



## Designing Staircase for Age-Friendly Housing

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### Authors' contributions

*This work was carried out in collaboration between both authors. Author RUF has carried out the proposed research work as part of Post Graduate thesis drafted the thesis and performed the statistical analysis. Author TN has designed the research work and monitored the overall research work carried out. Both authors read and approved the final manuscript.*

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### ABSTRACT

**Aim:** The study aimed to design a staircase for age-friendly housing by discovering the gap between existing staircase design and requirements of the elderly people.

**Sample:** Sixty elderly women in the age of sixty and above who were living independently in a separate house was the criteria for the selection of sample. Purposive sampling technique was adopted to draw the sample.

**Study Design:** Ex post facto research design was adopted for the study.

**Place and Duration of Study:** The area selected to conduct the study were the Kurnool and Nandyal towns of Kurnool District of Andhra Pradesh. The study was conducted in the year 2019-2020.

**Methodology:** The design recommendations for staircase in elderly housing proposed by various researchers served as yardstick to identify the existing staircase features in the elderly houses. An interview cum observation schedule was developed for gathering information about the existing staircase features in elderly houses. The elderly houses were physically observed by the investigator. The existing staircase features were measured in terms of above the recommendations, exactly as per the recommendations and below the recommendations with scores of 3,2 and 1 respectively. The elderly people were asked to express their requirements for

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staircase design in terms of essential, preferred and neutral with scores of 3,2,1 respectively. Frequencies and percentages were calculated for the existing staircase and requirements of elderly houses. Chi square analysis was performed to find out the relationship between existing staircase features and requirements of the elderly people. Taking into consideration of the elderly people requirements, staircase design was developed.

**Results and Conclusion:** The design of handrails, risers and treads of staircase was not found as per the recommendations in most of the houses. Staircase with wider treads and lower risers were the features felt essential in designing a staircase by most of the elderly people. Staircase that facilitates safety and easy use was designed for the elderly housing as per the recommendations.

*Keywords: Elderly people; design recommendations of staircase; existing staircase features; requirements of elderly; staircase design.*

## 1. INTRODUCTION

Elderly people desire to have adequate housing that enables them to age in place without losing independence and comfort. Staircase present in any place provides access to enter and exit the home while maintaining as much independence and safety as possible to the users [1]. Climbing staircase has been reported as one of the difficult tasks for elderly people in their day to day living. Elderly people are likely to fall when climbing staircases in the home environment that might lead to injuries and physical impairment. In addition, elderly people might also develop fear of falling that may influence their performance while ascending or descending staircases [2]. Staircase design is one of the important features that has to be considered while planning and designing elderly housing. Staircase also plays a crucial role in promoting physical health benefits due to stair climbing as a form of exercise that improves in weight control and cardiovascular fitness [3,4]. Stairs are believed to have a higher potential for increasing light to moderate physical activity [5,6]. Many studies have recommended that the staircase in elderly houses should be designed with proper handrails, treads and riser in such a way that facilitate safety, comfort and usability for elderly and people with disabilities [7,8,9,10,11]. Hence the present study aimed to (i) identify the gap between existing staircase design features and requirements of elderly concerning staircase and (ii) design a staircase with all the requirements that facilitates safety and comfort.

## 2. MATERIALS AND METHODS

Ex post facto research design was followed to conduct the study. The area selected to conduct the study was Kurnool and Nandyal towns that represents the urban scenario of Kurnool District

in the state of Andhra Pradesh. Sixty elderly women in the age of sixty and above who were living independently with or without a spouse were the subjects in this study. Purposive sampling technique was adopted to draw the sample from the selected areas. The design recommendations for staircase in elderly housing proposed by various organizations and authors served as a yardstick for identifying the staircase features in the existing houses [12]. An interview cum observation schedule was developed for gathering information about the existing staircase features and requirements of the elderly people. The existing staircase features were measured in terms of above the recommendations, exactly as per the recommendations and below the recommendations with scores of 3,2 and 1 respectively. The elderly was asked to express their staircase design requirements in terms of essential, preferred and neutral with scores 3,2 and 1 respectively [12]. Frequencies and percentages were calculated for existing staircase features and requirements of elderly. Chi square analysis was performed to find out the relationship between existing staircase features and design requirements of the elderly. The null hypothesis formulated for the study was (i) There exists no significant relationship between existing staircase features and requirements of elderly with reference to staircase design to age in place. Taking into consideration the elderly requirements a staircase design was developed that facilitates safety and comfort.

## 3. RESULTS AND DISCUSSION

### 3.1 Profile of the Respondents

The most popular types of houses found in the study were Independent houses, Independent

double storied houses, Apartments or flats and Duplex type of houses. Majority (83.33%) of the respondents had own houses and only 16.67 percent were staying as tenants. The socio economic status of the respondents was measured using Kuppuswami socio-economic scale [13]. More than 73.33% of the sample were in upper-middle category.

### 3.2 Existing Staircase Features

Twelve standard design recommendations [14,15,16,17,18] proposed by various authors and organizations were identified to assess the design of staircase in elderly housing (Table 1).

Majority (80%) of the stairs had tread width below the recommendations. Eighty-one per cent of the staircase had handrails at proper height. More than half (51.67%) of the staircase were provided with continuous handrails on both sides of the stairs and fifty-eight per cent of handrails were rounded at ends. Forty-three per cent of the staircase had risers at a height as per the recommendations. Majority (98%) of the staircase had no wider or curved treads. All the staircase had non-slip nosings of contrasting color and there was no door opening directly onto the stairs. Majority (88%) of the staircase had risers per flight below the recommendations. More than half (53.33%) of the staircase were designed with wider treads and lower risers.

The width of the tread, ends of handrails, curved treads, minimum depth at landing of stairs, number of risers in a plight were some of the features of a staircase that were not designed as per standards in most of the houses in which the elderly were residing.

### 3.3 Design Requirements in Staircase

The respondents were asked to state their requirements to design staircase that enables the elderly people to use comfortably (Table 2).

Majority (80%) of the elderly felt neutral with reference to the provision of width of stairs as per the recommendations. Seventy-one per cent of the elderly preferred to have staircase with handrails at proper height. Forty-eight per cent of the respondents felt it was essential to provide a staircase with continuous handrails on both sides. Fifty-one per cent felt essential to have

handrails rounded at ends. Forty-one per cent preferred to have risers at a height of 5 to 7 inches. All the respondents felt neutral for staircase with no wider or curved treads and non-slip nosings of contrasting color. The respondents felt neutral to avoid doors opening directly onto the stairs (93%) staircase with 12 risers per flight (88%) in the houses.

Fifty-three per cent of the elderly felt neutral for staircases designed with wider treads and lower risers.

The elderly preferred to have handrails, risers at proper height. The respondents felt it was essential to design steps and staircases with wider treads and lower risers.

### 3.4 Relationship between Existing Staircase Design and Requirements of Elderly

Chi square analysis was done to find out the relationship between existing staircase and requirements of the elderly people (Table 3).

The null hypothesis formulated for the study include  $H_0$ : There exists no significant relationship between existing staircase features and requirements of elderly with reference to staircase design to age in place.

The design recommendations specified for staircase included were width and height of risers, provision of handrails and number of stairs per flight. Forty-three percent of the elderly preferred to have provision of stairs as per the recommendations.

The Chi-square value was found to be highly significant. There is a strong evidence against the null hypothesis. For this reason, there exists a relationship between the design of existing staircase and the requirements of the respondents to age in place with reference to the design of staircase Hence, null hypothesis was rejected.

### 3.5 Designing Staircase

Keeping in view the design requirements of the elderly and proposed standard design recommendations, staircase was designed focusing on provision of handrails, height of

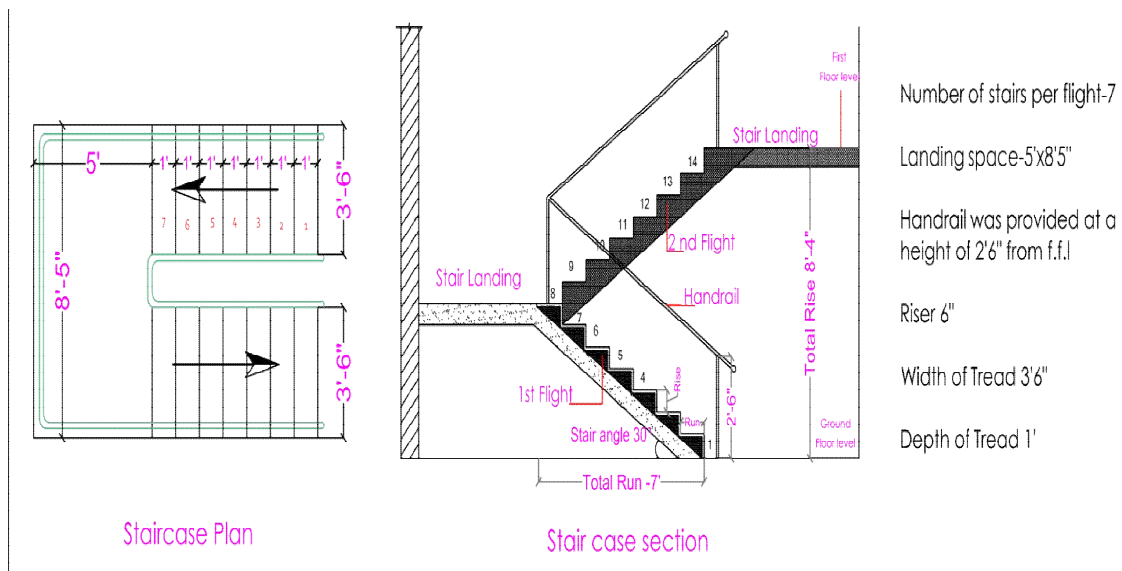
risers, width of treads, stair landing space, proper clearance spaces that facilitates elderly people to climb staircase easily without any trouble (Fig. 1).

**Table 1. Distribution of respondents by existing staircase design features**

S. no	Staircase design recommendations	Status of existing staircase design features against the recommendations						Total	
		Above the recommendations		Exactly as per the recommendations		Below the recommendations		N	%
		N	%	N	%	N	%		
1	The minimum width or tread 3 feet 3 inches to 5 feet	0	0	12	20	48	80	60	100
2	Handrails should extend from 2 to 3 feet on the top and bottom of each flight of steps and ramps	4	6.67	49	81.67	7	11.67	60	100
3	Ends of handrails are rounded.	35	58.33	0	0	25	41.67	60	100
4	Continuous handrails were provided on both side of walls	31	51.67	0	0	29	48.33	60	100
5	Height of risers was 5 inches to 7 inches	26	43.33	29	48.33	5	8.33	60	100
6	Wider or curved treads were never used	0	0	1	1.67	59	98.33	60	100
7	Non-slip nosings were used and this were of contrasting color	0	0	0	0	60	100	60	100
8	No doors should open directly onto the stairs	0	0	0	0	60	100	60	100
9	5 feet of minimum depth at landing of stairs	5	8.33	26	43.33	29	48.33	60	100
10	Number of risers limited to 12	1	1.67	6	10	53	88.33	60	100
11	Steps and staircases were designed with wider treads and lower risers.	32	53.33	0	0	28	46.67	60	100
12	Soffit of the stairs shall be cordoned off either by building a wall in front of it or by putting handrails to guide persons around the space.	18	30	32	53.33	10	16.67	60	100

**Table 2. Distribution of respondents by their requirements in designing staircase**

Staircase requirements of the elderly	Adequacy of staircase requirements						n=60	
	Essential		Preferred		Neutral		Total	
	N	%	N	%	N	%	N	%
The minimum width of tread should be 3 feet 3 inches to 5 feet	0	0	12	20	48	80	60	100
Handrails should extend from 2 to 3 feet on the top and bottom of each flight of steps and ramps	4	6.67	43	71.67	13	21.67	60	100
Ends of handrails should be rounded.	31	51.67	0	0	29	48.33	60	100
Continuous handrails should be provided on both side of walls	29	48.33	0	0	31	51.67	60	100
Height of risers should be 5 inches to 7 inches	23	38.33	25	41.67	12	20	60	100
Wider or curved treads should never used	0	0	0	0	60	100	60	100
Non-slip nosings should be used and should be of a contrasting color	0	0	0	0	60	100	60	100
Avoid doors that open directly onto the stairs	3	5	1	1.67	56	93.33	60	100
Minimum depth required at landing of stairs 5 feet	5	8.33	21	35	34	56.67	60	100
Number of risers shall be limited per flight 12	1	1.67	1	1.67	58	96.67	60	100
Steps and staircases should be designed with wider treads and lower risers.	28	46.67	0	0	32	53.33	60	100
Soffit of the stairs should be cordoned off either by building a wall in front of it or by putting handrails to guide persons around the space.	0	0	0	0	60	100	60	100



**Fig. 1. Floor plan and section drawing of staircase**  
 \*f.f.l - finished floor level

**Table 3. Relationship between existing staircase design and requirements of elderly**

Existing staircase features	Design requirements with reference to staircase					
	Neutral		Preferred		Total	
	N	%	N	%	N	%
Below the recommendations	27	45.00	1	1.67	28	46.67
Exactly as per the recommendations	6	10.00	26	43.33	32	53.33
Total	33	55.00	27	45.00	60	100.00
$\chi^2$ value	36.4069					
Probability value	<.0001*					

Note- \*- significant at 1 per cent level

#### 4. CONCLUSION

The design of staircase was not found as per the recommendations in most of the houses. Staircase with handrails, risers at proper height and wider treads were the features felt essential by most of the elderly people. The findings of the study emphasize the lacking features in existing staircase design in elderly houses. The study mainly focused on the design of staircase that aids the elderly people to overcome difficulties in using staircase. The design of staircase can be adopted while planning staircase for elderly housing as this was developed following the recommendations to design a staircase.

#### CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Pynoos J, Nishita CM. The cost and financing of home modifications in the United States. *Journal of Disability Policy Studies*. 2003;14:68–73.
2. Scott V, Pearce M, Pengelly C. Technical report: Injury resulting from falls among Canadians age 65 and over. On the analysis of data from the Canadian Community Health Survey, Cycle 2.1 as presented in Report on senior' falls in Canada. Ottawa: Public Health Agency of Canada; 2005.
3. Lee KK, Perry AS, Wolf SA, Agarwal R, Rosenblum R, Fischer S, Victoria E G, Richard E W, Silver L D. Promoting Routine Stair Use: Evaluating the Impact of a Stair Prompt Across Buildings. *American Journal of Preventive Medicine*. 2012;42(2):136-141.
4. Lewis A, Eves F. Specific effects of a calorie-based intervention on stair climbing in overweight commuters. *Annals of Behavioral Medicine*. 2001;42(2):257-261.
5. Cohen SM. Examining the effects of a health promotion intervention on the use of stairs. *Journal of Articles in Support of the Null Hypothesis*. 2013;10(1).
6. Mansi I A, Mansi N, Shaker H, Banks D. Stair Design in the United States and Obesity: The Need for a Change. *Southern Medical Journal*. 2009;102(6):610-614.
7. Irvine CH, Snook SH, Sparshatt JH. Stairway Risers and Treads: Acceptable and Preferred Dimensions. *Applied Ergonomics*. 1990;21(3):215-225.
8. Ishihara K, Nagamachi M, Komatsu K, Ishihara S, Ichitsubo M, Mikami F, Osuga Y, Imamura K, Osaki H. Handrails for the Elderly: A Survey of the Need for Handrails and Experiments to Determine the Optimal Size of Staircase Handrails. *Gerontechnology*. 2002;13:178-5-189.
9. Karen K, Edward, S. An evaluation of stairway designs featured in architectural record between 2000 and 2012. *International Journal of Architectural Research*. 2016;10(1):96-112.
10. Mlyasike-deSliva V, Allard F, Mc Ilroy WE. Where do we look when we walk on stairs? Gaze behavior on stairs, Transitions and Handrails. *Experimental Brain Research*. 2011;209(1):73-83.
11. Zietz D, Johannsen L, Hollands M. Stepping characteristics and Centre of

- mass control during stair descent: Effects of age, fall risk and visual factors. *Gait Posture*. 2011;34:279-284.
12. Unesha FR, and Neeraja T. Smart Home for Elderly: Exploring Gap between Existing Home Communication System and Needs of Elderly. *International Journal of Current Microbiology and Applied Sciences*. 2020;9(08):2152-2158.
  13. Saleem SM. Modified Kuppusswamy scale updated for year 2018. *PARIPEX-Indian Journal of Research*. 2018;7(3):435-436.
  14. Central Public Works Department. Guidelines and Space Standards for Barrier Free Built Environment for Disabled and Elderly Persons; 1998. Accessed on 21 July 2020. Available: <https://cpwd.gov.in/Publication/aged&disabled.PDF>
  15. Model Building Bye-laws. Town and Country Planning Organisation, Ministry of Urban Development, Government of India; 2016. Accessed 21 July 2020. Available:<http://mohua.gov.in/upload/uploads/files/files/MBBL.pdf>
  16. Model Guidelines for Development and Regulations of Retirement homes. Ministry of Housing and Urban Affairs, Government of India; 2019. Accessed 21 July 2020. Available:<http://mohua.gov.in/upload/uploads/files/files/Retirement%20Model%20Guidelines%20Book.pdf>
  17. National building code. Requirements for accessibility in built environment for elders and persons with disabilities. Bureau of Indian Standards, New Delhi. 2016;1:49-136. Accessed 21 July 2020. Available:<https://standardsbis.bsbedge.com/>
  18. Parker WR. Housing for the elderly. In J. De Chaira and J. Callender, editors. *Time Saver Standards for Building Types*, 2nd ed. Mc Graw-hill International Editions. 1987;87-101.

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