Medical Research Archives

European Society of Medicine

OPEN ACCESS

Published: September 30, 2023

Citation: Ravindran RM, Kutty VR, et al., 2023. Assessment of Household Environmental Risk Factors for Falls Among Community Dwelling Older Persons in Thiruvananthapuram District of Kerala, Medical Research Archives, [online] 11(9). https://doi.org/10.18103/mra.v11i9.4385

DOI
https://doi.org/10.18103/mra.v11i9.4385

ISSN: 2375-1924

RESEARCH ARTICLE

Assessment of Household Environmental Risk Factors for Falls Among Community Dwelling Older Persons in Thiruvananthapuram District of Kerala

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ABSTRACT

Falls constitute a major public health problem among older persons worldwide. This study attempted to observe and identify the potential environmental hazards within and outside the houses that could have caused fall-related injuries of older persons. The modifications done to the house after the falls were also observed.

Households of older persons who were hospitalised at a tertiary care centre in Thiruvananthapuram district of Kerala, India for complaints of fall related injuries (participants of a case-control study) were observed using a guide that was customized and adapted for the setting.

The areas around the houses were slippery and had several tripping hazards. Marble, granite and tiled floors were found to be slippery. Door thresholds, door mats with no grip backing and plastic chairs were found to be potential tripping hazards. Steps/stairs were important in causation of falls. The bedrooms were often dark, small and cluttered with furniture. The bathrooms were frequently located outdoors and at a different level from the rest of the house. Lighting was a problem within the house, inside the toilet and bathrooms. Commonest alteration made to prevent falls was introduction of mats inside and outside the house. Changes that were needed for a safe environment for older persons are often challenged by the need to display status markers.

Several potential hazards were identified within and around the house. They either precipitated the falls or modified the outcome of falls. Further research is necessary to work out a guideline for constructing safe and friendly houses for older persons.

Introduction

Falls are common among older persons and a significant public health problem around the world. Every year, 25% to 30% of older adults over 65 years living in the community, sustain falls[1-5]. Falls frequently result in long standing complications like injuries, chronic pain, disability, fear of falling, reduced quality of life, premature and prolonged hospital admission, functional limitations resulting in long term care and even death among older persons[6-8].

Falls are multifactorial and around 400 risk factors have been identified for falls that could be broadly classified in to intrinsic and extrinsic factors[9-11]. Fall can be considered as a consequence of interaction between extrinsic, intrinsic and behavioural factors[12]. Intrinsic factors are those of physiologic origin or the host factors and extrinsic factors are the environmental or related hazards or environmental factors [13]. Slipping and tripping were the frequent cause of falls [3,4,14,15]followed by misplaced steps and loss of balance[16]. Slips happen frequently on wet floors in bathrooms or near it, or while mopping floor. Slippery surfaces like cemented surfaces with algae grown during rainy season, outside the house or on the road and smooth flooring using glossy tiles and polished marble or granite also pose threat to the older persons[14]. Trips often happened on thresholds, irregular floor or road, carpet edges, defects like crevices on the floor or road and some objects on the floor or road[14]. Other environmental or extrinsic factors that lead to falls are poor lighting, loose rugs, assistive devices, clothing and footwear[14].

Environmental factors are the cause for falls among 30-50% of falls among community dwelling older persons[17] (e.g., poor lighting, slippery floors and uneven surfaces). Falls due to extrinsic causes were more common than falls due to intrinsic causes among the Japanese older persons[18]. Many of these factors and contexts are modifiable[8,19,20]. Carter et al examined the prevalence, location and type of environmental hazards in the homes of older persons. They found that 20% of homes were free of hazards, 80% had at least one hazard, 39% had >5 hazards and nearly 5% had >15 hazards[21]. Homes of people with a recent hip fracture had more hazards than those of people without a hip fracture[22]. Bathrooms were identified as the most dangerous in half of the houses of older persons[21]. Absence of handrails, uneven floors, vinyl on the floor of bathroom, poor lighting, loose rugs, assistive devices, clothing and footwear were identified as environmental factors that led to falls among older persons [14,23, 24].

The state of Kerala in India has the largest proportion of older population (12.6%) which is predicted to increase to 37% in 2051[25-27]. Kerala is going to face the challenges associated with the rising older population even before the other states in India because of its advanced stage in the epidemiological transition[28]. This paper is an attempt to examine the potential built-environment risk factors in and around the houses of older persons that could have precipitated falls leading to hospitalisation in a tertiary care centre in Thiruvananthapuram district of Kerala. Structural alterations made to the houses after the falls were also observed in the context of the injuries sustained and the outcome of injuries.

Methodology

We adopted a qualitative approach using non-participant observation to identify the potential built-environment risk factors that precipitated falls and/or modified the outcome of falls among older persons in Thiruvananthapuram district of Kerala. The study was reviewed by the Institutional Ethics Committee of the Sree Chitra Tirunal Institute for Medical Sciences and Technology.

The participants were chosen from a hospital-based case control study conducted in a tertiary care hospital in Thiruvananthapuram, Kerala to identify the risk factors for fall related injuries that led to hospitalisation[29]. The households of participants (older persons who were admitted to the hospital with complaints of fall related injuries and enrolled into the study as cases) were considered for observation. For this examination, falls due to extrinsic causes (slipping and tripping) with in their dwellings or just outside alone were included. Those individuals who fell away from home, at workplace, some other house, office or public space were not considered for the study due to operational issues. The selected persons were contacted over the phone for their consent and directions to reach their houses. Some of them who did not stay at the houses where they sustained injuries were excluded at this stage. Among those who were followed up (129 persons), 37 persons were dead by the time we attempted to contact them. Only those houses within the district were included in the study for different reasons. Written informed consent was obtained from all participants.

Non participant observation was carried out as a three-stage funnel process beginning with descriptive observation, in which we carried out broad scope observation to get an overview of

the household setting. The investigator and two trained volunteers gathered information based on a guideline modified and adapted to our setting. Responses to each item were arrived at by consensus. The alterations done if any to prevent falls were noted in the second visit. The next step was focused observation in which, the transport access, entry to the house, immediate surroundings and inside of the house were observed. We paid attention to the reachable area of an old person in his/her household for the daily activities. The final step was selected observation, in which we investigated the potential built environmental factors and its possible interaction with the older person. The evenness, vegetation and dampness of the roads to individual houses were examined. The steps/stairs were examined for the regularity, finishing, uniformity, stability, visibility, height, evenness, whether fixed with handrails or distinct from the rest of the floor. Doors were examined for height, width, presence of thresholds and the level on both sides of the door. The available space, clutter, furniture and tripping hazards within each room were observed. Floors were inspected for the type of flooring, evenness, regularity, condition and smoothness. Roofs of the houses were observed to classify the houses and to gauge the economic situation of the households. Lighting of the rooms, halls and walkways were observed. Objects that had a potential to cause a fall were identified with in the rooms. The location of the bathroom, the level of the bathroom with the rest of the house, the type of toilet (Indian: squatting or Western: sitting), height of the toilet seat, type and area of floor, provision to sit and take a bath, the ease with which things can be reached and whether the dry and wet areas are separate were among the things observed.

The observation of the households was continued till we attained saturation of information (which occurs when further observations begin to add little or nothing to researcher's understanding).

Analysis of data

We did manifest level (basic level) content analysis for the categorization and summarization of observation data (no comments or theories as to why or how we observed). It involves the inductive coding process. Observation notes were transcribed into an observer commentary. Coding was done to generate simplest variations in patterns. Later codes were classified (axial coding) and grouped to form large themes by a process of comparing outcomes and linkages (selective coding) by using constant comparison method. Repetitions and variations from the common pattern were also identified.

Characteristics of the participants

Characteristics	**N=15**
Females	11
Age > 75 years	9
Activity status	
Bedridden	2
Using wheel chair/walker	2
Active	11
Type of injury	
Head injury	1
Hip fracture	2
Others	12
Socioeconomic status (SES)	
Upper	5
Middle class	4
Poor	6

Results

Transport access

Few houses had ready access to a motorable road within a distance of 15 metres from the house. The roads were in general narrow, had pot holes and were slippery due to water stagnation and growth of moss. Two of the houses had no independent access.

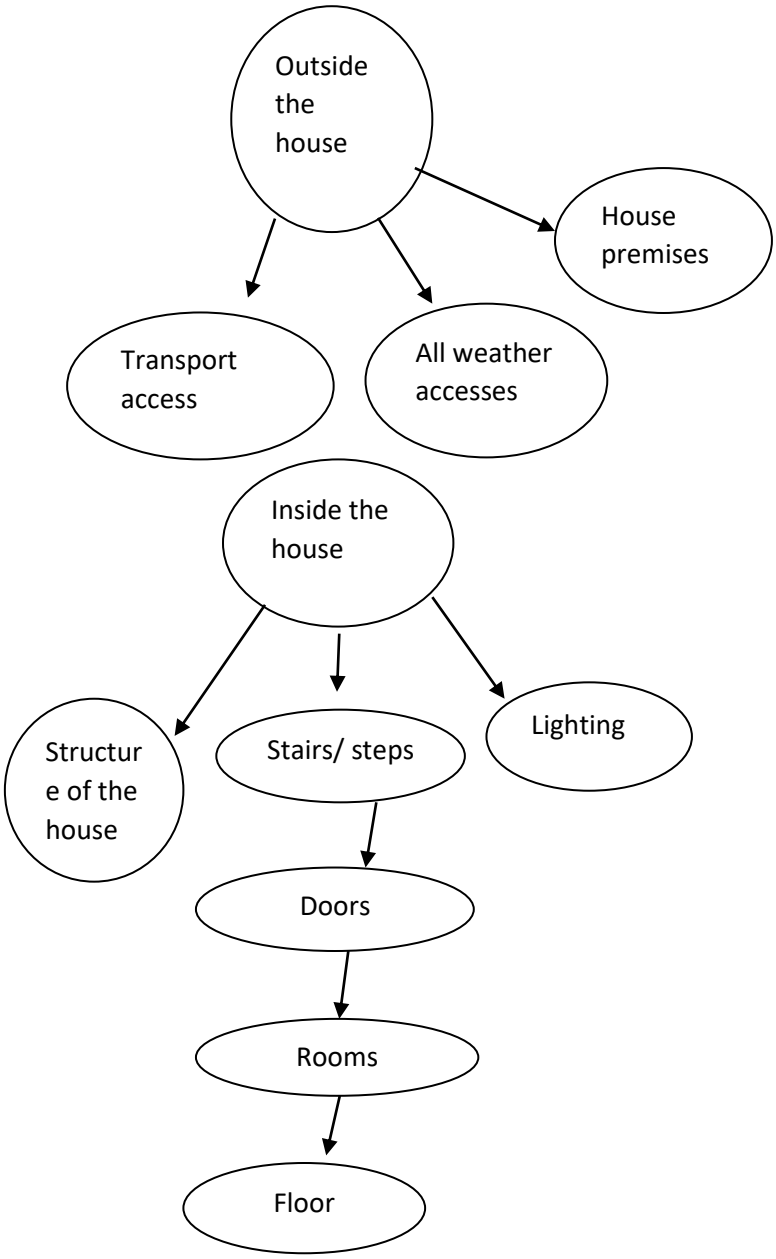
Only one house had access to bus transport within 15 metres. Four households were half a kilometre and the rest of the houses were at least one km away from bus access; the maximum distance being five kilometres.

All weather accesses

Most of the houses had kaccha roads (a dirt road or track that is unpaved) leading to them with vegetation grown on both sides. They were frequently irregular with loose mud and stones and were sloping up or down. As the observation was

made in a monsoon season, most of the roads were water logged. The hard trails were slippery due to the growth of moss or due to the presence of wet pasty layer of mud. At some places the way leading to house was between two compound walls. These were so narrow as to make those not habituated to such situations feel claustrophobic. Two of the houses were on the bank of a canal with a low boundary wall.

Figure 1: Qualitative content analysis coding framework



House premises

One third of the houses had non-slippery regular surface around them, either paved with interlocking tiles (terracotta) or filled with gravel/sand. The others were either cemented or firm surfaces accompanied by moss or water puddles. Some of the tripping hazards identified around the houses were ditches around a coconut tree, stones and logs, heaps of firewood, tools and materials used for construction.

A well was the main source of water for most of the houses and it was generally situated within the premises. All of them had side walls but not closed at the top. Two were covered with mosquito nets.

Structure of the house

The houses varied in the size, shape, facility, design and safety. The floor area of the houses ranged from 300 square feet to 2000 square feet. The smaller the area, the more was the

clutter; bigger houses with large carpet area appeared comparatively safer for the older persons.

Single storeyed houses were most common. The number of bedrooms ranged from one to five and were generally small in size. The roofing materials used were coconut leaf, processed metal or plastic sheet, tiles or concrete. Some of the houses were old and dilapidated, with mud wall, cow dung smeared floor, coconut leaf roof, low and narrow doors and high door thresholds. Few houses had no houses in the immediate neighbourhood.

Stairs/steps

Almost all the houses had two to four steps on both sides of the house. All the double storeyed buildings had stairs inside. Some of the single storeyed concrete buildings had stairs on the rear side to climb up the roof. The height, width and the steepness of the steps varied from house to house. A sandbag and concrete slabs served as steps in one of the houses. The steps were not always of uniform height. They were either too high or low. In most cases the steps were perfect and polished but was completely damaged in other situations. The edges of the steps were not distinct from the floor in some cases. A support to hold on for climbing the steps were absent in many houses.

Doors

Old houses had low and narrow doors which were difficult for older persons to negotiate. The doors were generally of uniform height and width. The modern houses had door thresholds (door sills) at front and back doors while old houses had thresholds at all the doors. The thresholds were of different height in different houses and in the same house at different doors.

Rooms

Rooms were generally small in houses with lesser floor area. The furniture present in the rooms reduced the space for older persons to move around. In some of the houses, different rooms were at different levels.

Floors

The type of flooring ranged from mud to marble. Four houses had marble or tiled floors. Rest had cemented floors with red or black oxide. The floor in one of the houses was completely damaged. Marble, granite and tiled floors were smooth and slippery.

Roof

The roofs ranged from coconut leaf thatch to concrete. Four houses were covered with processed metal or plastic sheets. Another four houses were tiled with sloping roofs. Four houses had concrete roofs. Rest two had a mix of tile and concrete. Protective parapet walls were absent for concrete roofs in some of the houses.

Lighting

Even during the day, lighting was insufficient in most of the rooms in almost all the houses. Halls were generally well lit. The walkways were dark even during the day in most houses.

Potential hazards inside the house

Almost all the houses had tripping hazards within the main halls and rooms frequently used by the older person. Door thresholds and furniture with legs pointing outwards were potential tripping hazards. Door mats with no grip backing and therefore slippery on a smooth floor had potential for slipping. Polyester cloth was used as door mat in a house. Plastic chairs were the commonest hazard noticed in all houses. One person fell while trying to sit on a plastic chair which slid back.

Bathrooms

Bathrooms were away from the main building in most of the houses. Some houses had attached bathrooms as well. Majority of the toilets had sitting type of commode. Some houses had more than one toilet. The floors of bathroom were either cemented or tiled. They were often slippery due to growth of moss. In most cases the bathrooms were at a different level from the rest of the house. Visibility was limited even during daytime in most of the bathrooms and some had no lighting at all. Some had arrangements for the older person to sit and take bath. The concept of separation of dry and wet areas was not observed in most of the bathrooms. There was no provision of grip bar in any of the bathrooms to prevent falls among older persons. Bathrooms were not provided with convenience for older persons to reach out to things needed for bath.

Alterations made after the falls

Some protective measures were consciously made to prevent further falls of older persons in some of their houses. In one of the houses where the older person fell outside the house on the way to the bathroom, mats to prevent falls were laid around the house on the cemented surface. In another house, where the older person fell inside the house in the bedroom, new antiskid mats were placed on the walk ways and the bedroom. In another case, mats were provided on the way to the bathroom and the halls where the older person usually spend most of the time. The thresholds were removed in a house where the older person fell and fractured a

lumbar vertebra. Bathroom (wet area) and toilet (dry area) were separated after the falls even though it was not a conscious effort. Some of the structural alterations were to accommodate the needs of older persons after the fall injury and not to prevent further falls. The squatting type of commode was replaced by sitting type for the convenience of older persons. But a separate outdoor bathroom with cement floor and squatting commode was built 15 metres away from home for a person who fell in the bathroom with tiled floor inside the house. One of the older persons started using a walk aid for support after the fall. Another person who is bed bound is being mobilized in a wheel chair after the fall. A rope functioned as a clutch for a bedridden person to get up from bed.

Discussion

Falls happen as a consequence of the interaction between active older people and the environment he/she is living in and not necessarily related to the person's frailty[19,30]. We examined some of the potential hazards present in houses of older persons that were likely to increase their risk for falls.

Household of an older person should have an independent and ready access to a motorable road. This is essential to transport a person in case of an emergency which will prevent delay of treatment that can influence their recovery status. But not all the houses observed had an independent and easy access to a motorable road. For an older person, chances of falling were high as they had to negotiate this distance to go out, particularly if they had difficulties with balance. This forced them to stay indoors for most of the day, which in turn increased the duration of interaction with the house and its hazards.

Some older persons in our sample fell on the roads leading to the house. The irregularity, vegetation, puddles and growth of moss definitely pose threat to the older persons. Due to the nature of the terrain most of the houses were at a different level from the road. In a few instances the track was too steep for older persons to climb.

The immediate surroundings of the household of an older person should be free of hazard as they spend most of their time in and around the house. Most of the falls occurred around the house while going to the outdoor toilet. They had to negotiate two level differences, one at the exit of the house and another at the entry of the bathroom. In a few cases there were more than two such changes in levels to be negotiated. This is similar to the finding that accidents were more in older adults who lived on the third floor or higher[31]. The ability to lift a leg through a height gets deranged when one grows old[32]. This is one of the reasons for tripping on obstacles. Absence of handrails and presence of uneven floors were identified as hazards by previous authors similar to our findings[23,33].

It is a practice to cement the surroundings of the house to level the ground or to prevent dust. But in the weather conditions in monsoon fed areas, moss tends to grow quickly on these cemented surfaces, leaving them slippery. Slippery floors were identified as a risk factor for falls among older persons in several earlier studies[29, 34, 35]. The indoor floors of some of the houses observed were also found to be slippery. Old houses had mud floors smeared with cow dung; comparatively safe in terms of the slipperiness and impact force. Cement floors with red or black oxide coating were smooth but appeared safe for older persons. The better off houses had polished marble and granite floors which were more hazardous for older persons. Hip fractures resulting from falls on wooden carpeted floors were less due to the low mean impact force applied[36].

The common modification suggested for prevention of falls was removal of floor mats and use of anti-slip mats in bathrooms[37]. Not all the carpets and doormats in the observed households were appropriate. In some houses, old clothes even polyester clothes were used as door mats that increased the risk profile. Carpets with rubber coating at the bottom is essential to prevent slipping on floors with marble and tiles.

Door thresholds were identified as a significant risk factor for falls in earlier studies[34]. Old fashioned houses had thresholds at all the doors, unlike modern houses that had them at front and back doors alone.

Both bedrooms and bathrooms have been identified as hazardous sites in previous studies[2,21]. The bathrooms observed were no different in terms of the hazards they posed for falls. Floor of the bathroom was significantly associated with falls among older persons in a study from Thailand[35]. There were bathrooms with glossy tiled floors and there was no separation of dry and wet areas. Moss grown on the rough cemented floors of some toilets made them slippery and hazardous. The location of bathroom outside the house was significantly associated with falls in an earlier study congruent to our finding[34]. Poor lighting and low chairs increased the risk for

multiple falls among older persons[38]. Lighting was very crucial in the precipitation of a fall event. There were no lights inside the bathroom in some cases and if there was one, the switch of the light was placed elsewhere and not at the entry of the bathroom. This shows the lack of concern for older persons during the construction of the houses.

Use of protective measures to prevent falls was observed mostly by their absence. Awareness of the special needs of older persons is limited. People seldom make conscious effort to modify houses so as to avoid falls as they age. Persistent environmental factors are part of the building or that are unlikely to change[39]. Better compliance was observed with cheap and simple interventions with variable factors in an intervention study similar to our reports[34].

Assessment of home hazards and modification that is professionally prescribed for older persons with a history of falling may reduce the risk of falling by one third[39]. Modifications include removal of loose carpets, repair of doorsteps, provision of grip bars, new beds and firm mattresses, furniture changes and improved lighting in the bedroom and bathroom[8]. The most common modification suggested as intervention to prevent falls among older persons was removal of floor mats and use of anti-slip mats in bathrooms[34]. Similarly, the commonest modification observed was laying mats on the floor to prevent slipping.

The modifications observed in the households of our sample were not always envisioned to prevent falls, but were part of the economic-transition of the household. After the falls, the thresholds were removed and bathrooms were separated for dry and wet areas in some of the houses. But in the same house, the floors were tiled which increased the potential to slip. Two older persons from the same household were bedridden due to injuries following fall in exactly the same way; indicating the inability to make the causal connection in this regard. In another house where an older woman fell and sustained an elbow fracture, a ramp was built in front of the house not as a modification for the older person in the house but for taking a two-wheeler inside the house.

The structural interventions to the house after the fall injury were to accommodate the incapacities of older persons with the injury. This depend on the age of the older person and whether he/she is mobile inside the house or outside the house. If the injured was dead or bedridden or recovered completely after the fall, there was no scope for alterations in the structure. If the necessary change is retrograde in terms of socioeconomic status marker or fashion norms, such a change will not be made. For example, in a house where an older woman slipped and fell in an indoor bathroom which had a tiled floor, an outdoor bathroom was constructed for her instead of changing the floor or taking other preventive measures in the indoor bathroom. In another case, instead of making any alterations to the structure of the house, the older person was given a walking stick.

No specific difference was noted with the gender of the victim and the structural alterations. Irrespective of the socioeconomic status, hazards were found in all the houses. However, the type of hazards noted were different across household with varying socioeconomic status. Thus, economic transition can either reduce or amplify the risk for falls for older persons within their household.

Conclusion

This study identified several modifiable environmental risk factors like clutter with in the room, slippery floors, improper steps, door thresholds, level differences, insufficient lighting and tripping hazards like plastic chairs for fall related injuries among older persons in Thiruvananthapuram. As falls in older persons are considered part of aging, causal connections between the risk factors and falls were never made. While examining the structural alterations done to houses for prevention of falls after the fall related injury among older persons, we could find that fixed parts of the house were seldom altered. In cases, where the cause was so evident, there was no attempt to remove or reform the cause, either due to lack of awareness, concern or lack of resources. Changes that are needed for a safe environment for older persons are often challenged by the need to display status markers. Therefore, we need to educate the household members of older persons regarding structural changes that would enhance or mitigate against known hazards such as tiled/marble flooring and smooth bathroom floors. Further research is necessary to advance our awareness regarding fall hazards within and outside the houses to develop low-cost strategies for modification of households and to work out guidelines for construction of safe and friendly houses and buildings for older persons.

Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

Funding Statement: The author(s) disclosed receipt of the following financial support for the

research, authorship, and/or publication of this article: This research was partially supported by the Fogarty International Centre, National Institutes of Health, awarded to the first author (D43TW008332; Asian Collaboration for Excellence in Non-communicable Diseases [ASCEND] research network). The contents of this publication are solely the responsibility of the authors and do not necessarily represent the official views of the National Institutes of Health and ASCEND Research Network.

Acknowledgments: Authors are thankful to Fogarty International Centre, National Institutes of Health for the funding and Dr Uma V Shankar for her contributions in preparing this article.

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