Ergonomic Evaluation of Residences (External Areas and Living Room) of the Elderly

Mrs. Roopa Rao
Assistant Professor, Department of Community Resource Management, College of Home Science, Nirmala Niketan, (Affiliated to University of Mumbai),
Mumbai; Maharashtra – 400020, India.
Email – rooparao72@gmail.com

Abstract: *Population aging is a global phenomenon. Living with an elderly person at home is a delicate phase in any family's life because majority of the elderly need assistance to accomplish Activities of Daily Living. Consequently, it is at home, where most falls/accidents occur. In order to increase the quality of life of the elderly - safety, comfort, physical and social health, the physical environment must be free of hazards. Home modifications must take into consideration the capabilities and limitations of the elderly. It is strongly believed that most accidents can be avoided with inexpensive measures.*

The objectives of the study is to: (i) determine the incidence of falls and accidents among the home living elderly, (ii) ergonomically evaluate the (external areas and the living room) existing residences of the home living elderly to identify potential safety hazards that lead to falls /accidents (iii) suggest economical & affordable changes/modifications in these areas of their home.

The data was collected from 90 participants (aged 60 years and above). Convenient (willingness to participate) and purposive sampling method was employed. The participant's background information was obtained through a self-constructed questionnaire. In addition, a survey of their residential space was conducted to observe the design modifications and suitability of interior (bathrooms, toilets and bedrooms) and exterior (corridors, ramps, handrails) facilities. The checklist HSSAT V.4.0, was used to assess the residential spaces ergonomically.

Results indicate that 31% had a fall/slip due to the physical environment in the last one year. Bathroom was identified as the most unsafe area in the home. 95.5% of the elderly could identify the unsafe areas/corners in their homes but were confident that their homes were accident free. Most common hazards are poor illumination, level changes in flooring and slippery flooring.

Key Words: *Design, Elderly, Ergonomics, Home Modifications, Safety, Sustainability.*

"To care for those who once cared for us is one of the highest honours."
— Tia Walker, The Inspired Caregiver: Finding Joy While Caring for Those You Love

1. INTRODUCTION:

Population ageing is becoming a major concern for policy makers too, during the last two decades. The increase in life expectancy has resulted in a major shift in the age group of 80 years and over, known as the 'oldest old'. According to the report titled "Situation Analysis of the Elderly in India" (2011) by The Central Statistics Office, Government of India, both the share and size of elderly population is increasing over time. From 5.6% in 1961, it is projected to rise to 12.4% of the population by the year 2026. For a developing country like India, this may pose mounting pressures on various socio-economic fronts including pension outlays, health care expenditures, fiscal discipline, savings level etc.

In India if we divide the total population into three major age-groups, i.e. age in years 0 - 14; 15 – 59 and 60 and above, it is a clear picture that during the last few decades the number of children (age 0 -14) is decreasing from 37.6% in 1991 and is projected to be about 25% by 2021. On the other hand, the proportion of population in the working age-group (15 – 59 years) and the aged/elderly (60 years and above) both are rapidly increasing. The improvement in life expectancy and decline in age-specific death rate among the elderly are chiefly due to the improvements in public health and medical advances in the prevention of many fatal infectious diseases.

Traditionally, older adults are taken care of by their families. A caregiving crisis is predicted owing to changing gender roles, employment of women, erosion of traditional family values, and an increasing trend for nuclear families. The number of older adults living alone is increasing. With decreased family support and informal caregivers, older adults in India care for themselves (http://ajgg.org/AJGG/V9N1/2013-164-RA.pdf accessed on 14.12.17). The WHO (World Health Organization) proposes 'active ageing', which aims to extend healthy life expectancy and quality of life for all people as they age, including those who are frail, disabled, and in need of care. It emphasizes on promoting an active lifestyle, which saves substantial health care–related expenditure. (According to

the WHO Global report on Falls Prevention in Older Age http://www.who.int/ageing/Publications/Falls_prevention7March.pdf accessed on 25.12.17).

The traditional Indian society and the age-old joint family system have been instrumental in safeguarding the social and economic security of the elderly people. However, with rapid changes in society and the emergence of nuclear families in India in recent years, the elderly is likely to be exposed to emotional, physical and financial insecurity in the years to come.

A few problems faced by the Indian elderly are: Economic Insecurity (World Bank 2001; Uppal and Sarma 2007), Isolation and Neglect, Lack of Preparedness for Old Age (http://www.helpageindiaprogramme.org/Elderly%20Issues/problems_of_the_elderly/index.html accessed on 17.12.17), Living Arrangement and Social Security (http://www.prb.org/Publications/Articles/2012/india-older-population.aspx accessed on 26.10.16) and most important of all Failing Health (http://www.helpageindiaprogramme.org/Elderly%20Issues/problems_of_the_elderly/index.html accessed on 02.10. 17).

Falls/Accidents among the Elderly: Falls is a major cause of injuries associated with old age. In a Multi-centric Community Study, evaluating Health Problems in the Elderly (2003), in 10 states across India, covering a total population of 10,200 elderly with equal rural and urban distribution, the incidence of falls (History of a single fall in the last 6 months) was found to be 14% (http://www.who.int/ageing/projects/SEARO.pdf accessed on 10.09.16).
Falls and fall related injuries are among the most serious and common medical problems experienced by older adults. Nearly one-third of older persons fall each year, and half of them fall more than once. (http://www.who.int/ageing/publications/Falls_prevention7March.pdf accessed on 10.09.16). Higher disability and psychological distress, was noted among those with a prior history of fall after 60 years of age and those with a history of three or more falls.

Falls occur as a result of a complex interaction of risk factors. The main risk factors reflect the multitude of health determinants that directly or indirectly affect well-being. These risk factors are categorized into four dimensions: Biological, Behavioural, Socioeconomic and Environmental factors.

Ergonomics: Ergonomics is the science and practice of designing the workplace, equipment, machines and environments keeping in mind the capabilities and limitations of the human users. The goal is to design jobs and tasks to remove incompatibilities between the work and the worker that hinder safe work performance. This allows person to prevent injuries, illnesses, and mistakes *and* improve overall worker health and business performance. The inclusion of ergonomics dedicated to safety may seem unusual, but there are a variety of issues that can crop up if seniors are living in a place that is not as accommodating to their particular condition. For instance, if an elderly resident has to overexert his or herself for simple tasks like reaching for dishes or doing laundry, it could lead to falls, pulled muscles or torn ligaments. According to the NSC (National Safety Council), overexertion is the third-leading cause of unintentional injuries in the India.

Home Modifications: Home modifications are changes made to adapt living spaces to meet the needs of people with physical limitations so that they can continue to live independently and safely. These modifications may include adding assistive devices/technology or making structural changes to a home so that the elderly can independently perform ADL (Activities of Daily Living). The main benefit of making home modifications is that they promote independence and prevent accidents. Most Indians want to age in their homes (Aging-in-place), but most homes are not designed to accommodate the needs of people over age 65 years. Most of them live in homes that are more than 20 years old. As these buildings get older along with their residents, they may become harder to live in or maintain. A good home modification plan should have inclusive design (universal design) features, use assistive technology and improve accessibility and adaptability.

Justification for the study: Although India will be the youngest country in the world by 2020 with an average age of 29 years, the number of elderly people is likely to increase significantly. According to the 2014 "State of Elderly in India" report released by a non-profit organization, there will be 143 million elders in our country by 2021. Presently, the elderly in divided into three categories: the young old (60 – 70 years), the middle-aged old (70 – 80 years) and the oldest old (80 plus years). While the overall population of India will grow by 40% between 2006 and 2050, the population of those aged 60 and above will increase by 270%. Out of this, the oldest old segment, which is the most vulnerable on account of suffering from disabilities, diseases, terminal illness and dementia, is also the largest growing segment of the elderly population, at a rate of 500%. (http://www.livemint.com/Politics/z6BacVOwf5SvmpD9P1BcaK/20-of-population-to-be-elderly-by-2050-HelpAge-India-repor.html accessed on 04.10.17).

It is our responsibility to create a society where people are not worried about getting old. In order to increase the quality of old people lives, safety, comfort and physical and social health, must be taken care of. It is thus

important that the home they live in has a safe, comfortable and healthy living environment as long as possible. This study was conducted to provide practical solutions to help the home-living elderly live well at home and safeguard their health and independence.

2. AIMS AND OBJECTIVES:

The overall aim of this study is to assess the home safety measures and practices adopted by individual families in Mumbai city and its suburbs and to plan/create/design a safe, accident free home environment for the elderly. The specific objectives are to:

i. determine the incidence of falls and accidents among the home living elderly
ii. ergonomically evaluate the (external areas and the living room) existing residences of the home living elderly to identify potential safety hazards that lead to falls /accidents
iii. suggest economical & affordable changes/modifications in these areas of their home.

3. METHODOLOGY:

A descriptive study was conducted to assess the residences of the home-living elderly aged 65 years and above. The study was conducted on ninety residences of the home-living elderly in Mumbai city and its suburbs to understand the current condition of the elderly due to improper design at home. Based on the knowledge of the population and the purpose of the study, purposive (willingness to participate) and convenient sampling technique was employed.

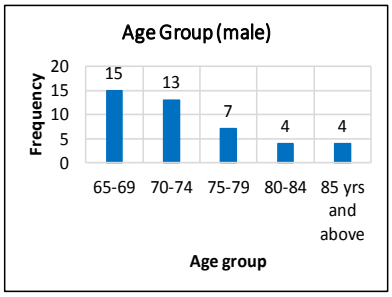
The participant's background information was obtained through a self-constructed questionnaire. Structured and open-ended interview method was used during home visits without affecting the self-esteem or emotional status of the elderly. Observation was also used as a tool to identify accident-prone areas in their residences. Certain questions were asked to the elderly in order to know the areas that the elderly perceived are the most dangerous in the house and what preventive measures could be taken. In addition, a survey of their residential space was conducted to observe the design modifications and suitability of interior (bathrooms, toilets and bedrooms) and exterior (corridors, ramps, handrails) facilities. The checklist HSSAT V.4.0, was used to assess the residential spaces ergonomically.

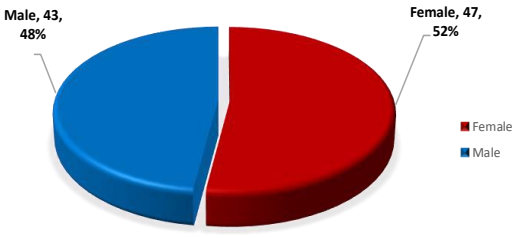
Descriptive Statistics of Mean, Standard Deviation, Percentages and Frequencies were calculated for all variables using MS Excel.

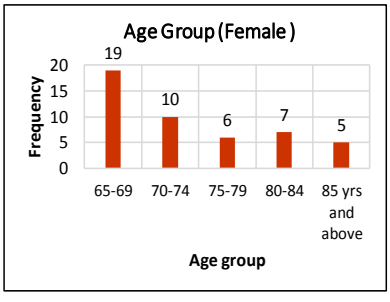
4. RESULTS AND DISCUSSIONS:

Of the ninety elderly participants, 43 (48%) were males and 47 (52%) females (Fig 1). Extreme care was taken to not hurt their sentiments or bring back painful memories if any. 57 (63.3%) were the Young – Old in the age group of 65 to 74 years; 24 (26.6%) were the Old in the age bracket of 75 to 84 years and 9 (10%) respondents were the Oldest – Old. The average age of the sample is 73.43 years.

Fig 1: Profile of the Sample





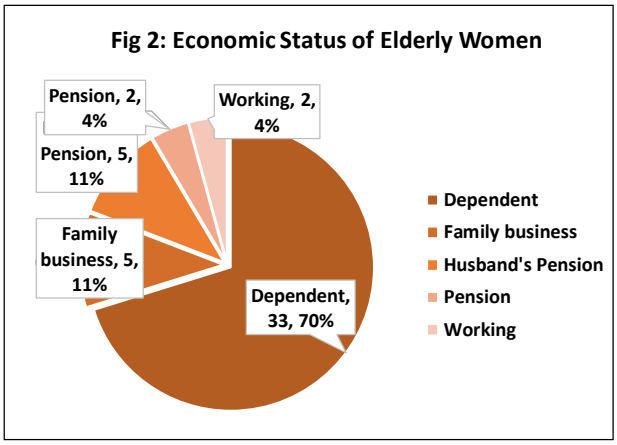


Marital Status	65–69 years f (%)	70 -74 years f (%)	75-79 years f (%)	80–84 years f (%)	> 85 years f (%)	Total f (%)
Divorced	01 (2.3)	01 (2.3)	00 (0)	00 (0)	00 (0)	02 (4.7)
Married	13 (30.2)	10 (23.3)	05 (11.6)	02 (4.7)	02 (4.7)	32 (74.4)
Single	02 (4.7)	01 (2.3)	00(0)	01 (2.3)	00 (0)	04 (9.3)
Widow	00 (0)	02 (4.7)	01 (2.3)	02 (4.7)	02 (4.7)	07 (16.3)
Total	15 (34.5)	13 (30.2)	07 (16.3)	04 (9.3)	04 (9.3)	43 (100)

Marital Status	65–69 years f (%)	70 -74 years f (%)	75-79 years f (%)	80–84 years f (%)	> 85 years f (%)	Total f (%)
Divorced	00 (0)	00 (0)	00 (0)	00 (0)	00 (0)	00 (0)
Married	11 (23.4)	09 (19.1)	01 (2.1)	06 (19.1)	03 (6.4)	30 (63.8)
Single	01 (2.1)	00 (0)	01 (2.1)	00 (0)	00 (0)	02 (4.3)
Widow	07 (14.9)	01 (2.1)	04 (8.5)	01 (2.1)	02 (4.3)	15 31.9)
Total	19 (40.4)	10 (27.3)	06 (12.8)	07 (14.9)	05 (10.6)	47 (100)

The percentage of elderly women married [30 (63.8%)] was lower than the percentage of men married [32 (74.4%)] and 15 (31.9%) women were widowed as against [7 (16.3%)] men who lost their spouses (Fig 1). This may be due to the prevalent practice of men getting married to women of relatively much lower age-groups, especially in the good old days. 45 (50%) of elderly live with either their children or with their children and grandchildren, this shows that the family structure is still strong in these households. 26 (28.9%) of elderly live with their spouse. The depressing fact is that 17 (18.9%) live alone. Of these 2 (2.2%) were very frail and feared that no one would notice them if they died, coz they had practically no visitors. About 25% [(11 (25.6%)] of the elderly men and about 30% [14, (29.7%)] of the women live with their children. More than 35% of the elderly men live with their spouse as compared to 25% of elderly women, which again reflect the differences in their marital status.

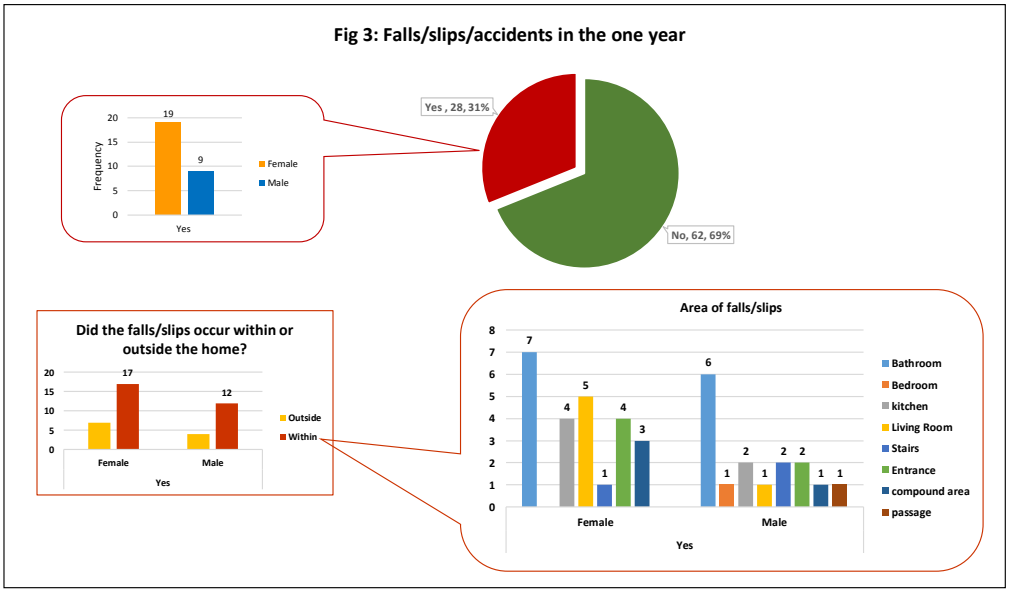
The economic independence reveals the problem of day-to-day maintenance of livelihood of the elderly. The distressing fact here is the high proportion of elderly females and males were totally dependent on their family members About 43 (47.8%) of the elderly had to depend on others for their day-to-day maintenance. Less than 30% [14 (29.8%)] elderly women but majority [33 (76.7%)] of elderly men were economically independent.



As a large proportion of the elderly women 25 (53.2%) were found (Fig 2) to be economically dependent on their children/family members. 2 (4%) women continued their job despite difficulty faced in travelling to and from workplace because they had no other option. 5 (11%) said they barely managed to survive and buy the basics with their husband's pension amount. Among the economically dependent elderly men, 2 (4%) were supported by their spouses, who were still in the working people bracket.

While assessing a person's health condition is important to take into consideration the perception of the individual about his/her health. A person may be considered to be in good health is he/she feels so. The study sought information on the state of physical health of the elderly as to whether they are mobile or confined to home or confined to bed only. 92.2% of the (sample population) elderly were mobile and enjoyed evening walks and a chat with building/colony friends. More than 50% [46 (51.1%)] of the respondents self-rated their health as being fair and 31 (33.8%) rated themselves as having excellent or very good health. 15 (16.7%) had no medical concerns, whereas the remaining respondents mentioned about taking medication for either or and BP (high/low), diabetes, problem of joints, fatigue/tiredness, breathlessness, respiratory problems or arthritis.

28 (31%) respondents had a fall/near fall, slips or trips in the last one year (Fig 3). When asked the reason for the accident, they stated negligence of their part, poor lighting etc.



The bathroom was identified by the elderly as the most unsafe room, with multiple hazards. The elderly women felt that the living room (Fig 3) because of the furniture and clutter was the next unsafe room in their residences. All respondents were aware that falls, slips, trips are the most common accidents (Fig 6.6) in old age. 39 (43.3%) stated that the incident occurred due to slippery flooring, 17 (18.9%) said that if there was something to catch or hold on to (such as a grab bar) the incident wouldn't have occurred. The elderly respondents were able to identify instantly at least one modification they could make to prevent such accidents.

Although many of the elderly recognized what could be done to prevent falls/slips/trips in general terms, they had not made these recommended changes to make their homes safer. It was often indicated that they would plan eliminating the hazards in the future when they needed to make them. 86 (95.5%) of the older people in this study did not think their homes were unsafe. They rated their homes as being very safe, fairly safe and safe, although they were found to quite hazardous during the home visits and observation.

Safety hazards that lead to falls /accidents among the home living elderly

The safety check for accident prone areas in the homes of the elderly was conducted through home visits. Ergonomic Assessment of environment/physical hazards in each room or area of older people's homes (including outside areas) was conducted using the modified checklist (adapted from the HSSAT V 4.0.)

The checklist focused on identifying physical hazards in the home environment in common areas, furniture arrangement or incidents associated with falls (or the prevention of falls) in older people. The checklist consists of potential hazards which may increase the risk of falling, slipping or tripping (e.g. scatter rugs on slippery surfaces, inadequate lighting) and the absence of safety devices which may prevent such incidents (e.g. grab rails in the bathroom and toilet, and night lights). Criteria and instructions for deciding if the article/layout/arrangement was hazardous was predetermined for each item being assessed. A thorough inspection of each part of the elder person's house was completed. A decision was made about each item and a 'hazard' scored if a potential hazard was present or safety device absent. If a hazard item area was not there to be assessed (e.g. no stairs outside, no dining room) then the hazard items were scored as 'not applicable. The modified HSSAT V.4.0 checklist divided the areas in the home into 5 areas: External areas, Entrances/Hall, Kitchen, Private areas, Bath and Toilet. Findings of the external areas and entrances/hall are only discussed in this paper.

Fig 4: Rickety/ shaky Wooden stairs

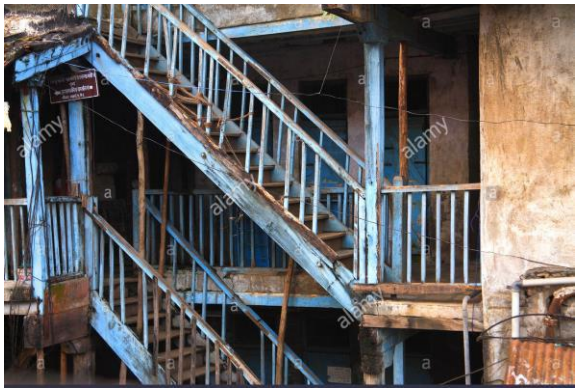
External Areas: External areas are those areas that are outside the residence and which are mostly neglected and not taken into consideration. There are high chances of falls/slips due to an obstacle or poor maintenance. Summary of the observations made during investigation of the external areas are reported in Table 1:

The entrance foyer in most Mumbai buildings/colonies are aesthetically decorated. This was seen in more than 90% (82, 91.1%) homes of the elderly. The entrance areas of almost all buildings were well-lit and had bright white light for safety as well as security. 8 (8.9%) felt that if the society authorities should switch on the lights early in the evening especially during monsoons and winters.

Table 1: Home Safety Audit (External Areas)

	Details	Female (n = 47)		Male (n = 43)		Total (n = 90)	
		Yes	No	Yes	No	Yes	No
1.	All entrances have outdoor lights	44 (93.5%)	3 (6.4%)	38 (88.3%)	5 (11.6%)	82 (91.1%)	8 (8.9%)
2.	Walkaways to the door/entrance of building is clear of debris, cracks & potholes	8 (17%)	39 (83%)	8 (18.6%)	35 (81.4%)	16 (17.9%)	64 (71.1%)
3.	Building's main entrance has a ramp	33 (70.2%)	14 (29.8%)	29 (67.4%)	14 (39.5%)	62 (68.9)	28 (31.1%)
4.	Outdoor steps, ramps have s non-skid surface	15 (32%)	32 (68.1%)	16 (37.2%)	27 (62.8%)	31 (34.4%)	59 (65.6%)
5.	Outdoor stairs is in good repair/free from cracks, holes etc.	46 (97.9%)	1 (2.1%)	41 (95.3%)	2 (4.7%)	87 (96.7%)	3 (3.3%)
6.	There is bright lighting for safety as well as security	43 (91.5%)	4 (8.5%)	40 (93%)	3 (7%)	83 (92.2%)	7 (7.8%)
7.	Front door has a peephole in good condition	13 (27.7%)	34 (72.3%)	14 (39.6%)	29 (67.4%)	27 (30%)	63 (70%)
8.	Threshold between internal and external area is on the same level	12 (25.5%)	35 (74.5%)	15 (34.9%)	28 (65.1%)	27 (30%)	63 (70%)
9.	Threshold is clearly identified by using visual clues	13 (27.7%)	34 (72.3%)	14 (39.6%)	29 (67.4%)	27 (30%)	63 (70%)

Fig 5: Shaky/Rickety stairs



Using stairs to reach upper levels of house becomes tough. It is not just the problems during climbing stairs, there are also numerous cases of falls which happen on stairs. 64 (71.1%) complained about debris or other such obstacles in their pathways. Some even mentioned about uneven surface/flooring which was a hurdle mainly because they missed a step.

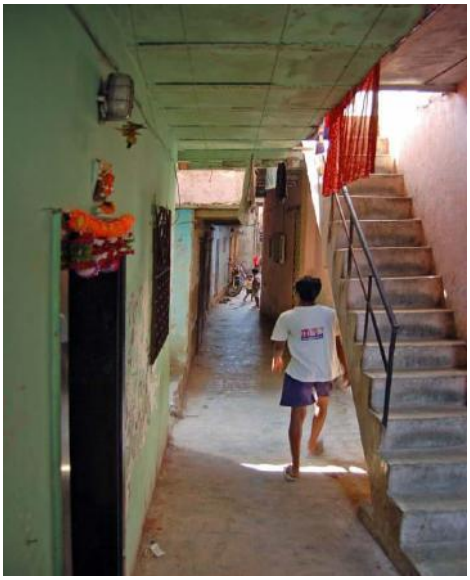
About 23% said that the outdoor stairs have non-skid flooring however some stairs were made of white marble which tend to be very slippery especially during the monsoons. The risk of fall and accidents is thus very high in these stairs.

There was a provision of ramp in few buildings, but they were steep due to which the elders said they feared using it. The ramps were built in concrete mainly and did have a rough surface, however due to constant wear and tear, most of them had a smooth surface, which made it a high-risk area for accidents/falls.

Few observations during home visits:

- The wooden steps in some buildings are not stable and were shaking/rickety (Fig 4 and Fig 5).
- The riser of the stair is either too high or too low. Very few buildings had appropriate riser height.
- The tread width of a few stairs is very wide, requiring a full body forward push while using them.
- The riser (stair height) was found to be high and the tread smaller, which made it difficult to place the foot properly while using the stairs.
- The nosing of the stairs is smooth and round due to constant wear and tear.
- There were obstacles/clutter in the stairs making it difficult to use.
- Absence of handrails (Fib 6) in most residences. Some did have a railing, but it was built for support and security.

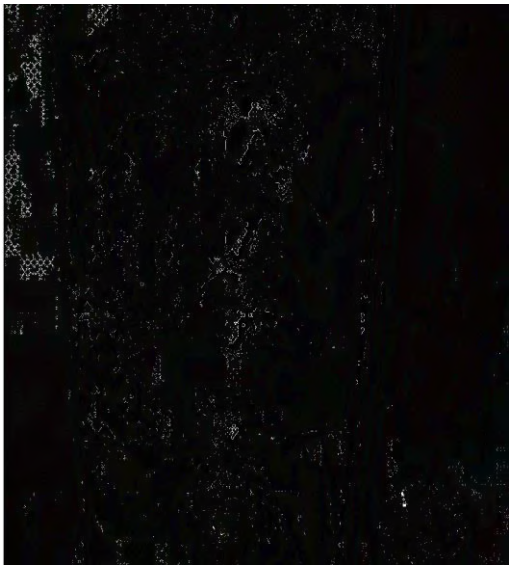
Fig 6: Absence of handrails



Due to the risk of accidents and falls most elderly are scared to venture out of their residence complex alone, which restricts their mobility to a large extent.

Some elderly faced problems in operating the elevator buttons. They were either too difficult to reach (especially the upper floor buttons) or were difficult to operate (difficult to press the buttons, numbers not visible, etc.). Many elders feared using the elevators alone. It is recommended that the emergency buttons must be easily distinguished, this may be done by either a colour code or a pictorial instruction. In most elevators, the emergency buttons were not within the reach of the elderly residents. The knobs/buttons too were observed to be inappropriate for the elderly to operate.

Fig 7: Numbers of Elevator buttons not visible



52 (57.8%) did not have elevators in their buildings, making it difficult for them to plan outings independently. Stairs are not recommended at this age due to some functional limitations. Also, some old buildings had lifts with collapsible doors. These are difficult to operate as well as a safety hazard.

Entrances/Halls: The entry to the home is a connection to the rest of the world. It is important for receiving guests, for bringing in the groceries, for getting to appointments and for getting out to social events. It should be safe and convenient at all times and on all days, no matter what the weather is. Barrier-free entryways make it easier for the elderly to gain access to their home. The entrance of residences should be wide, without steps and without level differences. It should be easy to locate and must facilitate movement. Entryways leading into the home and into other rooms should not be divided by a threshold, because this is a common tripping hazard.

63 (70%) responded (Fig 8) that the external and internal areas are separated by a threshold. They also mentioned that the internal area and the threshold were of the same colour and material (white marble in most homes), making it difficult for them to identify the threshold at the correct moment. Level differences in residences is a tripping hazard. Two residences were modified and the threshold leveled but only after an accident. Many elders reported that they used walkers and walking stick, mainly for mental support rather than physical support.

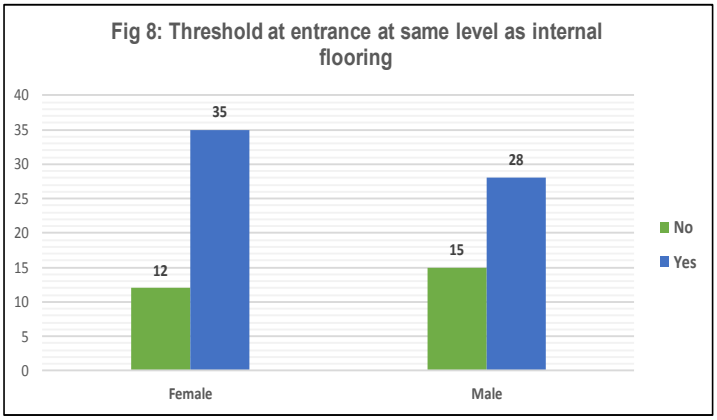


Table 2: Home Safety Audit (Entrances/Hall)

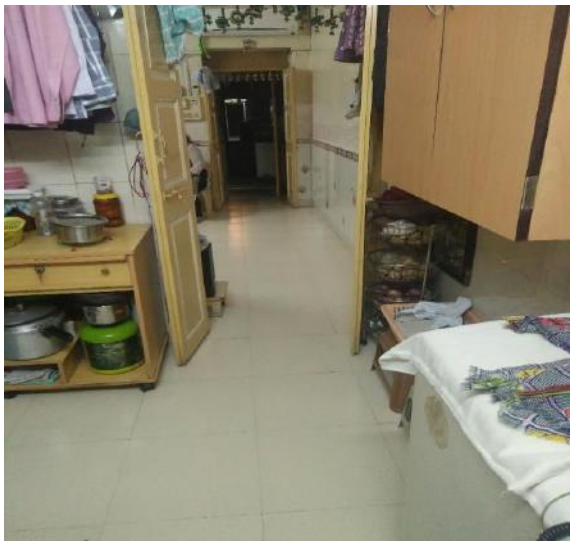
Details		Female (n = 47)		Male (n = 43)		Total (n = 90)	
		Yes	No	Yes	No	Yes	No
1.	Doors (with release mechanism) close slowly	14 (29.8%)	23 (48.9%)	14 (32.6%)	29 (67.4%)	28 (31.1%)	52 (57.9%)
2.	All doorways are wide	36 (76.6%)	11 (23.4%)	31 (72.1%)	12 (27.9%)	67 (74.4%)	23 (25.6%)
3.	Full length glass panels/doors are avoided or are clearly marked for visibility	6 (12.7%)	41 (87.2%%)	16 (37.2%)	14 (32.6%)	22 (24.4%)	68 (75.6%)
4.	Doors are in contrast colour to walls and floors	4 (8.5%)	43 (91.5%)	9 (21%)	34 (79%)	13 (14.4%)	77 (85.6%)
5.	Floor is free of clutter and hazards such as cords and loose rugs, toys, low furniture etc.	8 (17%)	39 (83%)	9 (21%)	34 (79%)	17 (18.9%)	73 (81.1%)
6.	Windows are easy to open/close	2 (4.3%)	45 (95.6%)	1 (2.3%)	42 (97.7%)	3 (3.3%)	87 (96.7%)
7.	Flooring is in good condition (even, matt finish, non-slip and clutter free)	4 (8.5%)	43 (91.5%)	6 (14%)	37 (86%)	10 (11.1%)	80 (88.9%)
8.	Blind corners are avoided	11 (23.4%)	36 (76.6%)	12 (27.9%)	31 (72.1%)	23 (25.6%)	67 (74.4%)
9.	Lighting in all areas is consistent so the elderly are not moving from darker to lighter areas	4 (8.5%)	43 (91.5%)	12 (27.9%)	31 (72.1%)	16 (17.8%)	74 (82.2%)
10.	Easy access to a telephone	14 (29.8%)	33 (70.2%)	3 (7%)	40 (93%)	17 (18.9%)	73 (81.1%)

Few other observations during home visits are reported in Table 2:

- According to the results of the study conducted, 67 (74%) homes have wide doorways. Doors are an important part of access, and hence must be appropriately placed and designed. A hinged door is generally quiet to operate and closes easily providing good sound and light proofing.
  - In many homes the doorways were blocked/narrowed due to clutter or poor furniture arrangement.
  - Too many objects, materials kept were hanging behind the door (Fig 9) due to which the door could not be pushed back, narrowing the width of doorway. Moreover, the door would close repeatedly posing to be hazard.

- None of the homes had automatic door closers. Automatic door closers can be convenient if installed correctly in an appropriate location. For a door closer to help the elderly and not be a barrier, it must allow the door to swing open without requiring too much pushing force.
- 77 (85.6%) homes had the same colour for walls and flooring. It is always recommended due to functional limitations, that doors must be of a contrasting colour as that of the walls and floors.
- In more than 80% homes, the floor is not free of clutter. There were hazard such as cords, loose rugs/carpets, doormats, toys, etc.
    - Statistics show that 65% of the elderly had falls in the living room/hall due to clutter.
- Carpet/rugs edges in the hallway were rolled at the edges and hence a high risk for the elderly.
- Wires/cords from lamps, television, music system was lying across the traffic path is some homes.

Fig 9: Clutter behind the doors

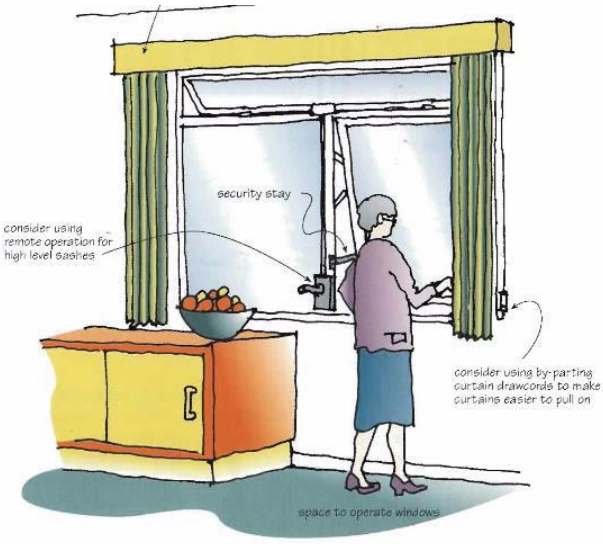


Windows should be designed to suit the aesthetic and functional requirements of a space. They must maximize natural light intensity at floor level while minimizing glare. Windows will be most useful if they are easy to open and close and are at a height that suits especially the elders. Low window sills (at 90mm height from floor level) provide a view for a seated person. The window opening and closing mechanism should be easily grip and operated using one hand. Standing adults can reach window locks and operating mechanisms up to 1400mm above floor level.

Lightweight net curtains, adjustable blinds, reflective or tinted glass and applied tinted films increase privacy without destroying the view.

- Most homes had double hung casement windows and few others had sliding windows.
- 87 (96.7%) mentioned that the windows were not easy to open/operate. The elderly women especially stated that cleaning and maintenance of windows was a problem.
    - Sliding windows were easier to operate but very difficult to clean.

Fig 10: Design of Windows



Increasing illumination levels is very vital to ensure independence for the elderly. Light cannot correct deteriorating eyesight, but it can help to compensate, restoring self-confidence. Proper illumination helps avoid visual missteps and prevent falls.

- Only 16 (17.8%) homes of the elderly were well illuminated. Shadow due to incorrect lighting was not evident in these homes.
- In 74 (82.2%) homes the illumination levels were not adequate. The placement of the source of artificial light (tube lights and incandescent bulbs) were the main reason for shadows and uneven illumination levels.

User friendly home design should be both aesthetically pleasing and functional. To achieve this the spaces inside the house, need to be easy to move around. 80 (88.9%) elderly responded that the flooring in the living room is aesthetically pleasing but is slippery especially during the monsoons. Ceramic tiles were found in most homes. Tiled flooring contains multiple joints between each tile and when new forms a seamless finish. But with constant wear and tear and in heavy traffic areas it was found that the tiles had chipped off and thus a hazard for the elderly. Moreover, these tiles can be very slippery especially when wet.

Almost all homes had loose rugs and mats at the entrance doorway, in front of the bathroom and toilet doors and some even had small doormats in the kitchen. Such loose rugs and mats can create a trip hazard and must be avoided altogether. A loose mat or rug must be fixed with a backing so as to ensure that it stays flat and in place.

5. Recommendations based on the results of the study:

Table 3: Suggestions for modifications in the homes (External areas and Living room)

Problems observed in the homes of the elderly	Suggestions for improvement
Lighting	– Brighter staircase lighting – Large rocker light switches that turn on/off with a push – General lighting from a steady source – Placement of task lighting in appropriate work areas
Clear walkways	– Accessible path of travel to the home – Walkways must be in good repair for safe walking – Doorbell in accessible location – Surface to place packages on when opening door
Stairs	– Should be well lit at all times. – Should have a landing at the top as the bottom for the user to steady themselves before changing directions – Handrails on both sides of staircases and outside steps. – Increased visibility by adding contrast strip on top and bottom stairs, colour contrast between treads and risers on stairs and use of lighting. – Should have no doors that obstruct the top or bottom landing
Ramps and Walkways	– Should be well lit at all times. – Should have a horizontal landing at the top as the bottom providing the user an opportunity to rest or steady themselves before changing directions – Handrails on both sides. Double handrail, preferably, with the lower handrail suited to people of short stature. – Exterior ramps must not exceed a slide of 1" mount for every 100" because many wheelchair-bound individuals, cannot lift themselves to a higher incline. – Exterior concrete ramps must have broom-finish. Ensure that broom strokes lie perpendicular to the ramp slope. – Ramps can be built to doorway, if needed. A portable ramp can also help in certain situations.
Threshold	– Flush it preferably with exterior and interior flooring level.
Grab bars	– Bracing in walls around tub, shower, shower seat, and toilet for installation of grab bars to support 90 – 100 kgs – Grab bars should have graspable size and must be slip resistant
Elevators	– Adequate hand rails on all three sides of the elevator.
Doorways and Doors	– House number should be clearly visible from far – Doorbell must be in accessible location – Surface to place packages/bags when opening door – All exterior doors must have secure, easy-to-use locks, bolts and knobs. – Door should open into the house (inward opening) to avoid accidents. – A fish-eye lens viewer/peephole should be installed at an appropriate height. – Door closers can be convenient if installed in an appropriate location. – The 'D – pull' handle is the most appropriate. Door knobs are difficult to grip and turn.
Floor and Flooring	Arrange furniture so that there is a clear pathway between rooms (is plenty of space to move around). – Remove items (boxes, old articles, old furniture etc.) from stairs, hallways, and pathways. – Keep low-rise side tables, magazine racks, footstools, plants etc. out of the path of traffic. – No steps between rooms/areas on the same level – No changes in surface levels as far as possible – Non-slip flooring in foyer, entrance – Smooth, non-glare, slip-resistant flooring in bathroom and shower – Colour/texture contrast to indicate change in areas – Do not store boxes near doorways or in passage. – Remove newspapers and all clutter from pathways.
Windows	– Plenty of windows for natural light – Low windows or taller windows with low sill height – Window curtains/blinds/shades/cords are easy to reach and open/close
Electrical, Safety and Security	– Security light at main entrance door – Rocker or touch light switches – Light switches must be located near entrance to every room/area. – Keep electric, appliance and telephone cords out of walkways, but do not put cords under a rug. – Do not use extension cords across pathways – Electrical cords/wires should be out of the flow of traffic – Security alarm, emergency alert system and/or video-monitoring system.
Reach	– Cabinets/shelves must be easy to reach; knobs/pulls easy to use to open/close. – Pull-down shelving – Glass-front cabinet doors – Open shelving for easy access to frequently used items

6. CONCLUSION:

Most falls among the elderly occur in known rather than in unknown areas. The results of this study prove strongly that falls among the elderly can be prevented. A fall often results from multiple factors, one of the main factor being hazards in the home. Homes can be modified for the elderly taking into consideration their physical and cognitive strengths, capabilities and limitations and their anthropometric measurements.

Aging increases postural instability, thus a simple economic solution is to consider installation of support bars or grab rails. Ensuring that circulation path is free of clutter and furniture is another simple change that can be made immediately. Another suggestion is to place the most used objects in areas where old people can see and reach easily.

After identifying the potential risks, an ergonomic approach was used to suggest simple changes in the existing layout/arrangement in the homes. Many a times, the older adults themselves had practical solutions to the problem being discussed. Involving them in making the modifications helps understand their capabilities and limitations. Improving awareness of older adults, caregivers and family members is also important to their safety.

Designers and Architects working in the housing industry must deliver creative and innovative solutions to meet the everyday needs on the ageing population. Smart homes are homes equipped with technology such as lighting, kitchen safety, door switches, movement sensors, individual tracking badges, reminder systems etc., that promotes independence, ensures safety, security and increases the quality of life. Installation of smart home technology might be a stigma to some elderly leading them to think themselves as older and frailer than other adults, but if accepted well, it can be an enormous boon to their comfort and safety.

One limitation of the study was the convenient sampling method adopted. Participants were urban elderly predominantly from the modern Indian population and culture. The study findings cannot be generalized to rural elderly with common facilities shared among several houses, or other regions and cultures of India. Although the HSSAT Checklist has potential for clinical application, further research is needed to establish and improve its psychometric properties for clinical use. The effectiveness of the assessment and modifications in reducing injury in older adults also needs to be investigated.

Way Forward: The results of the present study reflect the circumstances and consequences of falls among the home living elderly. To avoid such incidence, more emphasis needs to be given to the circumstances leading to falls in houses with inadequate lighting, level changes in the house, uneven floor of the house and slippery floor of the house. Designers, architects, town planners and builders must aim at creating accessible built environments. The built environment should take into consideration the physical and mental capabilities of the people using them.

The Government should take more interest in ensuring quality constructions and safe environments are created. According to the WHO global report on falls prevention in older age, public health policies and strong legislation can effectively decrease falls in older adults (WHO global report on falls prevention in older age http://www.who.int/ageing/publications/Falls_prevention7March.pdf accessed on 5.03.17). Nonetheless, the actual translation of these policies is a problem, especially in health promotion sector in India. Fall prevention must be emphasized in public health policies and health programs for elderly people. Falls are an emerging public health problem and a barrier to active ageing in India. There is an urgent need for coordinated and collaborative efforts of health professionals, researchers, policy makers, and health care delivery systems to prevent falls and promote active ageing.

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