly, especially in marginalised or disadvantaged populations, which will propel the community one step closer to attaining healthy ageing. The findings advocate for an interdisciplinary approach in assessing and mitigating the risk factors of recurrent episodes of injurious fall.

REFERENCES:

1 World Health Organization. Ageing and health [Internet]. Available: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health (Accessed 15 November 2019).

2 Ministry of Health and Family Welfare, Government of India. National Programme for Health Care of the Elderly (NPHCE). Available: https://mohfw.gov.in/major-programmes/other-national-health-programmes/national-programme-health-care-elderlynphce (Accessed 15 November 2019).

3 Ministry of Health and Family Welfare, Government of India. National Programme for the Health Care of the Elderly (NPHCE): an approach towards active and healthy ageing. Operational guidelines. Available: http://health.bih.nic.in/Docs/Guidelines

/Guidelines-NPHCE.pdf (Accessed 15 November 2019).

4 Dey S, Nambiar D, Lakshmi JK, Sheikh K, Reddy KS. *Health of the elderly in India: challenges of access and affordability.* Available: https://www.ncbi.nlm.nih.gov/books/NBK109208 (Accessed 15 November 2019).

5 Tinetti ME. Preventing Falls in Elderly Persons. *New England Journal of Medicine* 2003; **348(1):** 42-49. https://doi.org/10.1056 /NEJMcp020719

6 Sirohi A, Kaur R, Goswami AK, Mani K, Nongkynrih B, Gupta SK. A study of falls among elderly persons in a rural area of Haryana. *Indian Journal of Public Health* 2017; **61(2):** 99.

7 Patil SS, Suryanarayana SP, Dinesh R, Shivraj NS, Murthy NS. Risk factors for falls among elderly: a community-based study. *International Journal of Health and Allied Sciences* 2015; **4(3):** 135. https://doi.org/10.4103/2278-344X.160867

8 Peter RM, Joseph A, John KR, Logaraj M. A community-based case-control study on the risk of fall among the elderly in rural Kattankulathur block, Tamil Nadu. *Indian Journal of Community Medicine* 2019; **44(3):** 277. https://doi.org/10.4103 /ijcm.IJCM_122_19

9 Pitchai P, Dedhia HB, Bhandari N, Krishnan D, D'Souza NRJ, Bellara JM. Prevalence, risk factors, circumstances for falls and level of functional independence among geriatric population – a descriptive study. *Indian Journal of Public Health* 2019; **63(1):** 21. https://doi.org/10.4103/ijph.IJPH_332_17

10 Chacko TV, Thangaraj P, Muhammad GM. Epidemiology of fall and its risk factors among elders in a rural area of Coimbatore, India. *International Journal of Community Medicine and Public Health* 2017; **4(10):** 3864-3869. https://doi.org/10.18203 /2394-6040.ijcmph20174265

11 Joshi K, Kumar R, Avasthi A. Morbidity profile and its relationship with disability and psychological distress among elderly people in Northern India. *International Journal of Epidemiology* 2003; **32(6):** 978-987. https://doi.org/10.1093 /ije/dyg204

12 Sharma PK, Bunker CH, Singh T, Ganguly E, Reddy PS, Newman AB, et al. Burden and correlates of falls among rural elders of South India: Mobility and Independent Living in Elders Study. *Current Gerontology and Geriatrics Research* 2017. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5485263 (Accessed 15 November 2019). https://doi.org/10.1155/2017/1290936

13 Ek S, Rizzuto D, Fratiglioni L, Johnell K, Xu W, Welmer A-K. Risk profiles for injurious falls in people over 60: a population-based cohort study. *Journals of Gerontology series A* 2018; **73(2):** 233-239. https://doi.org/10.1093/gerona/glx115

14 Ministry of Tribal Affairs, Government of India. *Statewise ITDP/ITDA Area Statement.* 2016. Available: https://tribal.nic.in /ST/1-ITDAArea.pdf (Accessed 14 November 2019).

15 Directorate of Census Operations. *Census of India 2011: District Census Handbook West Bengal.* 2014. Available: http://censusindia.gov.in/2011census /dchb/1911_PART_B_DCHB_NORTHTWENTYFOURPARGANAS.pdf (Accessed 14 November 2019).

16 Office of the District Magistrate. *North 24 Parganas District: Blocks [Internet].* Available: http://www.north24parganas.gov.in /blocks (Accessed 22 June 2020).

17 Stata. *Power analysis for survival studies.* Available: https://www.stata.com/features/overview/power-analysis (Accessed 14 November 2019).

18 Stata. *stpower cox.* Available: https://www.stata.com/manuals13 /ststpowercox.pdf (Accessed 14 November 2019).

19 Global Tobacco Surveillance System. Global Adult Tobacco Survey (GATS) indicator guidelines: definition and syntax. 2009. Available: https://www.who.int/tobacco/surveillance /en_tfi_gats_indicator_guidelines.pdf (Accessed 14 November 2019).

20 World Health Organization. *What is moderate-intensity and vigorous-intensity physical activity?* Available: https://www.who.int /dietphysicalactivity/physical_activity_intensity/en (Accessed 14 November 2019).

21 Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. *Journal of Nutrition, Health and Aging* 2009; **13(9):** 782-788. https://doi.org/10.1007/s12603-009-0214-7

22 Nestle Nutrition Institute. *A guide to completing the Mini Nutritional Assessment – Short Form (MNA®-SF) .* Available: https://www.mna-elderly.com/forms/mna_guide_english_sf.pdf (Accessed 14 November 2019).

23 Nestle Nutrition Institute. *Mini Nutrition Assessment [Internet].* Available: https://www.nestle.com/sites/default/files/asset-library /documents/library/events/2010-malnutrition-in-older-people /mna_mini_english.pdf (Accessed 14 November 2019).

24 Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged: the index of ADL: a standardized measure of biological and psychosocial function. *JAMA* 1963; **185(12):** 914-919. https://doi.org/10.1001/jama.1963.03060120024016

25 McCabe D. Katz Index of Independence in Activities of Daily Living (ADL). General Assessment Series. New York, NY: Hartford Institute for Geriatric Nursing, 2019.

26 Milos V, Bondesson Å, Magnusson M, Jakobsson U, Westerlund T, Midlöv P. Fall risk-increasing drugs and falls: a cross-sectional study among elderly patients in primary care. *BMC Geriatrics* 2014; **14(1):** 40. https://doi.org/10.1186/1471-2318-14-40

27 Axmon A, Sandberg M, Ahlström G, Midlöv P. Fall-risk-increasing drugs and falls requiring health care among older people with intellectual disability in comparison with the general population: a register study. *PLoS ONE* 2018; **13(6):** e0199218. https://doi.org/10.1371/journal.pone.0199218

28 Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. *Journal of Geriatric Physical Therapy* 2007; **30(1):** 8-15. https://doi.org/10.1519/00139143-200704000-00003

29 Bohannon RW. Single limb stance times: a descriptive meta-analysis of data from individuals at least 60 years of age. *Topics in*

Geriatric Rehabilitation 2006; **22(1):** 70-77. https://doi.org/10.1097/00013614-200601000-00010

30 Whillans J, Nazroo J. Assessment of visual impairment: the relationship between self-reported vision and 'gold-standard' measured visual acuity. *British Journal of Visual Impairment* 2014; **32(3):** 236-248. https://doi.org/10.1177/0264619614543532

31 Schwenk M, Lauenroth A, Stock C, Moreno RR, Oster P, McHugh G, et al. Definitions and methods of measuring and reporting on injurious falls in randomised controlled fall prevention trials: a systematic review. *BMC Medical Research Methodology* 2012; **12(1):** 50. https://doi.org/10.1186/1471-2288-12-50

32 Forman DE, Berman AD, McCabe CH, Baim DS, Wei JY. PTCA in the elderly: The 'Young-Old' versus the 'Old-Old'. *Journal of the American Geriatric Society* 1992; **40(1):** 19-22. https://doi.org/10.1111/j.1532-5415.1992.tb01823.x

33 Ghilotti F, Bellocco R. *Recurrent-event analysis with Stata: methods and applications.* Bologna: XV Italian Stata Users Group Meeting, 2018.

34 Stata. *FAQ: Analysis of multiple failure-time survival data.* Available: https://www.stata.com/support/faqs/statistics/multiple-failure-time-data (Accessed 14 November 2019).

35 Amorim LD, Cai J. Modelling recurrent events: a tutorial for analysis in epidemiology. *International Journal of Epidemiology* 2015; **44(1):** 324-333. https://doi.org/10.1093/ije/dyu222

36 Prentice RL, Williams BJ, Peterson AV. On the regression analysis of multivariate failure time data. *Biometrika* 1981; **68(2):** 373-379. https://doi.org/10.1093/biomet/68.2.373

37 Peeters G, van Schoor NM, Lips P. Fall risk: the clinical relevance of falls and how to integrate fall risk with fracture risk. *Best Practice and Research Clinical Rheumatology* 2009; **23(6):** 797-804. https://doi.org/10.1016/j.berh.2009.09.004