AN ERGONOMIC APPROACH TO INTERIORS OF BATHROOM AND WATER CLOSETS FOR THE ELDERLY

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CERTIFICATE

This is to certify that the thesis entitled "**AN ERGONOMIC APPROACH TO INTERIORS OF BATHROOM AND WATER CLOSETS FOR THE ELDERLY**" submitted by **Ms. MEGHNA S. KELGERI** for the degree of **MASTER OF HOME SCIENCE** in **FAMILY RESOURCE MANAGEMENT** of College of Community Science, University of Agricultural Sciences, Dharwad is a record of research work carried out by her during the period of her study in this University, under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles.

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1. INTRODUCTION

The old age is an integral part of human life. It is the precious time spent by an individual with and around the environment, where it gives the feeling that one has entered to the childhood again. Elderly or old age consists of ages nearing or surpassing the average life span of human beings. The boundary of old age cannot be defined exactly because it does not have the same meaning in all societies. The 'National Policy on Older Persons' (1999) adopted by Government of India defines 'senior citizen' or 'elderly' as a person who is of age 60 years or above. Although retirement from accustomed work is usually at the age of 60 years, general vitality and interest may continue at the moderate pace for some more years. The first five years may be considered young old, the second five years as old-old and the years thereafter as oldest-old.

The elderly constitutes a rapidly growing proportion of our population. During the last few decades, there has been a tremendous increase in the population of elderly persons in the world and it becomes very essential to gain familiarity in understanding of the ageing related needs of the elderly population (Bhandari, 1999). According to Population Census (2011) there are nearly 104 million elderly persons (aged 60 years or above) in India out of which 53 million are females and 51 million are males. The size of elderly population is increasing over time from 5.6 per cent in 1961 to 8.6 per cent in 2011.

Advancing age is associated with increasing physical frailty, cognitive impairment and economic vulnerability, and requires appropriately supportive environments. Among community dwelling older adults face accidents such as falls, expose to heat, smoke, fire, flames and electric shock in the home, apart from these interior problems they are also susceptible for the health problems because as the age increases the health problems also increases, hence they are not capable of tolerating the pain caused to them. Thus, aging of the population presents a range of challenges to housing providers. It is important to give thought to the housing needs of those in the old age cycle of family life.

Adequate housing is the basic necessity. The ageing of the population presents the range of challenges to the housing providers. It is not just that there will be more old people in coming decades or that will represent significantly higher proportion of the total population, but their needs and aspirations will be different too.

The older one more likely he or she is to spend every movement at home. Taking into account the prolonging of human life, it is certain that the home environment issue will effect more elderly people and its implications nationwide. A home may be divided into number of discreet areas which include bedroom, kitchen, living room, bathroom and others. Each area has special functioning work task and it is thus, necessary to design the functional areas which do not impede the profile of an ageing user. Most of us regard homes as safe place but accidents often occur in and around the homes. The homes need to be designed to promote familiarity and orientation with the environment. An ergonomic approach to interiors of home would improve the relationship between the ageing users and home environment.

Home is the one where we spend our valuable time with family hence the special features with regard to interior should be taken into consideration especially for the elderly people. In the urban areas due to space problems the physical aspects present in housing accommodation may not be in good condition, hence housing may be less comfortable for the aged people. So suitable considerations should be taken while planning keeping the elderly generation in mind. There is a strong relationship between ergonomics, interior and old age people. As the age increases there will be increase in physical, physiological, body pain and psychological health problems. Hence for these health problems they need a proper medication and also a good environment around them. The physical design of housing interior plays a major role in influencing the quality of life of all elderly residents. Sheehan (1992) stated that the physical design of housing interiors plays a major role in influencing the quality of life of all elderly residents. In order to continue the design criteria and recommendation for housing for elderly persons, one must first be aware of the functional needs of the residents. One must consider that ageing is a process, and the functional levels of each individual will generally decrease at different rates. Hence, during in old age the structural facilities of home should be given more importance than the functional facilities, but now a day the functional design is given more importance. Apart from the structural design housing

should fulfill the needs of safety, comfortability and privacy. The utilization of space, positioning of building materials, flooring and number of doors windows and their dimensions should be taken into consideration and should be planned keeping the elderly people in mind. Poor functional design may cause injuries and accidents due to falls. In order to achieve a good interior design, it should be planned carefully.

More considerations must be given to the housing problems of the elderly especially with special reference to bathroom and water closets. We cannot continue to build cities according to the goals set 40-50 years ago. We must have vision and find the solutions for today's problems. The city of tomorrow cannot solve urban housing problems without considering the housing problems of elderly people. Many people who live alone are middle aged or elderly and are logging to be close to other people. The bathroom is one of the crucial areas of the home where every family member needs to pay frequent visits. The slippery floors and smooth surfaces and lack of grab bars can make their visits traumatic and accidents more for people especially for children and elderly. To avoid these problems in the bathroom and water closet, there is need for ergonomics approach to interiors of bathroom and water closet conditions.

Ergonomics is defined as the study of the anatomical, psychological and physiological aspects of man in his working environment, with the objective of optimizing human safety, health, comfort and efficiency. Modern ergonomics increasingly deals with problems of adjusting the environmental conditions to their needs of people of limited ability as well. Poor ergonomic design can cause pain, discomfort and injury, poor aesthetic image can create stigma and decrease the pleasure in using spaces or objects (Allan *et al*., 1996). Thus, home ergonomics is becoming very important amongst home scientist, ergonomist, industrialist, builders and interior designers. Safety problems belong to the basic objectives of shaping the artificial environment of human life. Attention is focused mostly on road accidents and work environment; less attention is played to dangers arising in housing. Only few studies have emphasized on such fall risk and bathroom hazards. Bathroom safety is important for safe and independent living of elderly.

Rationale of the study

In home, bathroom and toilets are the most hazardous room in the house in terms of fall related injury and death. In India 21 per cent of falls occur at home and 18.9 per cent of them occur during bathing (Joshi and Dzouza, 2010). Bathroom hazards include slippery floor, sharp edges, obstacles, unavailability of water, and poor lighting and ventilation, whereas safety features include rubber mats and grab bars and safety practices, *viz.*, bedroom-to-bathroom area free from obstacles and soap that is within reach. Hence care must be taken while designing the house and proper application of ergonomics must be taken into account to overcome these problems. Keeping this in view, the present study was taken up with the following objectives

1. To study the socio economic status and existing housing conditions with special reference to bathroom and water closet of elderly.

2. To study the problems faced by the elderly in relation to existing bathroom and water closet conditions.

3. To develop the user friendly ergonomic bathroom and water closet designs for elderly.

2. REVIEW OF LITERATURE

In this chapter, the reviews were collected to get a base and develop a frame work for the study. To get information about the historical status and its development in current status which helps in the analyzing the problems related to the present study carried out under the heading “Ergonomic Approaches to Interior of Bathroom and Water closet For Elderly the available. There were very few studies done on the bathroom and water closet conditions for elderly in India keeping objectives in mind the studies related to the objectives of the present study were reviewed and presented under the following headings:

2.1 Demographic characters of elderly

2.2 Existing bathroom and water closet conditions of the elderly

2.3 Health status of the elderly

2.4 Suggestions for modification of bathroom and water closet

2.1 Personal and socio economic characters of elderly people

Bhakshi *et al*. (2001) conducted a study on “Senior citizens living in the families and in senior citizens homes” in Ludhiana. It revealed that 50 per cent of the total respondents belonged to the age group of 60-65 years. The family size of the respondents living in family varied from 6-9 members (51.60 %) whereas for those living in senior citizen homes varied from 2-5 members (61.60 %). The family occupation of (41.00 %) formal group was business and it was service for (50.00 %) of the respondents in the later category.

Sandhu *et al*. (2002) conducted a study on “Demographic features of the elderly and their families” in Urban Punjab. It revealed that maximum number of respondents (51.67 %) belonged to the age category of 60-69 years and less percentage respondents (21.66 %) were above 80 years of age. Only 9.16 per cent respondents were illiterate, 17.50 per cent of the sample could read and write without any formal education, 50.84 per cent had formal education. Only 9.16 per cent respondents lived alone and 18.33 per cent lived along with their spouse. Majority of respondents (72.50 %) lived with their

children, 38.34 per cent with their spouse. Majority (95 %) of the respondents lived in their own house.

Sarasa Kumari (2001) conducted a study on "Socio-economic conditions, morbidity pattern and social support among elderly women in a rural area" A community level descriptive study was carried out in Sreekaryam Panchayat during January-April 2000 with the sample size of 238 elderly. The results revealed that 44 per cent in rural set up and 2 per cent in urban set up were in lower income group, where as 7 per cent in urban set up, 5 per cent in rural set up were in middle income range. About 64.5 per cent were widows and 31 per cent were illiterate. Only 10 per cent were having old age pensions or any other source of income and the rest were economically fully dependent. About 70 per cent of the respondents had average living conditions

Bangari and Tamaragundi (2014) conducted a study on "Socio-economic and health problems of age old: a cross-sectional study in Chikodi taluk of Belgaum district in Karnataka." The study revealed that majority of the respondents belonged to nuclear families. Higher percentage of respondents were illiterate.

Naganad *et al.* (2010) conducted a study on design and pragmatic study of bathroom for elderly people in India. Sample size of the study was (97), both men (30) and women (67), major respondents were in the age range of 65-79 (53.6 %) followed by 55-64 (26.8 %) and 80-90 (19.6 %). The majority of them were from city *i.e.*, 68.1 per cent (urban). About 19.6 per cent are graduates and 50.6 per cent were illiterate and primary school combined. It shows that study includes older persons from all social class. Only 5.2 per cent were unmarried, the per cent of widow was high (30.9 %). One third of the elderly (28.9 %) were dependent financially, while 11.3 per cent were fully dependent on others and 38.1 per cent were partially dipendent.

2.2 Existing bathroom and water closet conditions of the elderly

Kaur and sharma (2009) conducted a study on "Interior of toilets, a cause and injuries among old age people" in Pantnagar. Two hundred families were surveyed and it was found that the people were trying to chase the modern style of interiors without taking into consideration the limitations of old age people. Forty three per cent of the selected respondents were having tile floor for their toilet, which caused fall and slip

among old age people. Besides this, 46 per cent of houses had raised platform in their toilets and it was one of the reasons for falling accidents. Thus the result revealed that fall accidents occurred in the toilet because of its interior.

Sandu *et al*. (2005) conducted a study on "Housing conditions and housing related problems of elderly" in urban Punjab. Field survey was conducted in Punjab state and 120 respondents who were above 60 years were the sample of the study. The results reported that the housing conditions of most of the elderly women respondents in urban Punjab were found to be satisfactory. Most of the houses had flooring made out of chips (55.5 %). The respondents expressed that flooring was too cold during winter (64.10). Day light was found sufficient in all the areas of their houses. Cross ventilation was observed in maximum number of bedrooms (80.80 %).

Sarambekar *et al*. (2010) conducted a study on "Convenience of work places for senior citizens" in Parbhani. Results indicated that the senior citizens faced many problems due to insufficient lighting (72.00 % male and 60.00 % female) in bathrooms and they also faced problems due to Indian toilet seats(32.00 % male and 52.00 % female).

Kashyap *et al*. (2014) conducted a study on "Ergonomics of old age homes and health. A total sample of 60 respondents was selected for the study. Structured interview schedule was developed to collect the information regarding the study. The results revealed that 13.3 per cent of the falls occurred in bathroom and water closet (15 %) was due to slippery flooring and due to slip.

Kashyap (2014) conducted a study on "Ergonomic assessment of old age homes in northern India" the study was conducted in four old age homes in Uttarkand state. The checklist was made to assess the old age homes ergonomically. The finding depicts that doors, windows, handrails and storage spaces in old age homes were not comfortable to the elderly people.

Kashyap and Sharma (2008) conducted a study on "Construction and dimensions of old age homes" The present study has conducted in two regions of Uttrakhand State *i.e.* Kumaon Haldwani block of Nainital district and Garhwal (Haridwar and Dehradun district). Fifteen elderly people from each selected old age

were selected randomly for the study. The old age room had separate bathroom and water closet, combined bath with water closet and storeroom. The dimensions of habitat room were found to be in accordance with National Building Codes, whereas the separate water closet and store room were different from National Building Codes consequent to this especially the elderly females faced pain in their body parts due to postural stresses especially in store room. The average width of the doors of bath with water closets was 0.63 cm which was observed to be far less than the standard recommended with width of 80 cm. Hence, it caused inconvenience to the elderly people.

Joshi and Dzouza (2015) conducted a study on "Bathroom hazardous among older adults in Western India: a cross sectional study" A total sample of 198 members were selected for the study. The results revealed that absence of bidirectional door, inadequate door width, slippery flooring, inappropriate bathroom size and high door threshold were the frequent architectural hazards. Frequent non architectural hazards include absence of non skid mat at the entrance, absence of exhaust fan, inadequate bathroom illumination at the pathway, unsafe hot water use, absence of light switch at the entrance and cluttered pathway.

Singh (2012) conducted a study on "Residential interiors for elderly people in Dharwad city.'' A total sample of 100 respondents was taken for the study Structured interview schedule was developed to collect the data. The results revealed that maximum percentage of the respondents faced the problems like slippery flooring (27 %) followed by bathroom away from bedroom (22 %) and difficulty in using Indian toilet (22 %). All the houses *i.e.* 100 per cent had bathrooms and water closets. Bathroom was found to be big for 30 per cent and medium for 28 per cent of the respondents, while the size of water closet was considered as big for 75 per cent of the sample households. About 23 per cent of the houses had medium size water closet.

Naganand *et al*. conducted a study on "Design and pragmatic studies of bathroom for elderly people India". The sample size for the study was 97 number (both men (30) and women (67)). The results reveled that 54.6 per cent respondents suffered with blood pressure, 60.1 per cent suffered with poor eye sight. About 22.70 per cent of

them suffered with diabetes (22.7%) followed by arthritis (9.3%), depression (5.2%), insomnia (3.1%). Cardiac problem (3.1%) and cancer (2.1%).

Jose *et al*. (2010) conducted a study on "Analysis and ergonomics of house for elderly people." The results revealed that the majority of the problems of elderly have been observed in bathroom and suitable suggestions have been provided accordingly with respect to lighting, architecture, space, floor, water closet, shower and bathtub.

2.3 Health status of the elderly

Aujla *et al*. (2001) conducted a study on" health problems faced by elderly in rural Punjab" in Ludhiana District with sample of 120 respondents(60 males and 60 females) above the age of 60 years. Results revealed that health problems like high blood pressure (33.00 %), diabetes (06.00 %), joint problems (33.00 %), weak eye sight (50.00 %), hearing problem and trouble with teeth (40.00 %), fatigue (13.00 %) and general weakness (25.00 %) were observed among elderly however among male weak eye sight (43.00 %), weakness (16.00 %), fatigue (11.00 %), blood pressure (13.00 %) were the common health problems. Irrespective of gender weak eye sight, blood pressure, joint pain, problem with teeth and weakness were common health problems among elderly.

According to Sandhu *et al*. (2002), The maximum number of elderly women (89.16) of urban Punjab faced age related health problems like reduced eye sight followed by fluctuating blood pressure and general weakness, Immobility was the least mentioned problem.

Nalina Devi and Judson (2001) conducted a study on problems faced by retired senior citizens in the areas of family, health and finance. Interview method was conducted with the sample size of 100 retired pensioners in the age group of 60-65 years. The study revealed that about 90 per cent of the respondents had health problems like blood pressure, constipation and blurred vision. Forty nine percent of them suffered from tooth decay and loss of teeth, thirty nine per cent of them suffered from hearing problems and thirty seven per cent of them suffered from arthritis and least of them *i.e.*, 13 per cent of them suffered from cataract, wheezing and stone formation.

Vijaylakshmi and Hema (2001) conducted a study on “Comparative study of problems faced by the elderly living in institutions and families” in Coimbatore. Sixty elderly of both the sexes were selected with equal presentations from institution and families. The results revealed that compared to elderly living in the families, the elderly in the institutions had more physical problems and body pain in various parts of the body. Statistically high significant difference was observed between the elderly living in institutions and families; where as no significant difference was observed in case of body pain and physical disorders. Among the physical disorders, 57 per cent of the elderly living in institutions had blood pressure, where as more per cent of the elderly living in families had asthma (50 %), diabetes (43 %) and reproductive disorders (13 %).

Bhaita *et al*. (2007) conducted a study on “A study of health problems and loneliness among the elderly in Chandigarh” A total sample of 361 aged above 60 years were taken for the study. The results revealed that majority (86.1 %) of the sample reported one or more health-related complaints, with an average of two illnesses. The illness was higher among the females (59.5 %) as compared to males (40.5 %). The main health-related problems were, disorders of the circulatory system (51.2 %), musculoskeletal system and connective tissue (45.7 %). It was also found that loneliness was prevalent more in females (72.8 %) as compared to males (65.6 %).

Leena *et al*. (2009) conducted a study on “Health and social problems of the elderly: A cross-sectional study in Udupi Taluk, Karnataka.” A total of 213 elderly patients (60 years old and above) who attended the outreach clinics were interviewed using a pre-tested schedule. Findings were described in terms of proportions and percentages to study the socio-economic status of the samples and its correlation to social problem. The results revealed that around 73 per cent of the patients belonged to the age group of 60-69 years old. Nearly half of the respondents were illiterate. Around 48 per cent felt they were not happy in life. A majority of them had health problems such as hypertension followed by arthritis, diabetes, asthma, cataract, and anemia. About 68 per cent of the patients said that the attitude of people towards the elderly was that of neglect. The results of the study showed that there is a need for geriatric counseling centers that can take care of their physical and psychological needs. The

stringent rules for eligibility to social security schemes should be made more flexible to cover a larger population.

Kusuma (2015) conducted a study on “Health status of elderly in rural areas need for social work intervention. A total sample of 100 respondents aged 60 years and above was taken for the study. Random sampling method was carried out to the selected sample. The results revealed that majority of the respondents were having arthritis problem (56 %) followed by hypertension (39 %), nervous disorder (26 %), diabetes (25 %) and least was the urinary infection problem *i.e.*, six per cent.

Nayer (2000) conducted a study on” Aged in Kerala.” It was found through the study that six per cent of aged were in good health while 6.9 per cent were in moderate health, while 20 per cent of them were in poor health and five per cent of them were in very poor health. Hence the study concluded that majority of them were facing the poor health.

Gyeongsil Lee *et al*. (2017) conducted a study on “Association between Body Mass Index and Quality of Life in Elderly People over 60 Years of Age.” The Korean version Medical Outcomes Study 36-Item Short-Form Health Survey (SF-36) was administered to elderly subjects (≥ 60 years) selected from welfare and health centers, and University hospitals. Socio demographic information and subjects' height and weight were also recorded. The results revealed that the study population's mean age was 74.2 ± 7.1 years, and the average BMI was 24.5 ± 3.2 kg/m^2. The selected participants were segregated based on BMI quartiles. The SF-36 scores were compared among the sex-stratified quartile groups after adjusting for age, education level, income, smoking, alcohol and arthritis diagnosis. The SF-36 scores were compared for four BMI quartiles stratified by sex, after adjusting for age, education level, income, smoking, alcohol consumption, and arthritis diagnosis. Men in the Q3 and Q4 groups had higher mental health scores than men in Q2 group. Additionally, men in the Q3 group had higher social function scores than those in the Q2 and Q4 groups. No differences were observed for the remaining six domains; no significant score differences were observed in any of the survey domains for the female subjects.

2.4 Suggestions for modification of bathroom and water closet

Dekker *et al*. (2005) conducted a study on "Hand supports in toilet use among the elderly." It was found that the preference and use of hand supports in toilet were comfortable for elderly people. An adjustable test frame was built with a toilet and three types of supports are vertical supports, front support and side supports. Fourteen respondents were asked which position they favored for each support. It was concluded that there is a preference for vertical supports for sitting down and standing up. However during toilet use the side supports were equally appreciated.

Nagananda *et al*. (2010) conducted a study on "Design and pragmatic studies of bathroom for elderly people India." They interviewed both men and women older than age of 55-90 years with 30 and 67 samples respectively. In depth interview with group of thirty subjects in the age range of 70 to 90 years revealed useful information to formulate the design criteria for toilet and bathroom layout. The study concluded that bathroom and toilet design must be as per specific requirement of elderly persons with back rest, hand grip and water hose (jet). It must be spacious with good ventilation, non-slippery floors with mat finished tiles, grip or grab bars to the entire bathroom, permanent sitting facility, by directional door access, and hand shower to avoid excessive movements. Master bedroom must be with night lamps to use night walking to the bathroom. Bigger size electrical switches should be at a comfortable height. Exit and ordinary fans are useful to maintain temperature to dry the bathroom. Alarm switch with falling sensor, telephone with single digit emergency dialing, customized timers, if time of bathing exceeds the time set, surveillance camera needs to automate for alerting other family members, were also suggested.

As occupational therapists, Hazen and McCree (2001) presented practical design implications for seniors. These environmental supports for assisting older adults are specific design guidelines based on age-related changes such as neuromuscular function changes and cognitive changes. Organizations and research institutes studying universal design (accessible home design) recommend a variety of physical changes in the homes

of individuals who cannot move around their living spaces easily or safely. These features include: adding a chair lift to stairs, replacing stairs with ramps, widening doorways or adding offset hinges, lowering cabinets, installing more raised toilets, adding grab bars to the bath tub or toilet, or installing alerting devices for the hearing or visually impaired.

Sandhu *et al*. (2003) conducted a study on "Assessment of physical features of houses and special provisions made in the rooms of elderly in Urban Punjab." Findings of the study showed that living conditions (household environment) of most of the respondents were found satisfactory as maximum number of respondents lived in good houses and enjoyed the provision of small but separate room. Most of the houses had non-slippery floor but were felt too cold during winter by the respondents. Day light was found to be sufficient in all areas of their house but observed light was found to be less in kitchen and more in bed room when compared with the recommended values. Cross ventilation was observed in maximum number of bedrooms.

The most recent AARP survey (Bayer and Harper, 2000) conveys the concepts and behaviors that older adults aged 45 and over have towards home modifications. Most of the respondents (86.00 %) have made at least one simple change to their home to make it easier for them to live there. Most common modifications reported were having installed nightlights (63.00 %), non-skid strips in the bathtub or shower (50.00 %), and higher wattage light bulbs (32.00 %). Safety was most often cited as a reason for making home modifications. A large percentage of respondents also gave the reasons for making these changes were to make the home easier to use by all members of the family, to increase the ability to live independently, to provide flexibility to adapt to the changing needs of family members, and to upgrade or modernize the home.

Martin *et al.* (2017) conducted a study on "Toilet assistive system designed for the reduction of accidental falls in the bathroom using admittance controller." This paper suggests an assistive system for the toilet with the objective of measuring human activities and to provide intelligent mechanical assistance to help seating and standing.

The project intends to develop a seating assistance as a technical aid in order to reduce accidents and falls in the bathroom. The preferred technique is human-robot physical interaction algorithms known in collaborative robotics (cobot) and adapting it to a personalized assistance technology installed on a smart toilet. First, the design of the mechanical assistance is presented. Then, an admittance controller is designed and implemented in order to help the user in a similar way as a cobot could be used. This technique could be used to assist the user and improve balance with adequate training and an adequate configuration of the admittance controller.

3. MATERIALS AND METHODS

The present study on “An ergonomic approach to interiors of bathroom and water closets for the elderly” is executed in the Department of Family Resource Management, College of Community Science, University of Agricultural Sciences, Dharwad during the year of 2017-2018. The materials and methods used for the present study are given under the following headings.

3.1 Research design

3.3.1 Type of research

In the present investigation, exploratory research design was used. This design was considered appropriate because it provides information about the existing situations. It calls the attention to the problems which need solutions.

3.1.2 Variables under study

Considering the objectives in view, the dependent and independent variables have been selected for the present study. The independent variables assumed to be related with the dependent variable were identified by review of relevant literature.

3.1.2.1 Independent variables

Age: It is referred to the chronological age of the respondents at the time of investigation and it was recorded as mentioned by them in complete years.

Socio-economic status: Socio-economic status depicts the overall status of the family and the living condition. Kuppeswamy scale (2017) was adopted to analyze the socio-economic status of the respondents.

Health condition and problems of elderly: Health condition means the health status of a patient. Problems of elderly in this study refer to person, whose age is more than sixty, facing the situation where it is harmful because of health issues or poor environment.

Bathroom and water closet conditions: It refers to the state of bathroom and water closets with regard to its working order which includes availability of supports, floor plan, dimensions, and reaches of essential materials and bathroom accessories and intensity of light.

3.1.2.2 Dependent variables

Problems related to bathroom and water closet: These are the problems faced by the elderly people in bathroom and water closet like slippery flooring, lack of grab bars, difficulty in using Indian toilet, difficulty in operating taps, insufficient water supply, insufficient force of water, insufficient natural and artificial lighting.

3.1.3 Operational Definitions

Ergonomics: It is the study of anatomical, physiological, and psychological aspects of human beings in their working environment with the purpose of maximizing human safety, health, comfort and efficiency.

Interior: Interior is the space that is surrounded by walls, floors and ceiling and having one or more openings such as doors and windows.

Bathroom: A bathroom is a room in the home for the personal hygiene activities, generally containing a sink (basin) and either a bathtub, a shower or both.

Water closet: It is a large bowl with a seat, or platform with a hole, which is connected to a water system and is used to get rid of urine or feces from your body.

Bathroom cum water closet: It is the room in which bathing and toileting provision is made in a single room.

Elderly: Elderly refers to the age nearing or surpassing the life expectancy of human beings and is thus the end of the human life cycle.

Lighting: It is the deliberate use of light to achieve a practical or aesthetic effect. Lighting includes both artificial light sources like lamps and day fixtures, as well as natural illumination by capturing day light.

Western toilet/Commode: It contains a piece of furniture containing a concealed chamber pot.

Indian toilet: A toilet which contains a toilet pan or bowl at floor level

Wall hung commode: A wall mounted water closet is the one that is fixed to the wall or in other words it is hung on the wall. It gives a different styling to your bathroom since this concept of a water closet highlights the modern way of bathroom designing. It has four parts, the wall tank, the flush, the toilet bowl and the seat.

Floor mount commode: This water closet is fixed to the floor where the tap finds its way attached to the bathroom floor.

Squatty potty: The squatty potty is a stool that is designed to fit around the front of a standard toilet bowl, providing lift to your legs and resulting in a squatting-type position rather than sitting position while moving your bowels.

Water jet: A nozzle placed at rear of the toilet bowl aims a water jet to the anus and serves the purpose of cleaning.

Grab bars: Grab bars are safety devices designed to enable a person to maintain balance, lessen fatigue while standing to hold their weights or in case of a slip or fall.

Faucet: A faucet is a device that controls the flow of a liquid or gas from a pipe or container. Sinks and baths have faucets attached to them.

Adjustable chair: A toilet seat is a hinged unit consisting of a round or oval open seat and usually a lid, which is bolted onto the bowl of a toilet used in a sitting position (as opposed to a squat toilet). The seat can be either for a flush toilet or a dry toilet.

3.2 Data collection

3.2.1 Locale of the study

The survey was conducted in the urban areas of Hubli and Dharwad cities. The sample were selected from in Krishinagar, Gandhi Nagar, Navanagar and Manjunath nagar areas.

3.2.2 Selection of sample for the study

Keeping in view the objectives of the study, purposive random sampling technique was adopted to select the sample for the study.

A total sample of 120 elderly population including both male and female aged 60 years and above residing in Hubli and Dharwad cities were selected as the sample for the study. Only one respondent was selected from each of the selected households.

3.2.3 Research tools

The pre-structured schedule was formulated to collect and observe the required information from the sample under the study by reviewing the relevant review of literature. It was pre-tested in a non-sample area and suitable modifications were made.

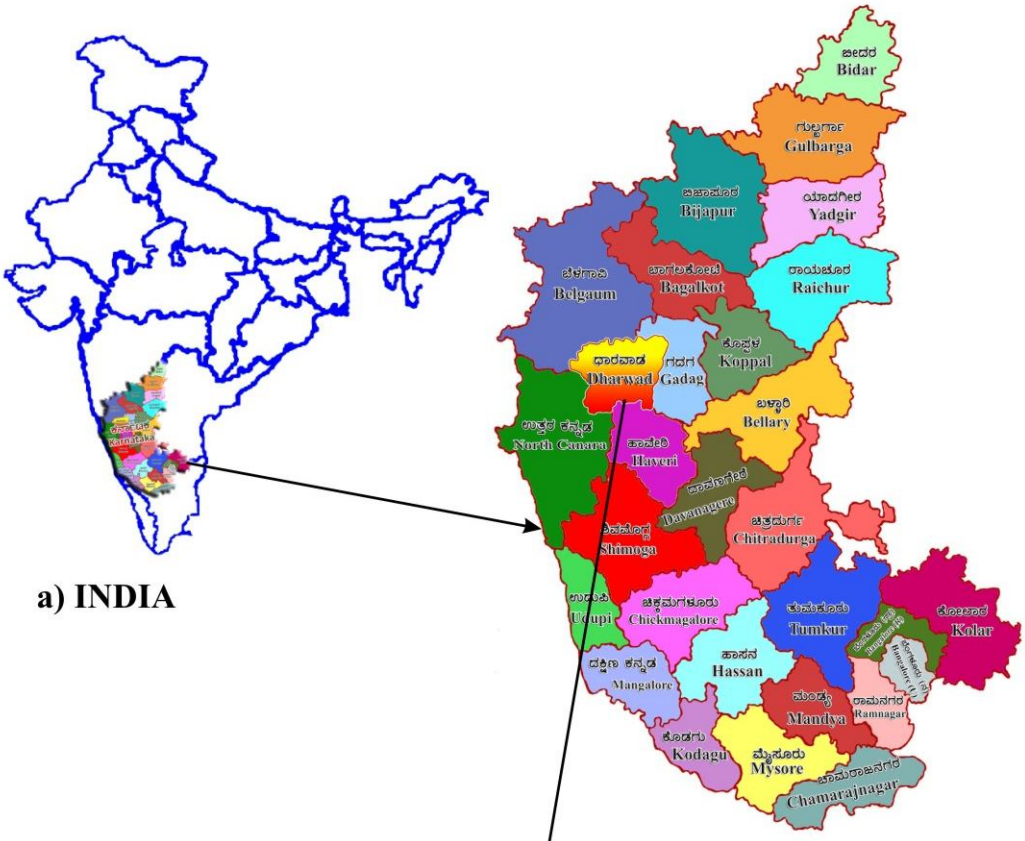

Fig. 1a: Locale of the study

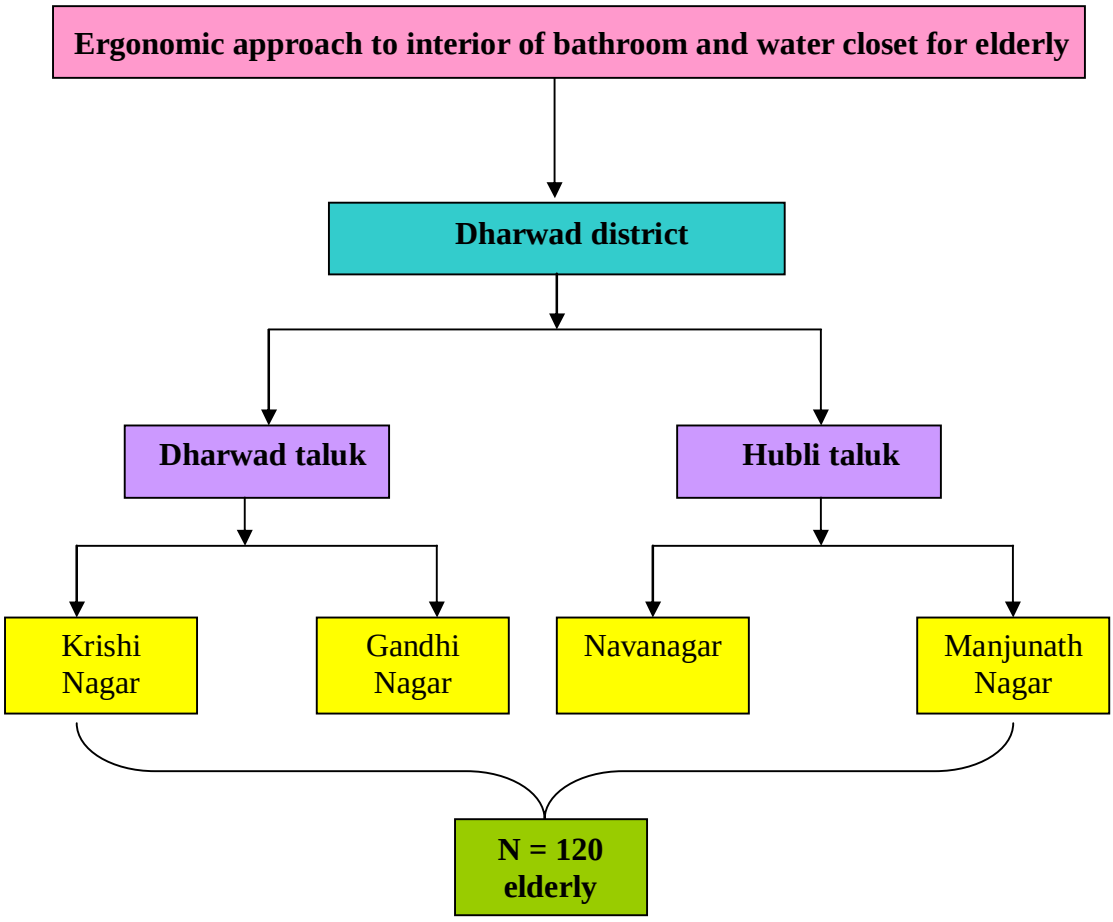

Fig. 1b: Schematic representation of the sampling procedure of selected respondents

3.2.3.1 Details of the schedule used to elicit the required information for the study is as follows

Segments	Content	Empirical measurement
Part I Back ground information of the selected elderly	General information of the respondent	Schedule developed for the study
Part II Socio-Economic status	Socio-Economic status of the family	Scale developed by Kuppeswamy (2017)
Part III Existing housing conditions with special reference to bathroom and water closet	Existing conditions of bathroom and water closets	Checklist developed for the study
	Dimensions of bathroom and water closets	Model Building Bye Laws (2016)
	Intensity of artificial and natural lighting	National Building Code of India (NBO,1966)
Part IV Problems among elderly in relation to bathroom and water closet	Nutritional status of the elderly	BMI classification for Asian adults of WHO (2004)
	General health problems of the elderly	Schedule developed for the study
	Extent of problems faced by the elderly in bathroom and water closets	Three point scale was used.
	Occurrence/impact of falls and accidents in bathroom and water closets	Schedule developed for the study
Part V	Suggestions for modification of existing bathroom and water closets	Schedule developed for the study

3.2.3.2 Tools used for recording measurement under the study

Sl. No.	Experimental Tools	Purpose
1	Anthropometry rod	To record the standing height of the respondents in centimeter
2	Weighing balance	To record the body weight of the respondents in kilogram
3	Measuring tape	To take the measurement of width, length and breadth of bathroom and water closets in meter
4	Lux meter	To record the intensity of light in bathroom and water closet

3.2.4 Method of data collection

Based on the convenience of the researcher and conveyance facility four areas were selected in Dharwad and Hubli cities under the study. The list of elderly families was made with the help of friends and relatives. From the list, 120 elderly who were cooperative and willing to give information regarding the purpose of the research were selected randomly for the study. A number of visits were made to the respondent's house with the help of friends and relatives to build the rapport with the respondents. The data was collected from the selected elderly through personal interview method and observation method. Each question was made clear during the personal interview method and the same emphasis was made in explaining the questions to all the respondents. Three to four sittings were carried out for each respondent to collect the data.

3.3 Data analysis

3.3.1 Coding

A coding plan was developed and code numbers were given to analyze the data and these were subjected to computer analysis.

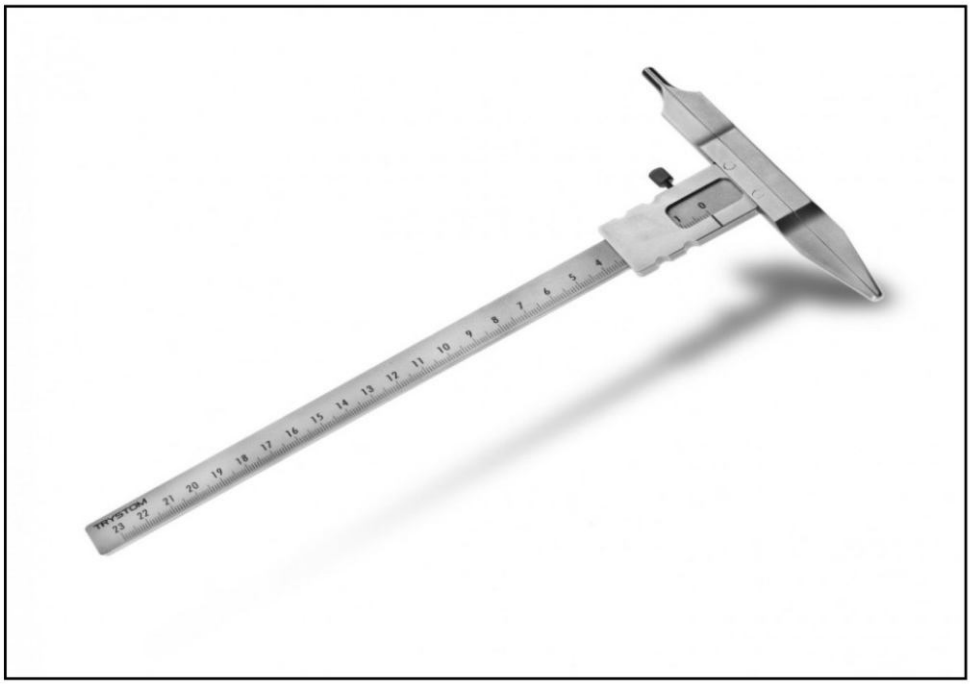

Plate 1: Anthropometric rod

Plate 2: Measuring tape

Plate 3: Weighing balance

Plate 4: LUX meter

3.3.2 Categorization and quantification of variables

For the purpose of analysis, the selected independent and dependent variables were measured and categorized as follows.

Age

Age of the respondents was classified based on the convenient intervals by considering minimum and maximum values into three groups as follows

Age range (years)
60-68
69-77
78-86

Socio economic status

Socio economic status depicts the overall status of the family and their living condition. Kuppeswamy scale (2017) was adopted to analyze the socio economic status of the respondents.

The data on education of the head of the family, occupation of the head of the family and monthly income of the families was collected. The scores were assigned according to the scores given by Kuppuswamy (2017). The details are as follows.

Education of head of the family	Score
a. Profession of honours	7
b. Graduate or post graduate	6
c. Intermediate or post high school diploma	5
d. High school certificate	4
e. Middle school certificate	3
f. Primary school certificate	2
g. Illiterate	1

Occupation of head of the family	
a. Profession	10
b. Semi-profession	6
c. Clerical, shop owner	5
d. Skilled worker	4
e. Semi-skilled worker	3
f. Unskilled worker	2
g. Unemployed	1
Monthly income of family	
a. >41430	12
b. 20715-41429	10
c. 15536-20714	6
d. 10357-15535	4
e. 6214-10356	3
f. 2092-6213	2
g. <2091	1

The classification of the total socio economic status scores of the sample according to Kuppuswamy (2017) is categorized as follows.

Socio economic status	**Scores**
Upper class	26-29
Upper middle class	16-25
Lower middle class	11-15
Lower upper class	5-10
Lower class	<5

Health conditions and problems of elderly

a) Body mass index:

Body Mass Index (BMI) of the elderly was collected to know the health status. The anthropometric measurements *viz.*, height and weight of each respondent were recorded. Measurements of standing height in (cms) were taken with foot wear off and body standing straight against anthropometric rod. A scientific weighing balance was used to record the weight (kg) of the respondent. The body mass index (BMI) expressed as the ratio of weight in kilograms to the height in square meters were computed to know the nutritional status of elderly.

$$BMI = \frac{\text{Weight (kg)}}{(\text{Height})^2\ \text{m}}$$

The selected sample was categorized as per the BMI classification of Asian adults (WHO) 2004 as follows:

Classification	BMI cut off points
Under weight	<18.5
Normal weight	18.5-24.9
Over weight	25.0-29.9
Obesed	>30

b) The data on general health of elderly was collected under the three main headings namely physical problems, body pain and physiological disorders. Under physical problems fatigue, general weakness, poor eye sight, loss of hearing and loss of appetite. The problems like pain in knees, pain in legs, back pain, shoulder pain, headache were collected under body pain. Accordingly blood pressure, asthma, diabetes, arthritis and coronary heart diseases were collected under physiological disorder. The score for each health problems of the respondents was given as follows

Yes	1
No	0

Bathroom and water closet conditions

The data on presence of sanitary fittings and fixtures, intensity of natural/artificial lighting and dimensions of bathroom and water closets was collected under bathroom and water closet conditions and analyzed as follows

a) Existing conditions of bathroom and water closets

Under existing condition of bathroom and water closets, the checklist was made and the scores were assigned as follows.

Present	1
Absent	0

b) Measurement of intensity of natural and artificial lighting

The measurement of natural and artificial light in bathroom and water closets was measured by digital LUX meter (LX-101A). The unit to measure the light intensity was Lux.

LUX-meter was used for measuring the quantity of light in bathroom and water closets at different timings *i.e.* three readings for natural light at 9am, 12 noon and 3 pm and one reading for artificial light at 8pm.

The dimensions of bathroom and water closets were measured with the help of measuring tape .The readings were taken by keeping the digital LUX meter horizontally on the floor at the center of the bathroom and water closets. Three readings for bathrooms were recorded and the mean intensity of the natural light available was calculated using the formula

The intensity of natural and artificial light in bathroom and water closets was calculated by using the formula

$$\text{Average intensity of natural light in bathroom} = \frac{A + B + C}{3} = \text{---------LUX}$$

(A, B and C: Readings taken at 9 am, 12 pm and 3 pm respectively)

The calculated average natural light (LUX) and artificial light (LUX) were recorded and compared with standard LUX given by the National Building Code of India (NBO), 1996.

The standard LUX in bathroom and water closet according to NBO, 1996 = 100 LUX

c) Dimensions of bathroom and water closet

The dimensions of bathroom and water closets of the selected respondents were measured and compared with the standard dimensions given by Model Building Bye Laws, 2016. The standards are as below.

Particulars	**Standard dimensions of bathroom**	**Standard dimensions of water closet**	**Standard dimensions of bathroom cum water closet**
Width	1.2 m	0.9 m	1.2 m
Height	2.1 m	2.1 m	2.1 m
Length	1.5 m	1.2 m	2.3 m
Area	1.8 m^2	1.1 m^2	2.8 m^2

Problems related to existing conditions of bathroom and water closets

The data on problems related to existing conditions bathroom and water closets was recorded on three point scale starting from 1 – Not problematic, 2 – Problematic to 3 – Highly problematic.

Plate 5: Collection of research data

Plate 6: Measurement of light using lux meter

3.3.3 Statistical analysis

The data collected was tabulated by keeping in view the objectives of the study. The data was analyzed employing suitable descriptive as well as relational statistics as follows**.**

Frequency and percentage

Frequency and percentages were calculated for marking the simple comparison and tabular analysis was carried out to interpret the background information, existing housing conditions, bathroom and water closet conditions, health status of elderly and suggestions for modification of bathroom and water closet.

Mean and standard deviation

Mean and standard deviation were used to analyze the health status of elderly and suggestions given by elderly for the modifications in bathroom and water closets.

Weighted Average

Weighted mean score was computed, where the number of respondents was not equal. It was calculated to delineate the opinion of the respondents regarding the usage of bathroom and water closets. The mean scores above 2.5 to 3.0 were considered as highly problematic. Similarly, the mean scores above 1.5 to 2.5 and 0 to 1.5 were considered as problematic and non problematic respectively.

Karl pearsons' coefficient correlation

Karl pearsons' coefficient correlation was used to study the relationship between independent variables *viz.*, age, SES, health problems, year of construction, existing bathroom conditions and dependent variable *viz.*, extent of problems faced in bathroom and water closet.

Student t-test

Chi- square test was used to analyze the association between the health status, suggestions for modification of bathroom and waters closets given by elderly and the gender.

Garret ranking

Garret ranking was used to know the major health problems faced by elderly, problems faced in bathroom and water closets and the preferences of elderly for modifications in bathroom and water closets.

4. EXPERIMENTAL RESULTS

In consistence with the objectives of the study, the necessary data collected from the selected respondents were analyzed and interpreted. The results obtained are presented in this chapter under the following headings.

4.1 Demographic profile and socio economic status of the selected elderly

4.2 Existing housing conditions in relation to bathroom and water closet

4.3 Health status of selected elderly

4.4 Problems faced by selected elderly in bathroom and water closet

4.5 Suggestions for the modification of bathroom and closet given by selected elderly respondents

4.6 User friendly ergonomic bathroom cum water closet designs for elderly

4.1 Demographic profile of selected respondents

The data on Demographic profile of selected respondents is presented in Table 1. The sample size of the study was 120 elderly, covering 70 men and 50 women.

Among the three categories of age groups, the 40 per cent of male respondents and 36 per cent of female respondents belonged to the age group of 60-68 years. This was followed by 37.14 per cent of male and 40 per cent of female in the age range of 69-77. Only 16 per cent of male and 24 per cent of female respondents belonged to the age group of 78-86 years.

Irrespective of gender, equal percentage (38.33 %) of them belonged to the age group ranging 60-68 years and 69-77 years followed by 23.33 per cent of them belonged to age group 78-86 years.

Regarding the educational level of the selected elderly, it was found that 51.42 per cent of male and 22.00 per cent of female were graduates, while 27.14 per cent of male and 12.00 per cent of female had finished their post graduation followed by PUC

Table 1: Demographic profile of selected respondents

N=120

Particulars	Respondents		Total N=120
	Male (n=70)	Female (n=50)	
Age (years)			
60-68	28 (40.00)	18 (36.00)	46 (38.33)
69-77	26 (37.14)	20 (40.00)	46 (38.33)
78-86	16 (22.85)	12 (24.00)	28 (23.33)
Education			
Illiterate	-	-	-
Primary school	-	10 (20.00)	10 (8.33)
High school	12 (17.14)	17 (34.00)	23 (19.16)
PUC	9 (18.85)	06 (12.00)	15 (12.5)
Graduate	36 (51.42)	11 (22.00)	47 (39.16)
Post-graduate	19 (27.14)	6 (12.00)	25 (20.83)
Occupation			
Working/ business	12 (17.1)	07 (14)	19 (15.83)
Retired	58 (82.8)	14 (28)	72 (60.00)
House wife	-	29 (58)	29 (24.10)
Marital status			
Married	55 (78.50)	41 (82)	96 (80.00)
Widow /widower	15 (21.4)	09 (18)	24 (20.00)
Living arrangement			
Living with spouse	21 (30.00)	10 (20.00)	31 (25.83)
Living with children and spouse	27 (38.57)	16 (32.00)	43 (35.83)
Living with children	14 (20.00)	18 (36.00)	32 (26.66)
Living single	08 (11.40)	06 (12.00)	14 (11.66)
Family size (number)			
<2	06 (8.50)	03 (6.00)	09 (7.50)
2-4	43 (61.42)	37 (74.00)	80 (66.66)
>5	21 (30.00)	10 (20.00)	31 (25.83)
Personal income per month (rupees)			
8000-15000/-	28 (40.00)	18 (36.00)	46 (38.33)
15001-22000	24 (34.28)	06 (12.00)	30 (25.00)
22001-30000	18 (25.7)	03 (6.00)	21 (17.50)

(Figures in the parentheses indicate percentage)

(male 18.85 %, female 12.00 %) and high school (male 17.14 %, female 34.00 %). Only 20 per cent of the female respondents had completed their primary education.

Irrespective of gender it was found that higher percentage of the elderly were graduates (39.16 %), while 20.83 per cent of them were post graduates followed by PUC (12.5 %), high school (19.16 %). Only 8.33 per cent of them studied up to primary school.

Regarding the occupation of the respondents, maximum number of male respondents were retired (82.8 %) and only 17.10 per cent of them were working or doing business. Among female respondents majority of them were house wives (58 %) followed by retired (28 %) and working or doing business (14 %).

Irrespective of gender, majority of the respondents were retired (60 %) followed by 24.10 per cent of them were house wives and 15.83 per cent of them were working or doing business.

Majority of both male (78.50 %) and female respondents (82 %) were married. Among the total sample 21.4 per cent and 18 per cent of them were widower and widow respectively.

Regarding the living arrangements of the respondents, 30 per cent of men and 20 per cent of women were living with spouse, while 38.57 per cent of men and 32.00 per cent of female were living with their children and spouse followed by living with children (male 20.00 %, female 36.00 %). Only 11.40 per cent of male and 12.00 per cent of female were living single.

It was observed that one third of the sample were living with spouse(35.83 %), while 26.66 per cent of them were living with children followed by living with spouse (25.83 %) and living single (11.6 %).

Regarding the size of the family of selected respondents, majority of male (61.42 %) and female respondents (74 %) belonged to the family size of 2-4 members. Thirty per cent and 20 per cent of male and female household respondents' family size was found to be above five members. Meager percentage of male (8.50 %) and female (6.00 %) respondents belonged to the family size of less than two members.

The monthly personal income of male respondents (40 %) and female respondents (36 %) ranged between Rs. 8,000/- to 15,000/-, while 34.28 per cent male and 12 per cent female respondents monthly personal income range between Rs. 15,001/- to 22,000/-. One fourth of the selected male sample (25.7 %) and meager of female sample (6 %) had income range between Rs. 22,001/- to 30,000/-

Irrespective of gender, 38.33 per cent of respondents' monthly personal income ranged from Rs. 8,000/- to 15,000/- followed by Rs. 15,001/- to 22,000/- (25 %) and 22001-30000 (17.50 %) income ranges.

The distribution of the elderly families according to the socio economic status as per Kuppuswamy (2017) is presented in Table 2. It is clear from the data that, higher percentage of elderly male families (44.28 %) and elderly female families (42 %) belonged to the upper class followed by upper middle class (male 17.14 %, female 22 %), lower middle class (male 15.71 %, female 18 %), lower upper class (male 10 %, female 8 %) and 12.85 per cent of male families and 10 per cent of elderly female families belonged to the lower class.

Further the table revealed that irrespective of gender, higher percentage of the elderly families belonged to upper class (43.33 %) followed by upper middle class (19.16), lower middle class (16.66 %) and equal percentage (9.16) were belonged to lower upper class and lower class.

4.2 Existing housing conditions of selected elderly

Majority of both male (87.10 %) and female respondents (76 %) were living in RCC, while 12.8 per cent of male and 24 per cent of female respondents were living in tiled house (Table 3).

Similar trend was observed with respect to housing tenure *i.e.* majority of male (87.1 %) and female respondents (94 %) were living in own house, where as 12.8 per cent of male and 6 per cent of female respondents were living in rented house.

The year of construction of house was categorized into three groups and in which maximum number of male (62.85 %) and female respondents (52 %) belonged to the category of less than 10 years, while 31.42 per cent of male and 38 per cent of

Table 2: Socio-economic status of the families of selected elderly

N=120

Socio economic class	Scores	Male (n=70)	Female (n=50)	Total (N=120)
Upper class	26-29	31 (44.28)	21 (42.00)	52 (43.33)
Upper middle class	16-25	12 (17.14)	11 (22.00)	23 (19.16)
Lower middle class	11-15	11 (15.71)	09 (18.00)	20 (16.66)
Lower upper class	5-10	07 (10.00)	04 (8.00)	11 (9.16)
Lower class	<5	09 (12.85)	05 (10.00)	11 (9.16)

(Figures in the parentheses indicate percentage)

Table 3: Existing housing conditions of the selected elderly

N=120

Particulars	Respondents		Total N=120
	Male (n=70)	Female (n=50)	
Type of house			
RCC	61 (87.1)	38 (76.00)	99 (82.5)
Tiled house	09 (12.8)	12 (24.00)	21 (17.5)
Housing tenure			
Rented	09 (12.8)	03 (6.00)	12 (10.00)
Own	61 (87.1)	47 (94.00)	108 (90.00)
Construction of house (in years)			
<10 years	44 (62.85)	26 (52.00)	71 (59.16)
10-20 years	22 (31.42)	19 (38.00)	41 (34.16)
>20 years	03 (4.20)	05 (10.00)	08 (6.66)
Presence of bathroom and water closet			
Separate bathroom and water closet	54 (77.1)	40 (80.00)	94 (78.3)
Bathroom cum water closet	16 (13.3)	10 (20.00)	26 (21.6)

(Figures in the parentheses indicate percentage)

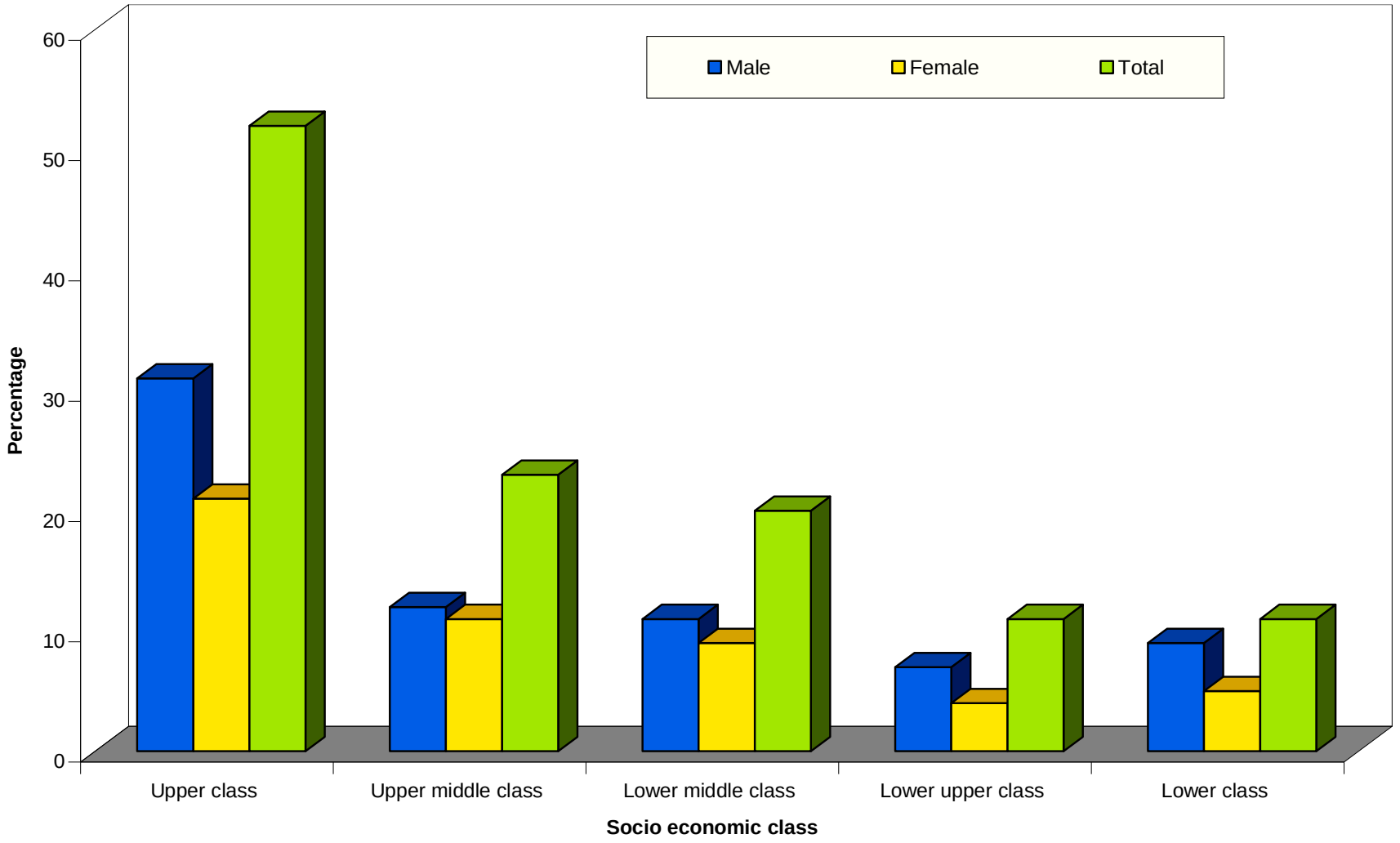

Fig. 1: Socio-economic status of selected elderly families

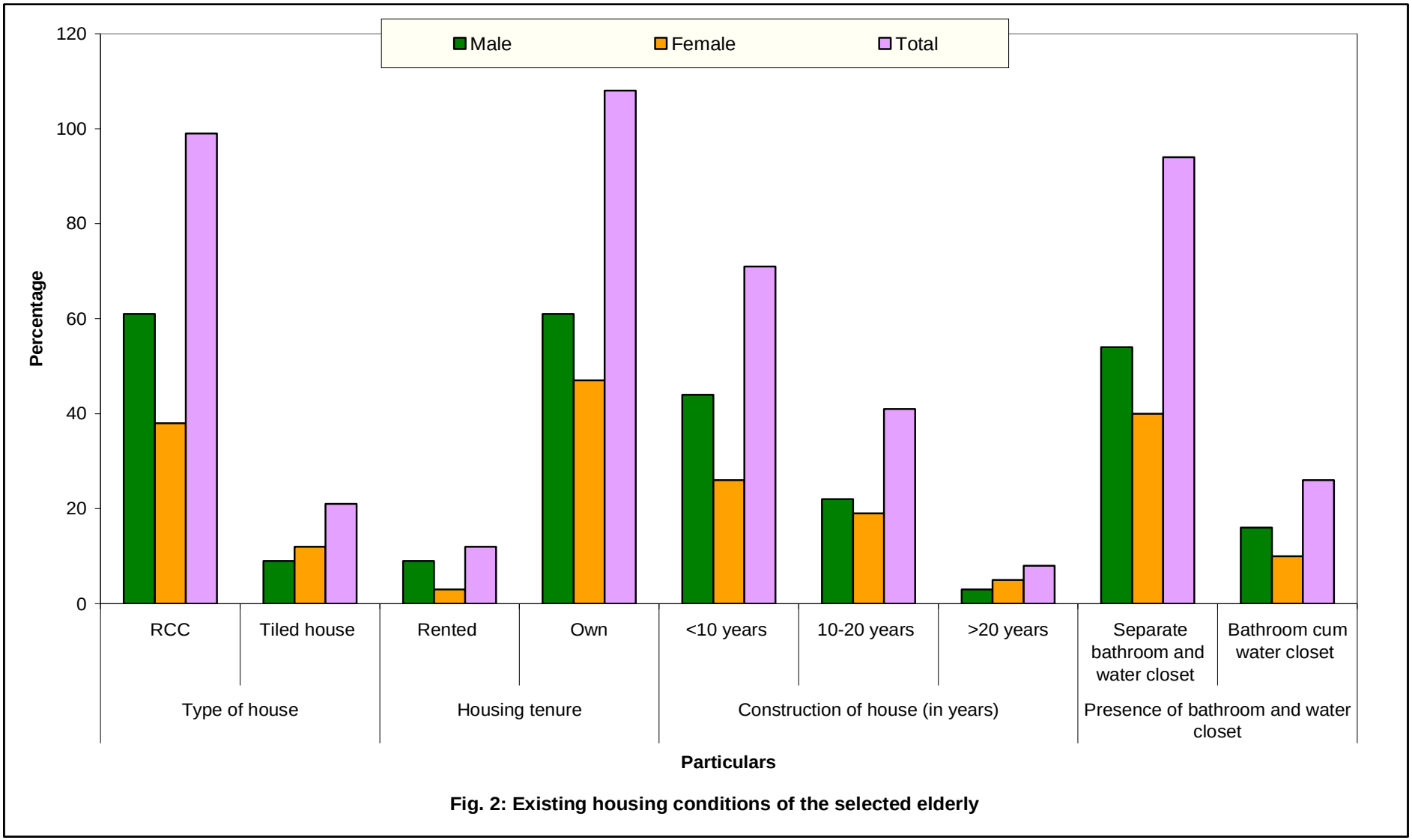

Fig. 2: Existing housing conditions of the selected elderly

Table 4: Existing conditions and presence of sanitary fitting and fixtures in bathroom and water closet in the selected households of elderly

N=120

Particulars	Bathroom n=94	Water closet n=94	Bathroom cum water closet n=26
Floor materials used			
Slippery tiles	43 (45.74)	33 (35.10)	11 (42.30)
Non slippery	37 (39.36)	46 (48.93)	11 (42.30)
Uneven	14 (14.89)	15 (15.95)	04 (15.38)
Non skid mat	42 (44.68)	56 (59.57)	112 (46.15)
Door threshold	41 (43.61)	37 (39.36)	13 (50.00)
Source of hot water			
Solar heater	10 (10.56)	-	04 (15.38)
Electric boiler	18 (19.14)	-	05 (19.23)
Electric coil	10 (10.63)	-	02 (7.69)
Gas geyser	25 (26.59)	-	05 (19.23)
Electric geyser	19 (20.21)	-	07 (26.92)
Heating water on gas stove	14 (14.89)	-	-
Both solar and gas geyser	17 (18.80)	-	03 (11.53)
Source of natural lighting			
Number of windows	17 (18.08)	-	-
Number of ventilators	70 (74.46)	81 (56.17)	26 (100.0)
Source of artificial lighting			
Compact florescent bulb	21 (22.34)	11 (11.70)	09 (34.61)
Bulbs	73 (77.65)	83 (88.29)	17 (65.38)
Sanitary fittings and fixtures			
Indian toilet	-	42 (44.68)	11 (42.30)
Western toilet	-	52 (55.31)	15 (57.69)
Wall hung commode	-	14 (14.89)	7 (26.92)
Floor mount commode		38 (40.42)	8 (30.76)
Wash basins	53 (56.38)	-	16 (61.53)
Water jet		7 (7.44)	4 (15.38)
Hand faucet	-	52 (55.31)	15 (57.69)
Bath tub	12 (12.76)	-	01 (7.14)
Soap holder	56 (59.57)	-	16 (61.53)
Hand showers	19 (20.21)	-	06 (23.07)
Tissue paper holder	-	27 (28.94)	12 (46.15)
Corner shelf	68 (72.34)	36 (38.29)	20 (76.92)
Shower	62 (65.95)	-	20 (76.92)
Towel and garment rack	53 (56.38)	-	26 (100.0)
Towel hangers	25 (26.59)	-	20 (76.92)
Grab bars	-	-	-
Storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories.	24 (25.93)		12 (46.15)
Others			
Shower chairs	58 (61.70)	-	20 (76.92)
Dustbin	35 (37.23)	14 (14.89)	16 (61.53)
Adjustable chair	-	14 (14.89)	-

(Figures in the parentheses indicate percentage)

female respondents belonged to the category of 10-20 years. Remaining percentage *i.e.* 4.20 per cent of male and 10 per cent of female respondents belonged to category of above 20 years.

Irrespective of gender, majority of the respondents belonged to the category of less than 10 years (59.16 %) followed by 10-20 years (34.16) and more than 20 years (6.66 %).

In houses of majority of male (77.10 %) and female respondents (80 %), separate bathroom and water closets were present, while in 13.30 per cent and 20 per cent houses of male and female respondents respectively, bathroom cum water closet was present.

The details of existing conditions and presence of fittings and fixtures in bathroom and water closets in the selected households of elderly is depicted in Table 4.

Data on floor materials, source of hot water, source of natural and artificial lighting and sanitary fittings and fixtures were collected under the existing bathroom and water closet conditions. Among 120 selected sample, majority of the elderly (94 No.) were using separate bathroom and water closet and 26 number of elderly were using bathroom cum water closet.

It is clear from the table 4 that more percentage of respondents (45.74 %) had slippery tiles followed by non-slippery (39.36 %) and uneven flooring (14.89 %) in bathroom.

Reverse trend was observed with respect to water closet *i.e.* 48.93 per cent of the respondent had non-slippery flooring followed by slippery flooring (35.10 %) and uneven flooring (15.95 %).

However, equal percentage of selected elderly (42.30 %) had slippery and non-slippery tiles followed by uneven flooring (15.38 %) in bathroom cum water closet.

Regarding the door threshold, half of the selected respondents (50 %) had threshold to the bathroom cum water closet, while 43.16 per cent and 39.36 per cent had door threshold to bathroom and water closet respectively.

It is clear from that table 4 that more percentage of the respondent (26.59 %) were using gas geyser as the source of hot water facility in bathroom as compared to others *i.e.* electric geyser (20.21 %), electric boiler (19.14 %), both solar and gas geyser (18.08 %), heating water and gas stove (14.89 %).

More percentage of the respondents (26.93 %) were using electric geyser as the source of hot water facility in bathroom cum water closet. While equal percentage (19.23 %) of the elderly were using gas geyser and electric geyser as the source of hot water facility followed by solar heater (15.38 %), both solar and gas geyser (11.53 %) and electric coil (7.69 %).

Regarding the source of natural lighting, the bathrooms in majority of the respondents' households (74.46 %) had ventilators followed by windows (18.08 %).

The water closet in majority of the respondents' households (56.17 %) had ventilators. It was good to know that 100 per cent of the respondents were having ventilators in bathroom cum water closet.

Regarding the source of artificial lighting, majority of the respondents (77.65 %) were using bulbs followed by 22.34 per cent of them were using compact fluorescent bulbs as a source of artificial lighting in bathroom.

Majority of the respondents (88.29 %) were using bulbs and only 11.07 per cent of them were using compact florescent bulbs as a source of artificial lighting in water closet.

Similar trend was observed with regard to source of artificial lighting in bathroom cum water closet *i.e.* majority of the respondents (65.38 %) were using bulbs followed by compact fluorescent bulb (34.16 %).

Regarding the type of toilet, majority of the selected elderly (55.31 %) were having western style (wall hung commode 14.89 %, floor mount commode 40.42 % in separate water closet and wall hung commode 26.92 per cent, floor mount commode 30.76 per cent in bathroom cum water closet) water closet facility followed by Indian toilet facility (44.16 %).

The data on sanitary fittings and fixtures revealed that majority of the respondents (72.34 %) had corner shelf in their bathroom and it was interesting to know that half the percentage of selected elderly were having other sanitary fittings and fixtures *viz.*, shower (65.95 %), shower chairs (61.70 %), soap holder (59.57 %). While, equal percentage (56.37 %) of them were having towel/garment rack and wash basin. Least percentage of them were having bath tub (12.76 %) in bathroom.

Regarding sanitary fittings and fixtures in water closet, about 38.29 per cent of them were having corner shelf followed by tissue paper holder (28.94 %), dustbin (14.89 %), adjustable chair (14.89 %) and waterjet (7.44 %).

Cent per cent of the respondents had towel/cloth rack in bathroom cum water closet, equal per cent (76.92 %) of the respondents had corner shelf, towel hangers and shower in bathroom cum water closet followed by wash basin and soap holder (61.53 %), tissue paper holder (46.15 %), hand shower (23.07 %), water jet (15.38 %) and bath tub (7.14 %).

The dimensions of bathroom and water closets in the houses of selected elderly were compared with the standard dimensions of bathroom and water closets given by Model Building Bye Laws, 2016. The details are shown in Table 5.

The width of the maximum number of bathrooms (71.27 %) was wider than the standards recommended, while 28.72 per cent of the bathroom were on par with recommended standard width.

Similar trend was observed with respect to the height of the bathroom. The height of maximum number (53.19 %) of the bathrooms was more than the standards recommended, while 46.80 per cent of them were on par with the standards.

Similarly, regarding the length of the bathroom, the length of maximum number (72.34 %) of the bathroom was more than the standards recommended, while 27.65 per cent of them were on par with the standards.

The area, of maximum number (92.55 %) of the bathrooms was more than the standards recommended by Model Building Bye Laws (2016), while 7.44 per cent of them were on par with the standards.

Table 5: Dimensions of bathroom and water closets of selected elderly in comparison with standards

N=120

Particulars	Bathroom n=94	Water closet n=94	Bathroom cum water closet n=26
Width (m)			
< Standard	-	-	-
On par with standard	27 (28.72)	39 (41.48)	07 (26.92)
> Standard	67 (71.27)	55 (58.51)	19 (73.07)
Height (m)			
< Standard	-	-	-
On par with	44 (46.80)	40 (42.55)	06 (23.07)
> Standard	50 (53.19)	54 (57.44)	20 (76.92)
Length (m)			
< Standard	-	-	07 (26.92)
On par with standard	26 (27.65)	37 (39.36)	8 (30.76)
> Standard	68 (72.34)	57 (60.63)	11 (42.30)
Area (m2)			
< Standard	-	-	-
On par with standard	7 (7.44)	27 (28.72)	7 (26.92)
> Standard	87 (92.55)	67 (71.27)	19 (73.07)

(Figures in the parentheses indicate percentage)
Standard dimensions: Reference: Model Building Bye Laws, 2016

Regarding the width of the water closet, about 58.51 per cent of water closet were wider than the standards recommended, while 41.48 per cent of the bathrooms were on par with recommended standard width.

Similar trend was observed with respect to height of the water closet, where the height of maximum number (57.44 %) of the water closets was more than the standards recommended, while 42.55 per cent of them were on par with the standards.

Similarly, the length maximum number of the water closets (60.63 %) was more than the standards recommended, while 39.36 per cent of them were on par with the standards.

The area, of maximum number of the water closets (71.27 %) was more than the standards recommended, while 28.72 per cent of them were on par with the standards.

Regarding the width of bathroom cum water closets, the maximum number (73.07 %) of the bathroom cum water closets were wider than the standards recommended, while 26.92 per cent of them were on par with the standards.

Similar trend was observed with respect to height of the bathroom cum water closet, *i.e.* the height of maximum number (76.92 %) of the bathroom cum water closets was more than the standards recommended, while 23.07 per cent of them were on par with the standards.

Regarding the length, maximum number the bathroom cum water closets (42.30 %) of were above the standards recommended followed by on par with the standards (30.76 %) and less than the standards recommended (26.92 %).

The area of maximum number (73.07 %) of the bathroom cum water closets was more than the standards recommended, while 26.92 per cent of them were on par with the standards.

Intensity of natural and artificial light available in bathroom and water closets is depicted in Table 6. The intensity of light was measured by the Lux meter at three

Table 6: Quantity of natural and artificial light available in bathroom and water closet

N=120

Type of light	Bathroom (n=94)	Water closet (n=94)	Bathroom cum water closet (n=26)
Natural light			
< 100	37 (39.36)	46 (48.93)	10 (38.46)
> 100	57 (60.63)	48 (51.06)	16 (61.53)
Artificial light			
< 100	56 (59.57)	69 (73.40)	16 (61.53)
> 100	38 (40.42)	25 (26.59)	10 (38.46)

(Figures in the parentheses indicate percentage)

Table 7: Nutritional status of the selected elderly

N=120

BMI classification	Respondents		
	Male n=70	Female n=50	Total N=120
Under weight (<18.5)	26 (37.14)	14 (28.00)	40 (33.33)
Normal weight (18.5-24.9)	16 (22.85)	8 (16.00)	24 (20.00)
Over weight (25.0-29.9)	21 (30.00)	19 (38.00)	40 (33.33)
Obese class (≥ 30)	7 (10.00)	9 (18.00)	16 (13.33)

(Figures in the parentheses indicate percentage)
Source: BMI classification for Asian adults (2004)

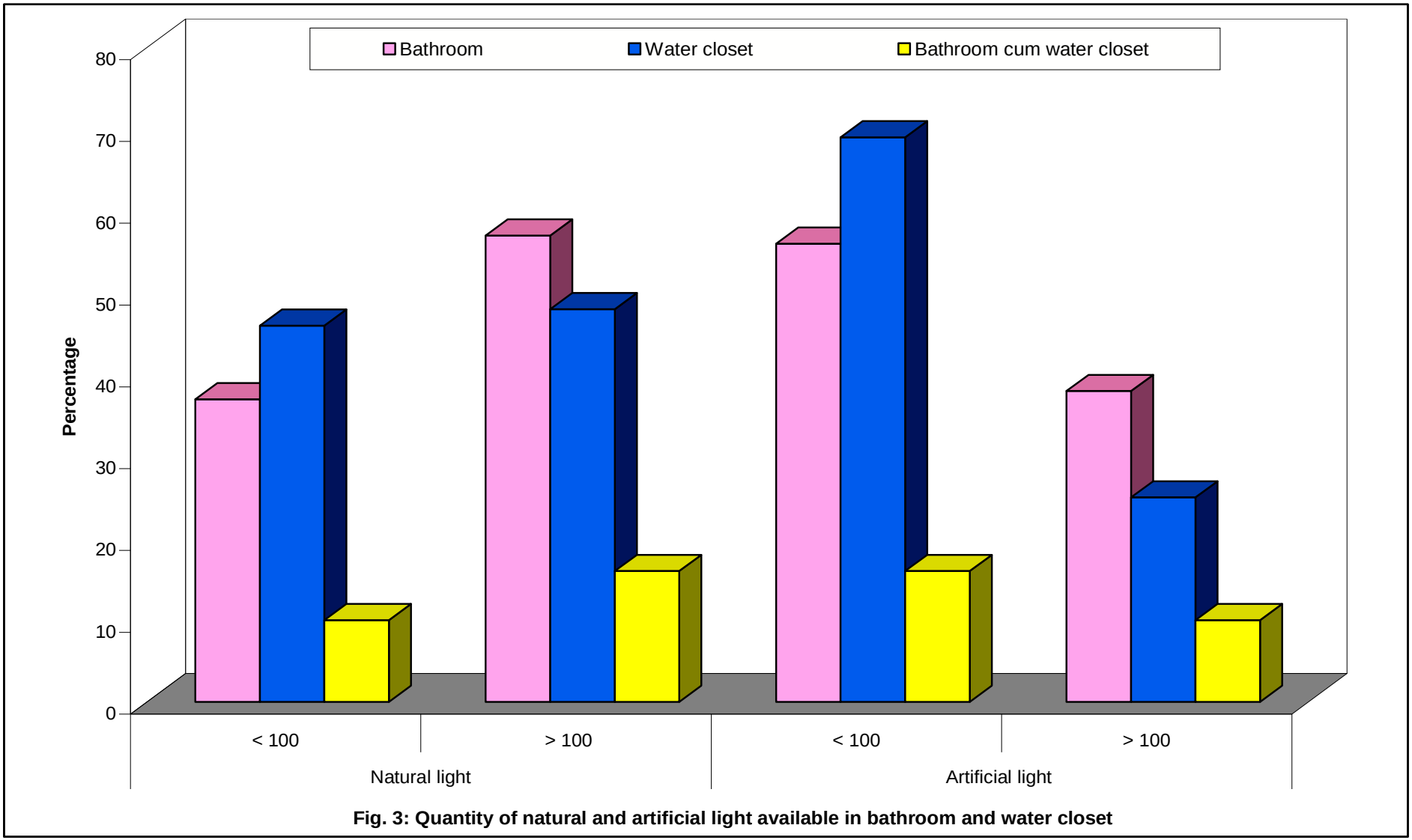

Fig. 3: Quantity of natural and artificial light available in bathroom and water closet

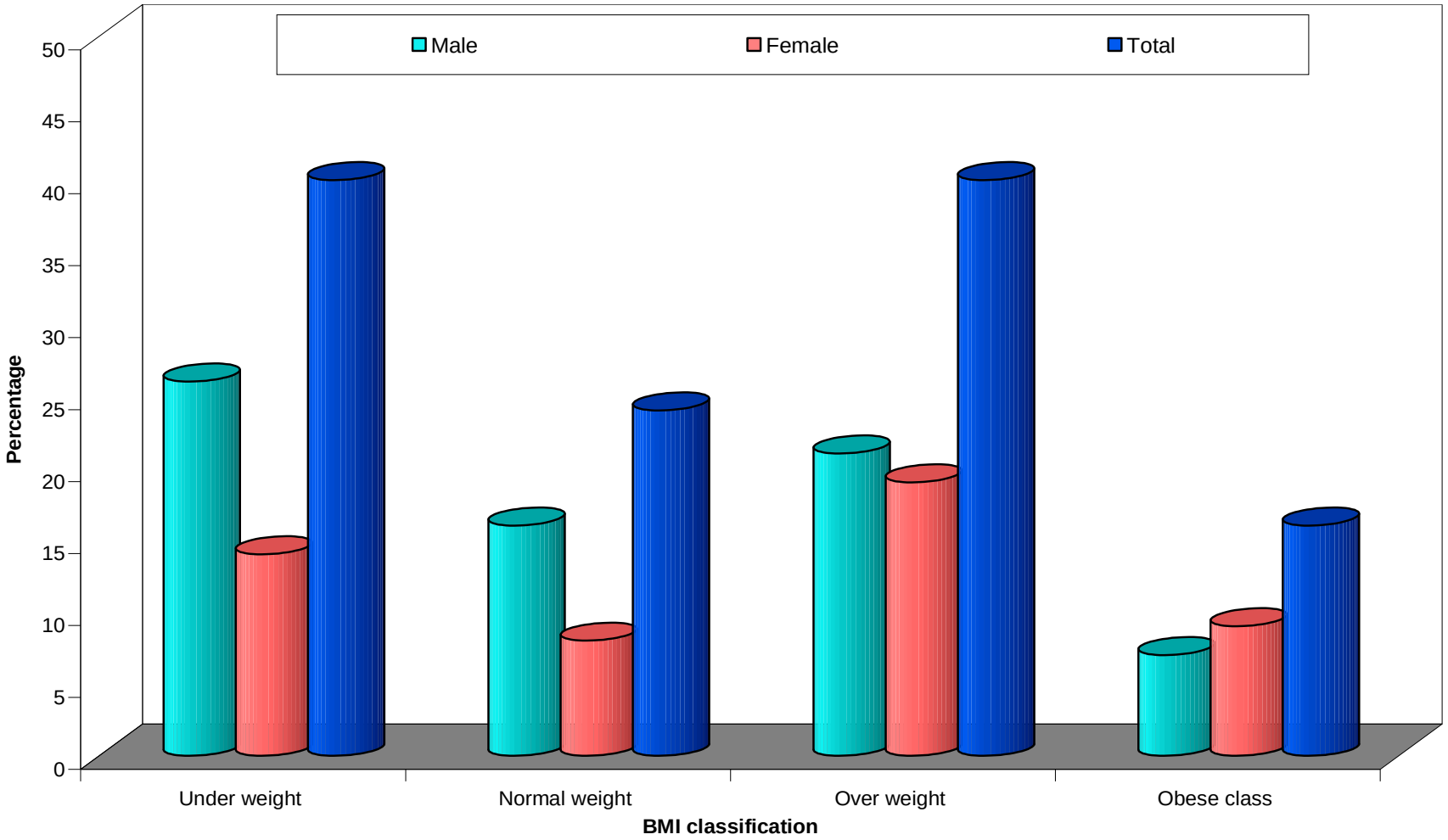

Fig. 4: Nutritional status of the selected elderly

different timings for natural light and one reading for artificial light. These readings were compared with the standards of National Building Code of India (NBO), 1996.

The results revealed that the intensity of natural light in maximum number (60.63 %) of bathrooms of the selected households was more than the recommended standard (100 Lux) followed by below the recommended standards (39.36 %).

Likewise, in maximum number of water closets (51.06 %) the natural light was more than the standard recommended followed by less than the standard recommended (48.93 %).

Similarly, in maximum number of bathroom cum water closets (61.53 %), the intensity of natural light was more than the standard recommended followed by less than the standard recommended (38.46 %).

The reverse trend was seen in case of artificial lighting *i.e.* in maximum number (59.57 %) of the bathrooms, the intensity of artificial light was less than the standard recommended followed by more than the standard recommended (40.42 %).

Similarly, in maximum number of water closets (73.40 %), the intensity of artificial light was less than the standard recommended (26.59 %).

Likewise, majority of the bathroom cum water closet (61.53 %), the intensity of artificial light was less than the recommended standard followed by more than the recommended standard (38.46 %).

4.3 Nutritional status of selected elderly

Nutritional status of selected elderly was accessed by using Body Mass Index (BMI). Body Mass Index was computed by using height and weight and graded according to Asian adults (WHO), 2004.

It is clear from the table that about one third of both male and female sample (30 % and 38 % respectively) belonged to overweight category of BMI classification. Similarly, 37.14 per cent and 28 per cent of male and female respectively were found to be in underweight category of BMI classification followed by normal weight (male

22.85 %, female 16 %). Only 10 per cent of male and 18 per cent of female were found to be in obese category of BMI classification.

Irrespective of gender, nearly one third and equal percentage (33.33 %) of elderly belonged to underweight and overweight followed by normal weight (20 %) and obese class (13.33 %).

The general health problems among the selected elderly is shown in Table 8. Regarding the physical health problems of elderly, general weakness was found to be a major health problem among both male (64.20 %) and female respondents (66 %) followed by poor eyesight (male 58.5 %, female 64 %), loss of hearing (male 50 %, female 54 %), fatigue (male 48.5 %, female 56 %), loss of appetite (male 34.2 %, female 40 %), while physical limitations was the least found problem among both male (15.7 %) and female respondents (10 %).

The association between the different physical problems faced by the elderly and the gender was found to be statically non-significant (x^2value:0.8).

Irrespective of gender, general weakness was found to be the major health problem among elderly (65 %) followed by poor eye sight (60.8 %), fatigue (51.6 %), loss of hearing (51.6 %), loss of appetite (36.6 %) and physical limitations (15.8 %).

Regarding the body pain, majority of both male (75.70 %) and female elderly respondents (86 %) experienced pain in knees followed by pain in legs (male 57.1 %, female 80 %), shoulder pain (male 58.5 %, female 58 %), back pain (male 44.2, female 54 %) and headache (male 45.7 %, female 34 %).

The association between the different body pains suffered by the elderly and the gender was found to be statically non-significant (x^2value: 2.8).

Irrespective of gender, ‘pain in knees’ was the major problem faced by the selected elderly (80 %) followed by pain in legs (66 %), shoulder pain (58.3 %), back pain (48.3 %) and headache (34.1 %).

The findings of physiological disorders of selected elderly revealed that majority of the male respondents (67.10 %) suffered from blood pressure and on contrary

Table 8: General health problems among the selected elderly

N=120

Sl. No.	Health problems	Male n=70	Female n=50	Total N=120	X^2 value
I	**Physical problems**				
a)	Fatigue	34 (48.5)	28 (56)	62 (51.6)	0.8 NS
b)	General weakness	45 (64.2)	33 (66)	78 (65)	
c)	Poor eyesight	41 (58.5	32 (64)	73 (60.8)	
d)	Loss of hearing	35 (50)	27 (54)	62 (51.6)	
e)	Loss of appetite	24 (34.2)	20 (40)	44 (36.6)	
f)	Physical limitations (back/leg/hands)	11 (15.7)	8 (10)	19 (15.8)	
II	**Body pain**				2.8NS
a)	Pain in the knees	53 (75.7)	43 (86)	96 (80)	
b)	Pain in legs	40 (57.1)	40 (80)	80 (66.6)	
c)	Back pain	31 (44.2)	27 (54)	58 (48.3)	
d)	Shoulder pain	41 (58.5)	29 (58)	70 (58.3)	
e)	Headache	25 (35.7)	16 (32)	41 (34.1)	
III	**Physiological disorders**				2.92NS
a)	Blood pressure (Low/High)	47 (67.1)	31 (62)	78 (65)	
b)	Asthma	15 (21.4)	7 (14)	22 (18.3)	
c)	Diabetes	45 (64.2)	35 (70)	80 (66.6)	
d)	Arthritis	30 (42.8)	16 (32)	46 (38.3)	
e)	Coronary heart disease	30 (42.8)	11 (22)	41 (34.1)	

(Figures in the parentheses indicate percentage)

NS- Non-significant
*Multiple answer

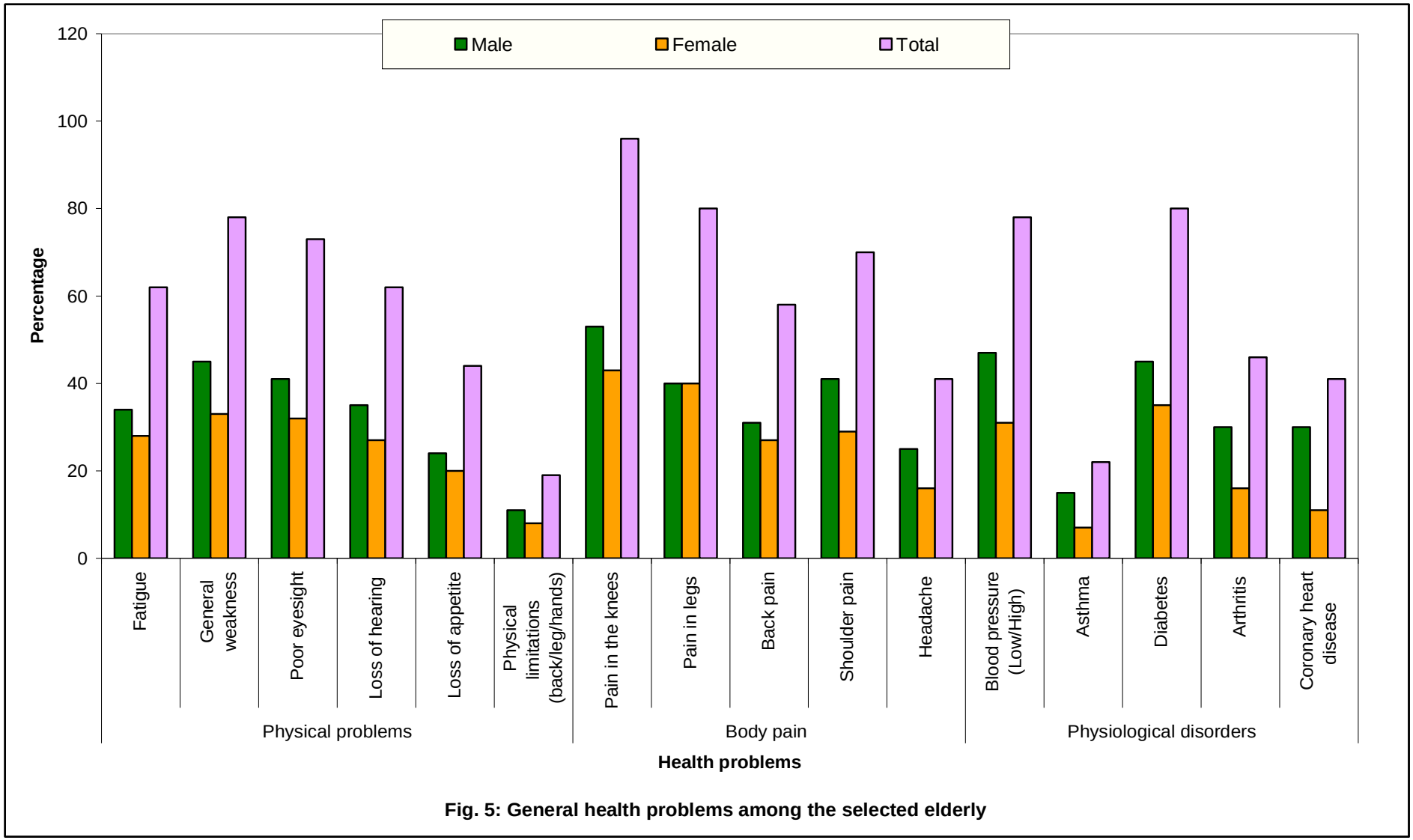

Fig. 5: General health problems among the selected elderly

majority of the female respondents (70 %) suffered from diabetes. About 62 per cent of female respondents were suffering from blood pressure, while 64.2 per cent of male were suffering from diabetes followed by arthritis (male 42.8 %, female 32 %), coronary heart diseases (male 42.8 %, female 22 %). Asthma was the least observed health problem among both male (21.4 %) and female (14 %) respondents.

The association between the different physiological disorders faced by the elderly and the gender was found to be statically non-significant (x^2value: 2.92).

Irrespective of gender, 'diabetes' was the major problem faced by the selected elderly (66.6 %) followed by blood pressure (65 %), arthritis (38.3 %), coronary heart diseases (34.1 %) and asthma (18.3 %).

4.4 Problems faced by selected elderly in bathroom and water closet

The opinion of selected elderly towards existing conditions of bathroom was collected on three-point scale starting from not problematic to highly problematic and is depicted in Table 9. Majority of the elderly respondents were facing problem in using separate bathroom and water closet (problematic 32.50 %, highly problematic 27.50 %) and only 18.33 per cent of them opined it as not problematic.

It is clear from the table that, majority of the elderly respondent were facing problem with flooring (highly problematic 43.33 %, problematic 45.74 %) followed by absence of grab bars (highly problematic 40.83 %, problematic 34.16 %), lighting (highly problematic 34.16 %, problematic 32.50 %), hot water facility (highly problematic 30 %, problematic 40 %), ventilation (highly problematic 31.66 %, problematic 36.66 %), water supply (highly problematic 36.66 %, problematic 31.66 %), storage facility (highly problematic 30.83 %, problematic 29.16 %), reaches of essential materials (highly problematic 27.50 %, problematic 32.50 %), shower (highly problematic 20 %, problematic 26.66 %), door width (highly problematic 10 %, problematic 7.50 %) and least was door threshold (highly problematic 5 %, problematic 10 %).

Cent per cent of the elderly respondents opined that size was not problematic. Majority of the elderly respondents (85 %) also opined that door threshold as not

problematic followed by door width (65.86 %), shower (53.33 %), storage facility and reaches of essential materials (40 %), lighting (33.33 %), ventilation (31.66 %), hot water facility (30 %) and least percentage of the selected elderly respondents opined flooring (20.83 %) as not problematic.

According to calculated mean scores, the existing water supply condition in bathroom was considered as highly problematic (2.50) by the elderly followed by flooring (2.2), absence of grab bars (2.15), using separate bathroom and water closet (2.11) and lighting, ventilation, hot water facility (2.00) as problematic and door threshold (1.20), door width (1.10), size (1.10) using bathroom cum water closet (1.00) as non problematic.

Opinion of selected elderly towards existing conditions of water closet is depicted in table 10.

Majority of the respondents (highly problematic 35 %, problematic 46 %) were facing problems with absence of grab bars followed by water supply (highly problematic 43.33 %, problematic 37.50 %), usage of toilet (Indian style) (highly problematic 36.66 %, problematic 42.50 %), lighting (highly problematic 38.33 %, problematic 32.50 %),flooring (highly problematic 35 %, problematic 34.16 %), hot water facility (highly problematic 29.16 %, problematic 39.16 %) and least percentage (highly problematic 10.83 %, problematic 32.50 %) of them were having problem with faucets.

Cent per cent of the elderly respondents opined that size of water closet was not problematic followed by storage facility and faucets (56.66 %), water facility (31.66 %), flooring (30.83 %), lighting (29.16 %), usage of toilet (Indian style) (20.83 %), water supply (19.16 %) and grab bars (18.33 %).

Regarding the height of the commode, majority of the selected elderly (33.33 %) opined it as ‘not problematic’, while 17.5 per cent of them opined it as problematic and 15.83 per cent of them opined height of the commode as highly problematic.

Table 9: Opinion of selected elderly towards existing conditions of bathroom

N=120

Existing conditions	Opinion of respondents			
	Highly problematic	**Problematic**	**Not problematic**	**Weighted mean score**
Using separate bathroom and water closet (n=94)*	33 (27.50)	39 (32.50)	22 (18.33)	2.11
Using Bathroom cum water closet (n=26)**	-	-	26 (100.00)	1.00
Flooring	52 (43.33)	43 (45.74)	25 (20.83)	2.20
Size	-	-	120 (100)	1.00
Storage facility	37 (30.83)	35 (29.16)	48 (40.00)	1.90
Lighting	41 (34.16)	39 (32.50)	40 (33.33)	2.00
Ventilation	38 (31.66)	44 (36.66)	38 (31.66)	2.00
Hot water facility	36 (30.00)	48 (40.00)	36 (30.00)	2.00
Water supply	44 (36.66)	38 (31.66)	38 (31.66)	2.50
Shower	24 (20.00)	32 (26.66)	64 (53.33)	1.65
Absence of Grab bars	49 (40.83)	41 (34.16)	30 (25.00)	2.15
Door width	12 (10.00)	9 (7.50)	78 (65.83)	1.10
Door threshold	6 (5.00)	12 (10.00)	102 (85.00)	1.20
Reaches of essential materials	33 (27.50)	39 (32.50)	48 (40.00)	1.87

(Figures in the parentheses indicate percentage
*Usage of separate bathroom and water closet
**Usage of bathroom cum water closet

Majority of the selected elderly opined floor mounted commode as problematic (highly problematic 26.08 %, problematic 39.13 %), while cent per cent of the respondents were not having problem with wall hung commode.

Regarding the type of the commode, cent per cent of the respondents opined water jet as not problematic, while using hand faucet was opined as highly problematic by 26 per cent and as problematic by 17.4 per cent of the respondents.

Regarding the tap water facility in water closet, majority of the elderly respondents opined it as problematic (highly problematic 16.98 %, problematic 43.39 %) followed by flush tank with tap water (highly problematic 12 %, problematic 11.4 %).

According to calculated mean scores, the absence of grab bars in water closets was considered as highly problematic (2.16) by the elderly followed by usage of toilet (2.15), lighting (2.09), flooring (2.04) and water supply (2.20) as problematic and wall hung commode (1.00), size (1.00), usage of hand faucet (1.40) usage of water jet (1.35) as non problematic.

Major health problems faced by the selected elderly in relation to bathroom and water closet is depicted in Table 11.

It is studied from the table that majority of the respondents ranked pain in knees while using toilet as first (GS:8664) and pain in legs while sitting and getting up as second (GS:8448). The problems like diabetes (GS:7212), physical limitations (GS:6780), poor eye sight (GS:6096), general weakness (GS:5640), shoulder pain (GS:5328), heart diseases (GS:4260), arthritis (GS:4044) and fatigue (GS:3996) were ranked from third to tenth respectively.

Problem faced by selected elderly in bathroom and water closets according to Garret ranking scores is shown in Table 12.

The majority of the respondents ranked slippery flooring (GS:8704) and lack of grab bars (GS:8501) as first and second respectively. ‘Difficulty in using Indian toilet’ (GS:6803) was ranked third followed by difficulty in operating taps (GS:6090), not

Table 10: Opinion of selected elderly towards existing conditions of water closet

N=120

Existing conditions	Opinion of respondents			Weighted mean score
	Highly problematic	Problematic	Not problematic	
Flooring	42 (35.00)	41 (34.16)	37 (30.83)	2.04
Size	-	-	120 (100)	1.00
Storage facility	24 (20.00)	28 (23.33)	68 (56.66)	1.63
Lighting	46 (38.33)	39 (32.50)	35 (29.16)	2.09
Ventilation	30 (25.00)	29 (24.16)	61 (50.83)	1.79
water facility	35 (29.16)	47 (39.16)	38 (31.66)	1.97
water supply	52 (43.33)	45 (37.50)	23 (19.16)	2.20
Usage toilet	44 (36.66)	51 (42.50)	25 (20.83)	2.15
Faucets	13 (10.83)	39 (32.50)	68 (56.66)	1.54
Grab bars	42 (35.00)	56 (46.66)	22 (18.33)	2.16
Door width	24 (20.00)	31 (25.83)	65 (54.16)	1.65
Door threshold	24 (20.00)	28 (23.33)	68 (56.66)	1.63
Commode (n=67)				
Height of the commode	19 (15.83)	21 (17.5)	40 (33.33)	2.07
Type of commode				
Wall hung (n=21)	-	-	21 (100.0)	1.00
Floor mounted (n=46)	12 (26.20)	18 (39.13)	16 (34.78)	1.91
Type of faucet				
Hand faucet	13 (26.00)	12 (17.14)	31 (55.35)	1.40
Water jet	3 (6.00)	2 (2.85)	6 (54.54)	1.35
Position of faucet	12 (24.00)	14 (20.00)	30 (53.57)	1.46
Indian toilet (n=53)				
Presence of support	-	-	-	
Tap water	9 (16.98)	23 (43.39)	21 (17.5)	1.77
Flush tank with tap water	6 (12.00)	8 (11.42)s	9 (7.50)	2.15

(Figures in the parentheses indicate percentage)

enough artificial lighting (GS:4969), insufficient water supply (GS:4966), insufficient force of water (GS:4800), and unsafe hot water facility (GS:3386) were ranked from fourth to seventh respectively. The elderly male respondents ranked slippery flooring as first and lack of grab bars as second while on contrary the elderly female respondents ranked lack of grab bars as first and slippery flooring as second.

The relationship between independent variables *viz.*, age, SES, health problems and bathroom and water closet conditions (Lack of accessories/ facilities) among elderly and the dependent variable *i.e.* extent of problems faced by elderly in bathroom and water closets is depicted in Table 13.

It is clear from the table that as the age progressed the extent of problems faced by selected elderly in bathroom and water closet was also increased. It was found to be statistically significant at one per cent level. Similarly, positive significant relationship was observed between poor bathroom and water closet conditions (absence of accessories/facilities) and extent of problems faced. Though the relationship between health problems and extent of problems faced in bathroom and water closet conditions was positive and it was proved to be statistically non-significant.

Occurrence of falls/accidents among elderly in bathroom and water closet is shown in Table 14

It is clear from the table that nearly one fifth of the respondents (19.16 %) had met with falls/accidents in bathroom and water closets. The reasons for accidents was due to absence of supports (9.1 %) followed by slippery flooring (7.5 %) and due to health problems (2.5 %). The occurrence of falls/accidents among female respondents (28.1 %) was comparatively more than male respondents (12.85 %).

The impact of falls and accidents on elderly was studied and is shown in Table 14(b). The elderly respondents suffered from lower back pain (10.8 %), sprain in legs (8.33 %), leg fracture (2.5 %) after the occurrence of falls/accidents in bathroom and water closets.

Table 11: Major health problems faced by the selected elderly in relation to bathroom and water closet

N=120

Health problems	Garret score (GS)					
	Male n=70	**Rank**	**Female n=50**	**Rank**	**Total n=120**	**Rank**
Pain in knees while using toilets	50554	I	3601	I	8664	I
Pain in legs while sitting and getting up	4928	II	3520	II	8448	II
Diabetes (frequent urination)	4207	III	3005	III	7212	III
Physical limitations	3955	IV	2525	V	6780	IV
Poor eye sight	3556	V	2540	IV	6096	V
General weakness	3290	VI	2350	VI	5640	VI
Shoulder pain (no supports in bathroom)	3108	VII	2220	VII	5328	VII
Heart disease (to be taken care not to lift heavy materials)	2485	VIII	1775	VIII	4260	VIII
Arthritis	2359	IX	1685	X	4044	IX
Fatigue	2331	X	1665	IX	3996	X

(Figures in the parentheses indicate percentage

Table 12: Problems faced by selected elderly in bathroom and water closet according to Garret ranking

N=120

Particulars	Garrett score					
	Male n=70	**Rank**	**Female n=50**	**Rank**	**Total N=120**	**Rank**
Slippery flooring	5054	I	3650	II	8704	I
Lack of grab bars	4921	II	3680	I	8501	II
Difficulty in using Indian toilet	4123	III	2680	IV	6803	III
Difficulty in operating taps	3325	IV	2765	III	6090	IV
Insufficient water supply (faucet)	3066	V	1900	VII	4966	VII
Insufficient force of water (faucet)	2730	VII	2070	VI	4800	VII
Unsafe hot water facility	1946	VIII	1440	VIII	3386	VIII
Not enough artificial lighting	2884	VI	2085	V	4969	V

Table 13: Relationship between health, bathroom and water closet problems among elderly and independent variables

N=120

Independent variables	Extent of problems faced in bathroom and water closet		
	Male n=70	**Female n=50**	**Total N=120**
Age	0.236*	0.236*	0.216*
SES	-0.00316 NS	-0.1704 NS	-0.0389 NS
Health problems	0.1017 NS	0.0535 NS	0.0535 NS
Poor bathroom and water closet conditions	0.6285**	0.6541**	0.6200**

NS- Non Significant
*Correlation significant at 0.05 level
**Correlation significant at 0.01 level

4.5 Suggestions for modification of existing bathroom is depicted in Table 15

It is clear from the table that, majority of the respondents (male 97.14 %, female 50 %), suggested for the provision of non-slippery floors with mat furnished tiles followed by provision of grip/grab bars to the entire bathroom (male 91.43 %, female 50 %), requirement of hand showers (male 87.14 %, female 72 %), provision of solar hot water facility (male 85.70 %, female 46 %), sufficient intensity of artificial light (male 78.50 %, female 26 %) and provision of temperature controlled faucet was the least suggested bathroom accessory by 2.8 per cent of male respondents.

Between male and female responses towards giving the suggestions, more number of suggestions have come from male as compared to female respondents. However the association between suggestions for modification of bathroom and gender was found to be statistically non-significant (x^2value: 2.82)

Preference of suggestions for the modification in existing bathroom according to Garret ranking scores is shown in Table 16.

Majority of the respondents ranked provision of non-slippery floor with mat furnished tiles (GS:12150) as first followed by provision of grip or grab bars to the entire room (GS:10350), provision of solar hot water facility (GS:9685), sufficient intensity of artificial light (GS:8400), provision of water jet (GS:7659), bathroom must be free from sharp edges (GS:6441), exhaust fan to maintain temperature and to dry the bathroom (GS:5700), requirement of hand showers to avoid excessive movement (GS:4650), need for storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories (GS:4266) and provision of bigger size electrical switches at comfortable height (GS:2289) ranked from second to tenth respectively.

Suggestions given by elderly for the modification of existing water closet is depicted in Table 17.

It is cleared from the table that majority of the respondents (male 92.8 %, female 82 %) suggest preference of western toilet followed by provision of hand support (male

Table 14a: Occurrence of falls / accidents among elderly in bathroom and water closet

N=120

Reasons for accidents	Respondents		
	Male n=70	**Female n=50**	**Total n=120**
Fall due to health problems (low sugar/ giddiness)	01 (1.4)	02 (4.00)	03 (2.5)
Fall due to no support	4 (5.7)	7 (14.00)	11 (9.1)
Fall due to slipperiness	4 (5.7)	5 (10.00)	09 (7.5)
Fall due to insufficient lighting	-	-	-
Total	9(12.85)	14(28.00)	23(19.16)

(Figures in the parentheses indicate percentage)

Table 14b: Impact of falls or accidents in bathroom and water closet on selected elderly

N=120

Reasons for accidents	Respondents		
	Male n=70	**Female n=50**	**Total n=120**
Sprain in leg	4 (5.7)	6 (12.00)	10 (8.33)
Leg fracture	2 (2.8)	1 (2.00)	3 (2.5)
Lower back pain	7 (10.00)	6 (12.00)	13 (10.8)

(Figures in the parentheses indicate percentage)

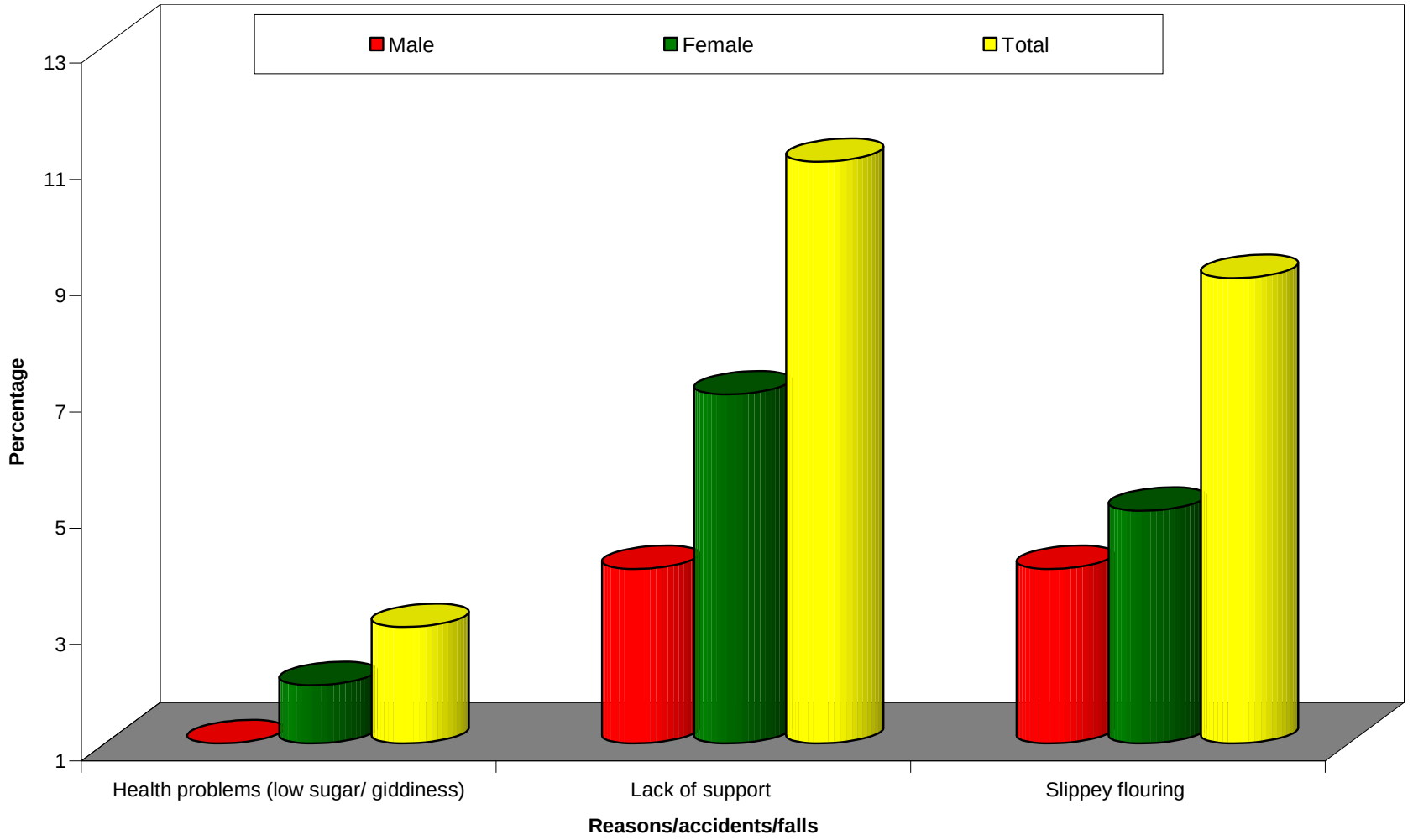

Fig. 6: Occurrence of falls / accidents among elderly in bathroom and water closets

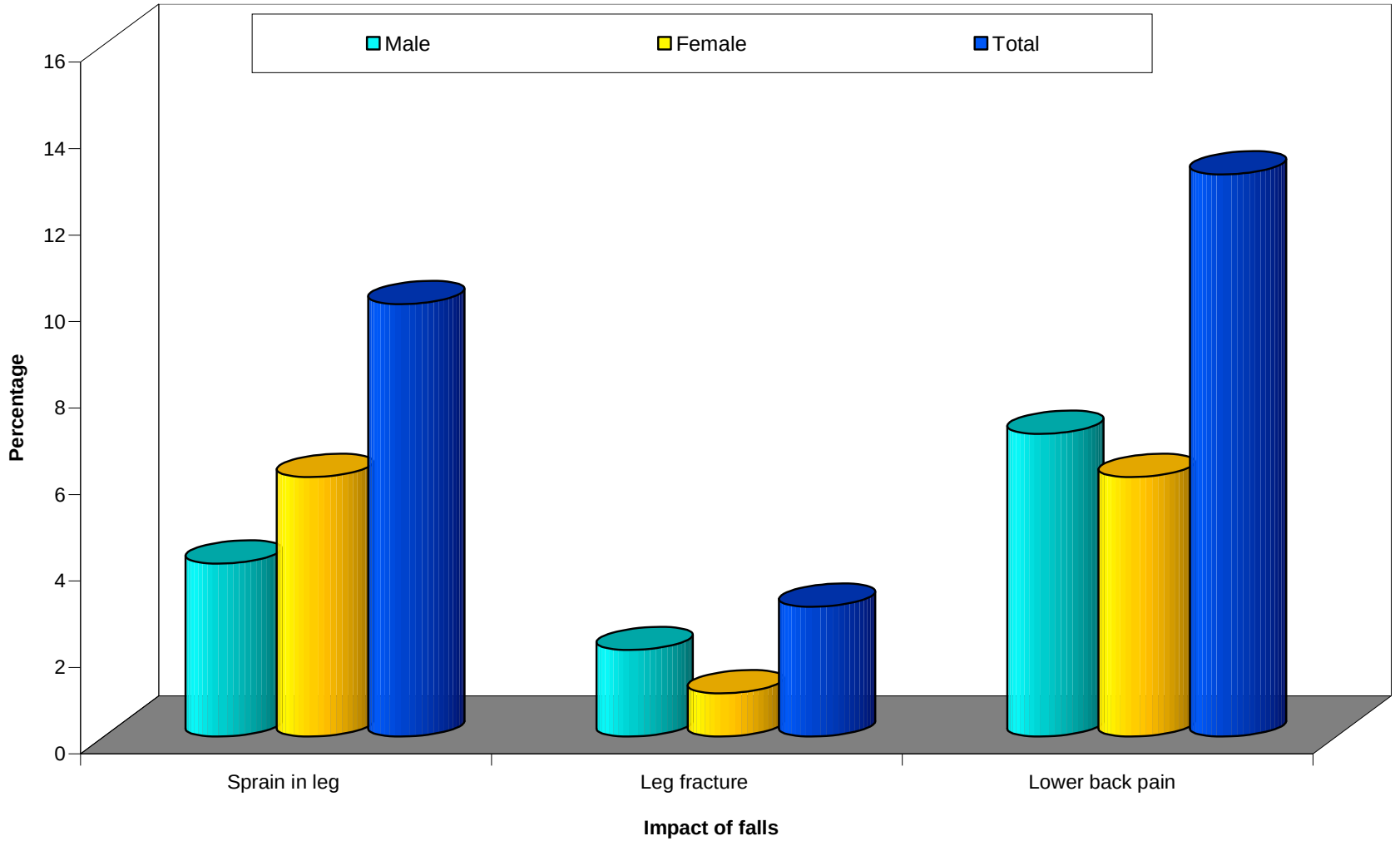

Fig. 7: Impact of falls or accidents in bathroom and water closet on selected elderly

Table 15: Suggestions given by the elderly for modifications in existing bathroom

N=120

Suggestions for modification	Male n=70	Female n=50	Total N=120	X^2 Value
Provision for sitting with back rest	24 (34.2)	17 (34.00)	41 (34.16)	2.82 NS
Provision of hand grip	60 (85.7)	34 (68.00)	94 (78.33)	
Provision of water jet	48 (68.5)	21 (42.00)	69 (57.5)	
Must be spacious	46 (38.33)	29 (24.16)	75 (62.5)	
Must be good ventilated	41 (58.57)	18 (36.00)	59 (49.16)	
Must be free from slippery and sharp edges	24 (3.4)	12 (24.00)	26 (30.00)	
Provision of non-slippery floor with mat furnished tiles	68 (97.14)	38 (76.00)	106 (88.33)	
Provision of grip or grab bars to the entire bathroom	64 (91.43)	35 (50.00)	99 (82.5)	
Requirement of hand showers to avoid excessive movement	61 (87.14)	36 (72.00)	97 (80.83)	
Provision of solar hot water facility	60 (85.70)	23 (46.00)	83 (69.16)	
Sufficient intensity of artificial light	55 (78.50)	23 (26.00)	78 (65.00)	
Bedroom should be with night lamp to ease night walking to the bathrooms	32 (45.5)	12 (24.00)	44 (36.66)	
Provision of bigger size electrical switches at a comfortable height	41 (58.57)	23 (46.00)	64 (53.33)	
Provision two way switches near bed	31 (44.2)	15 (30.00)	46 (38.33)	
Exhaust and ordinary fans to maintain temperature and to dry the bathroom	24 (34.28)	12 (24.00)	36 (30.00)	
Need of shelf to keep hand towels, napkin and garments	48 (68.5)	18 (36.00)	66 (55.00)	
Need for storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories	46 (65.71)	23 (46.00)	69 (57.50)	
Need for convenient reaches of shelves and storage facilities	24 (34.2)	12 (24.00)	36 (30.00)	
Provision of temperature controlled faucet	2 (2.8)	-	2 (1.666)	

(Figures in the parentheses indicate percentage)

NS- Non-significant
*Multiple answer

Table 16: Preference of suggestions for the modifications in existing bathroom

N=120

Suggestions for modification	Garret score (GS)					
	Male n=70	**Ranks**	**Female n=50**	**Ranks**	**Total N=120**	**Ranks**
Provision of non slippery floor with mat furnished tiles	6608	I	5592	I	12150	I
Provision of grip or grab bars to the entire room	5550	II	4800	II	10350	II
Provision of solar hot water facility	5105	III	4580	III	9685	III
Sufficient intensity of artificial light	4900	IV	3500	IV	8400	IV
Provision of water jet	4200	V	3459	V	7659	V
Bathroom must be free from sharp edges	4041	VI	2400	VI	6441	VI
Exhaust fan to maintain temperature and to dry the bathroom.	3500	VII	2200	VII	5700	VII
Requirement of hand showers to avoid excessive movement	2483	VIII	2167	VIII	4650	VIII
Need for storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories	1986	IX	1280	IX	4266	IX
Provision of bigger size electrical switches at comfortable height	1058	X	1231	X	2289	X

87.1 %, female 100 %), free from slippery, sharp edges and obstacles (male 84.28 %, female 64 %), provision of sufficient artificial light (male 80 %, female 56 %), need of squatty potty for western toilet (male 70 %, female 64 %) and adjustable chairs for sitting in Indian toilets (male 60 %, female 18 %).

Between male and female responses towards giving the suggestions, more number of suggestions have come from male as compared to female respondents. However the association between suggestions for modification of water closet and gender was found to be statistically non-significant (x^2 value:2.32)

Preference of suggestions for the modifications in existing water closet as for the garret ranking scores is shown in Table 18.

Majority of the respondents ranked hand supports/grab bars (GS:1754) as first followed by provision of western toilet (GS:1488), free from slippery, sharp edges and obstacles (GS:1239), provision of sufficient artificial light (GS:1084), need of squatty potty for western toilet (GS:485), sufficient force and supply of water (GS:643) and adjustable chairs for sitting in Indian toilet (GS:424) were ranked from second to seventh respectively.

4.6 User friendly ergonomic bathroom cum water closet designs for elderly

The designs are proposed based on the standards recommended by Model Building Bye Laws, 2016 (width- 1.2, height- 2.1, length-2.3, area- 2.8 m^2) and the suggestions given by the selected elderly for the modification of bathroom and water closets.

These designs are proposed to help the elderly people for toileting, bathing safely and comfortably. Both bathing and toileting region are mounted on a single piece of model, hence it is comfortable, safe and user friendly and it is suitable for all family members especially for the elderly people, children and persons with physical disabilities.

Table 17: Suggestions given by elderly for modification of existing water closet

N=120

Suggestions for modification	Male n=70	Female n=50	Total N=120	X^2 Value
Preference of western toilet	65 (92.8)	41 (82.00)	106 (88.33)	2.32 NS
Adjustable chairs for seating in Indian toilets	42 (60)	9 (18.00)	51 (42.5)	
Provision for sitting with back rest	54 (77)	16 (32.00)	70 (58.33)	
Provision of hand supports	61 (87.1)	50 (100.00)	111 (92.50)	
a) Front support	11 (15.71)	14 (28.00)	25 (20.83)	
b) Side support	32 (45.7)	16 (32.00)	48 (40.00)	
c) Vertical support	18 (25.7)	20 (40.00)	38 (31.66)	
Free from slippery, sharp edges and obstacles	59 (84.28)	32 (64.00)	91 (75.83)	
Provision of sufficient artificial light	56 (80.00)	28 (56.000)	84 (79.33)	
Need of Squatty potty for western toilets	49 (70.00)	32 (64.00)	81 (67.50)	

(Figures in the parentheses indicate percentage)
NS- Non-significant
*Multiple answers

Table 18: Preference of suggestions for the modification in existing water closet

N=120

Suggestions for modification	Garret score (GS)					
	Male n=70	**Ranks**	**Female n=50**	**Ranks**	**Total N=120**	**Ranks**
Provision of hand support/grab bars	882	I	872	I	1754	I
Preference of western toilet	736	II	712	II	1448	II
Free from slippery, sharp edges and obstacles	625	III	614	III	1239	III
Provision of sufficient artificial light	548	IV	536	IV	1084	IV
Need of squatty potty for western toilet	432	V	413	V	845	V
Sufficient force and supply of water	326	VI	317	VI	643	VI
Adjustable chairs for sitting in Indian toilet	214	VII	210	VII	424	VII

Elderly specific bathroom layout is shown in design I and II. The design includes built in and within reach shelves and cloth rack for the storage of clothes and bathroom accessories and toiletries, sink with mirror for burnishing and washing face, a dustbin below the sink for the waste disposal, a wall hung commode with both water jet and hand faucet facility with grab bars at comfortable height to hold the balance and to get up easily.

In design II, commode is replaced by Indian toilet with grab bars at both sides and at two different heights at squatting elbow height and shoulder height level to hold the body balance and get up easily. In extreme case *i.e.,* for disabled persons adjustable chairs are suggested. The non-skid mat is provided at the sink and water closet region to avoid slips, falls/risks and to keep the region dry. In the bathing region shower chair is fixed to the wall for the comfortable bathing. Grab bars are fixed at the left side of the shower chair to hold the balance and get up easily. Hand shower with taps and soap holder are fixed at the right side of the shower chair to avoid excessive movement and slips among elderly. The provision of exhaust fan and ventilator is made to maintain the temperature and to get enough natural lighting. Bigger size electrical switches at comfortable height should be provided. Compact florescent bulbs are preferred for sufficient artificial lighting. Solar hot water facility is suggested to the entire bathroom cum water closet unit *i.e.* for sink, water jet/faucet, hand showers/taps. Non skid flooring is recommended in bathing region to avoid falls/accidents.

Advantages

- The bathroom cum water closet is free from sharp edges and obstacles.
- The suggestions proposed in the design like provision of non-skid mat, sufficient artificial lighting, grab bars, solar hot water facility can be adopted by all under existing conditions.
- The proposed design occupies less space, is good looking, safe, comfortable, less expensive and user friendly.

Limitations

- The proposed floor plan is not applicable/ suitable for existing separate bathroom and water closets.

Applications

- It is suitable for all family members including elderly persons children and persons with physical disabilities/limitations.

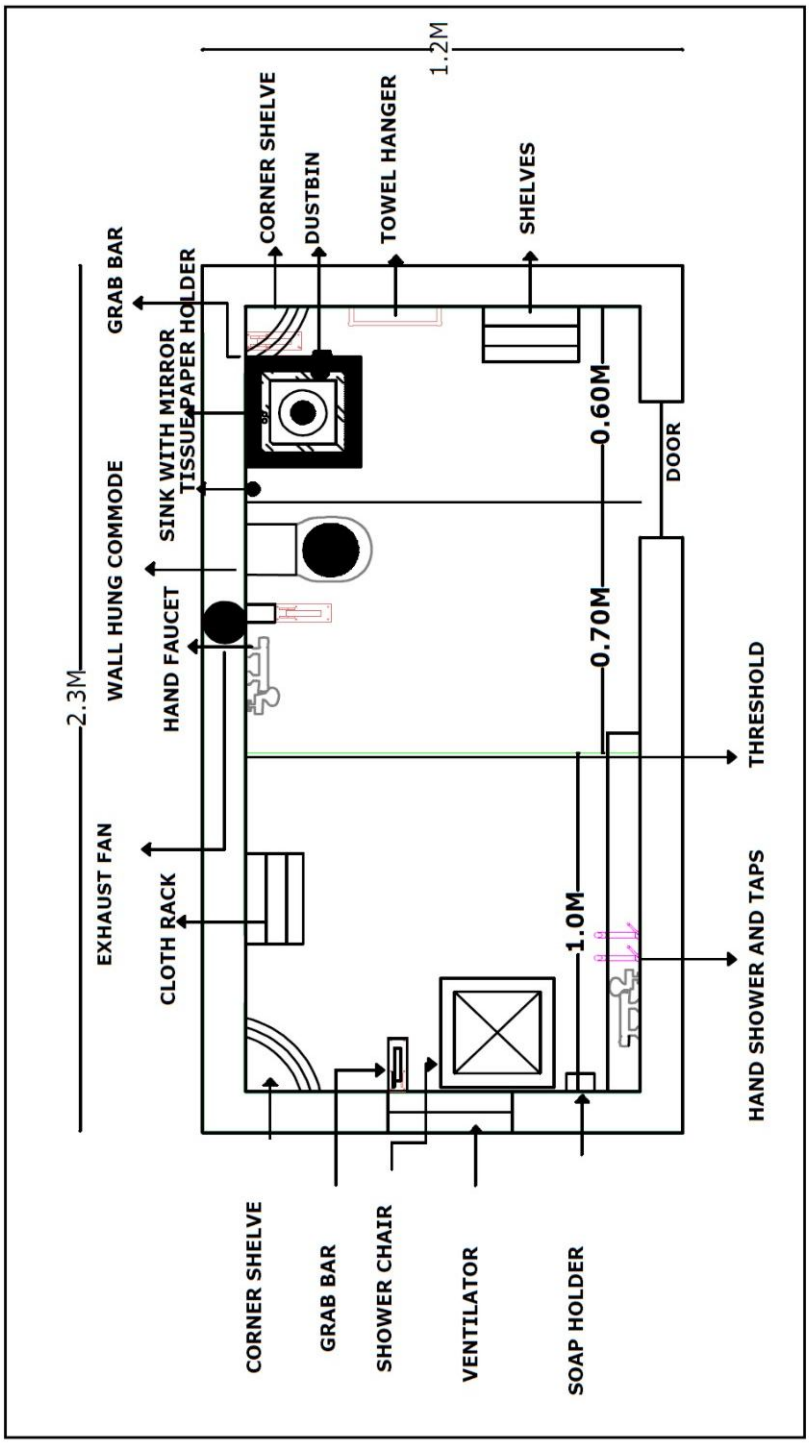

Plate 7: Floor plan of bathroom cum western style water closet (Design 1)

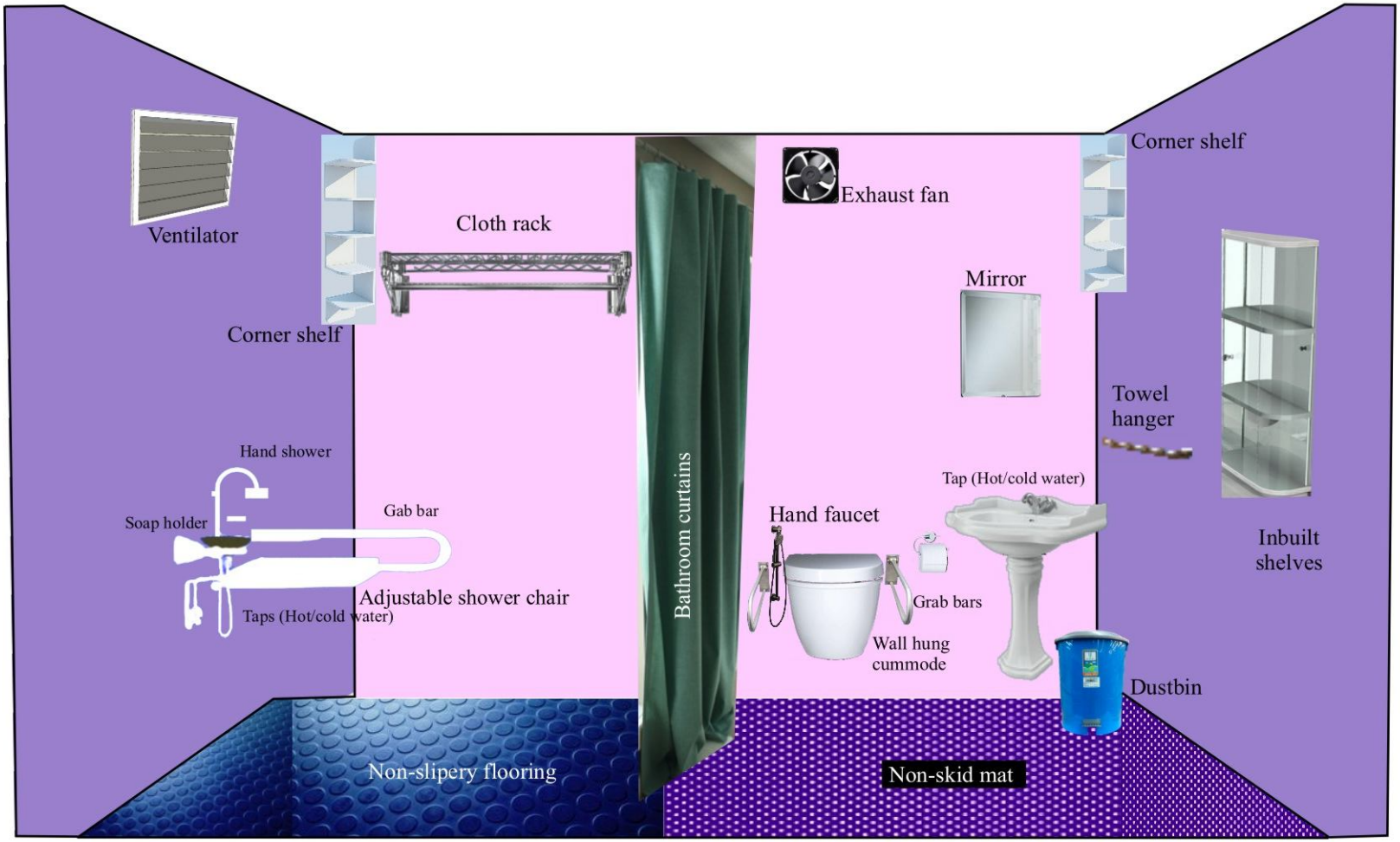

Plate 8: 3D Model design of bathroom cum western style water closet

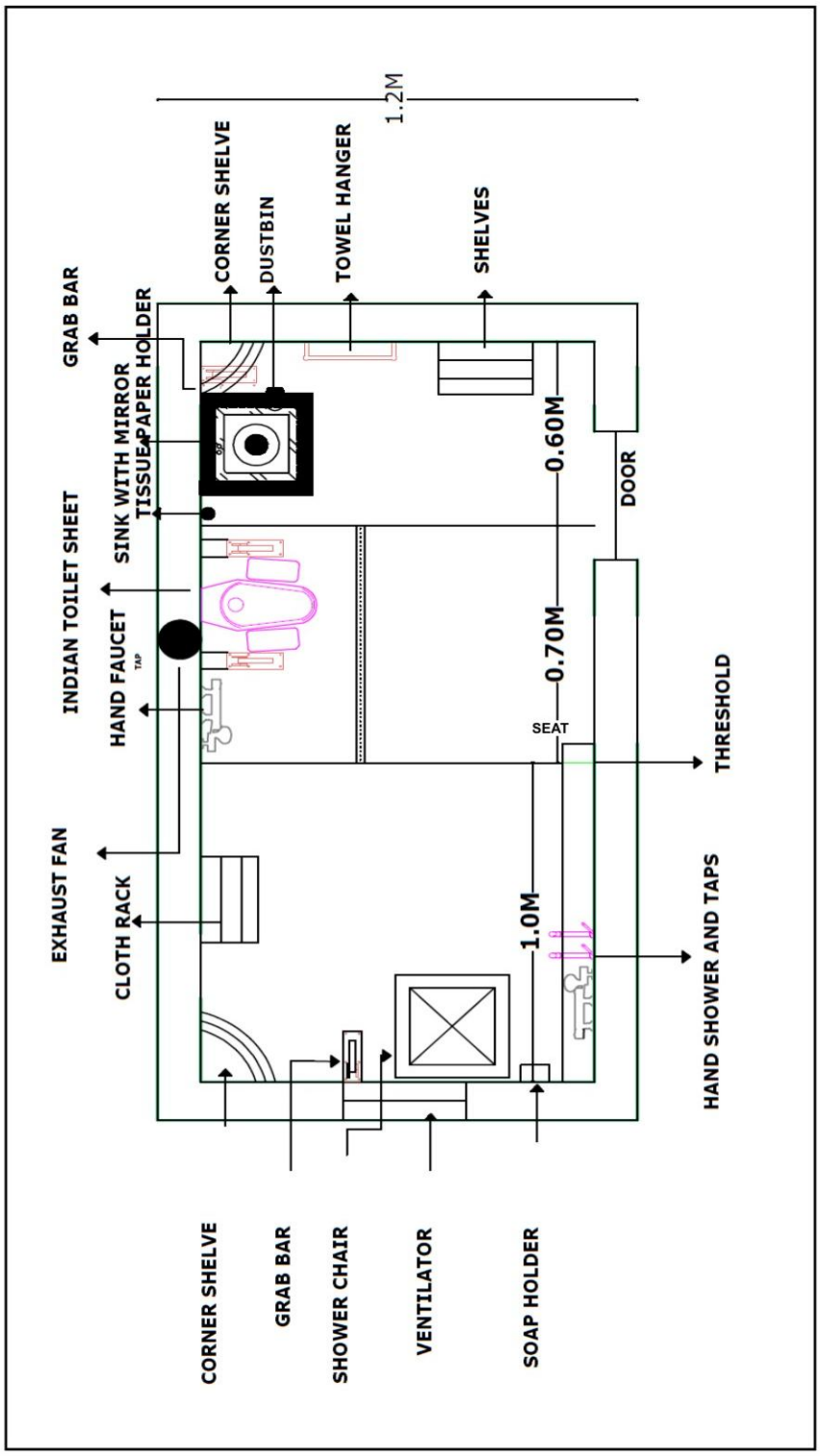

Plate 9: Floor plan of bathroom cum Indian style water closet (Design 2)

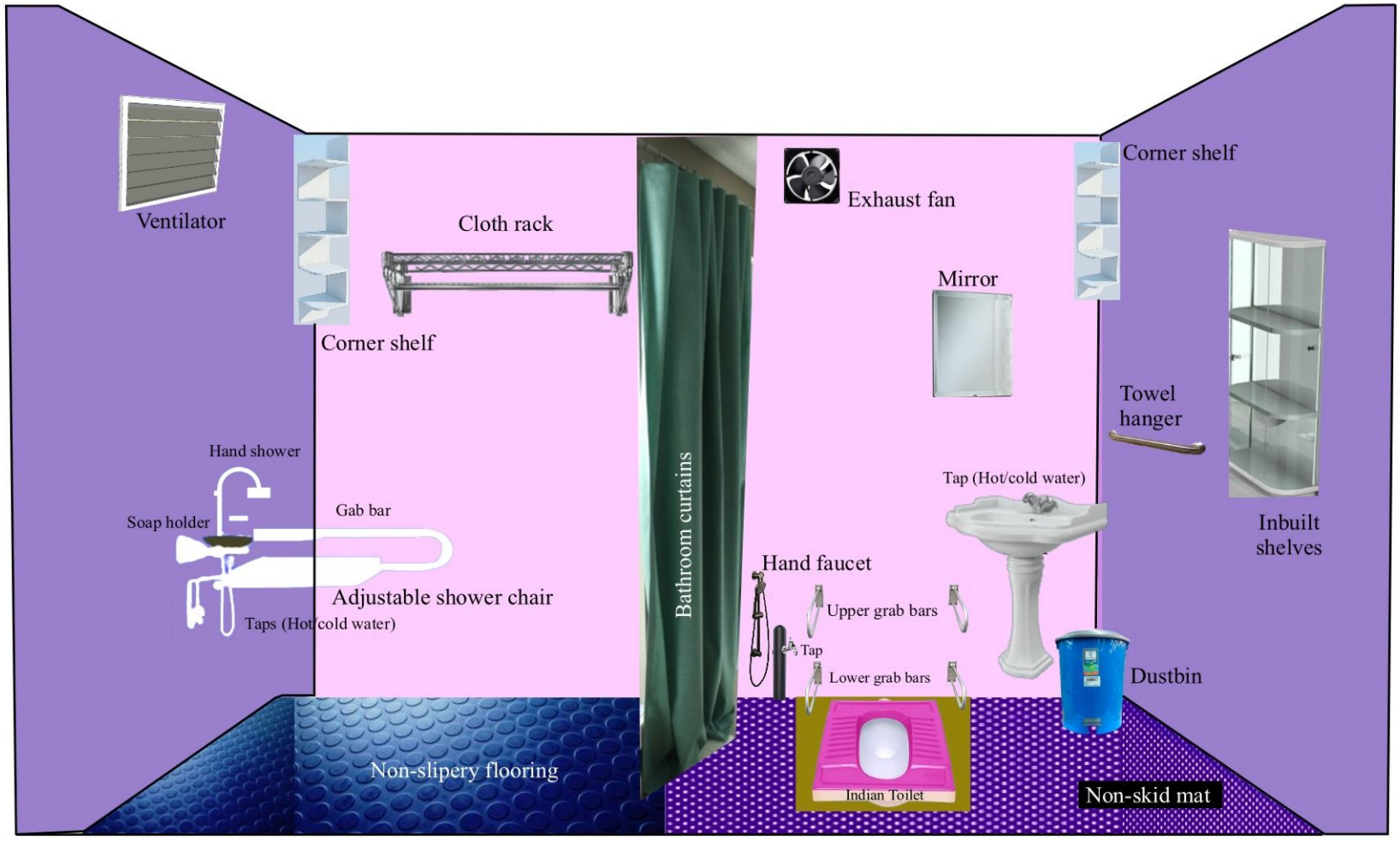

Plate 10: 3D Model design of bathroom cum Indian style water closet

a) Adjustable rails

b) Grab bar

c) Squatty potty

d) Adjustable chair for Indian toilet users

e) Non-skid mat

Plate 11: User friendly sanitary fittings and fixtures in water closet for elderly

a) Shower chair

b) Sink with grab bars and mirror

c) Bathroom cum water closet

Plate 12: User friendly sanitary fittings and fixtures in bathroom for elderly

5. DISCUSSION

In consistence with the objectives of the present study on "An ergonomic approach to interiors of bathroom and water closets for elderly", the results obtained under the study are discussed, interpreted and compared with related reviews and are presented in this chapter under the following headings.

5.1 Demographic profile of the selected elderly

5.2 Existing conditions and extent of problems faced by elderly in bathroom and water closets

5.3 Suggestions for the modification of bathroom and water closets

5.4 User friendly ergonomic bathroom cum water closet designs for elderly

5.1 Demographic profile of the selected elderly

Regarding the age of the respondents, maximum number of the elderly respondents were below 77 years and only 23.33 per cent of them were between the age of 78-86 years. Similar findings were reported by Bhakshi *et al.* (2001), where 50 per cent of the sample under study in Ludhiana belonged to the age of 60-65 years (Table 1).

With respect to educational level of the selected elderly, it was interesting to know that all the respondents were literate and none of them were illiterate. These results are supported by the study conducted by Sandhu *et al.* (2002), where only least percentage of the respondents were illiterate.

Majority of the selected elderly were retired, as the criteria for selection of age of the respondents was above 60 years, whereas the retirement from accustomed work is usually at the age of 60 years.

All the selected respondents under the study were married and 30 per cent of them were widow/widower. Majority of the respondents were living either with spouse or children with the family size of 2-4 members. Only least per cent of the selected respondents were living single. These results are in line with study made by Sandhu *et*

al. (2002) which discloses that majority of the respondents lived with spouse and least percentage of them were living single.

Higher percentage of the male (58.57 %) and 18 per cent of the female were getting personal income more than Rs. 15,000/month. The personal income included, pension, income from business and interest from fixed deposits. These findings are on par with the results of Singh (2012), where higher percentage of male (32 %) and female (18 %) were getting their personal income more than Rs. 15,000/- per month.

Regarding the socio economic status of selected respondents, higher percentage of the respondents belonged to upper class and upper middle class and least per cent of them belonged to lower upper class and lower class. This was due to the reason that, the average family income of the selected elderly was higher and higher percentage of them were working as in professional/semi-professional jobs. The components like average income of family and occupation were considered to assess the SES of families of elderly (Table 2).

5.2 Existing conditions and extent of problems faced by elderly people in bathroom and water closet

Higher per cent of both elderly male and female respondents were living in RCC type house and it was owned by them. The house were constructed recently *i.e.*, within 10 years of period.

The availability of bathroom and water closets in the houses of selected elderly respondents was analyzed with the help of checklist and it was observed that majority of the houses had separate bathroom and water closets. Majority of the selected respondents complained using separate bathroom and water closet as problematic. They expressed bathroom cum water closet would be more convenient and easy to use. This can also be supported by the expressions of elderly respondents already using bathroom cum water closet under the study.

Under the existing conditions of bathroom and water closets, the data on use of floor mats , source of hot water, source of natural lighting, source of artificial lighting, sanitary fittings and fixtures was collected (Table 4). The results reveled that maximum

number of the bathrooms and water closets of the elderly had slippery tiles and opined it as problematic which cause falls and slip among the old age people. This can also be supported by the findings of present study, where the main reason for the accidents in bathroom among 7.5 per cent of the elderly respondents was slippery flooring. These results are on par with a findings of Kaur and Sharma (2009).

Majority of the respondents were using electric geyser and considerable percentage of the respondents (25 %) were using gas geyser as it is convenient/ easy to use and gives instant hot water. Both solar and gas geyser were used as a source of hot water by nearly one third of the sample. In summer days, they were using solar as a source of hot water facility and rest in rainy days they were using gas geyser as the source of hot water facility.

Regarding the sanitary fittings and fixtures, majority of the selected elderly were using western toilet (58.83 %) as compared to Indian toilets (44.16 %), as the maximum number of houses of the selected elderly were constructed recently *i.e.* within 10 years of period and might have preferred for western toilet which is convenient and comfortable to use. Majority of them were having many of the accessories *viz.*, wash basin, water jet, hand faucet, soap holder, corner shelf, shower in bathroom and water closet. Only meager percentage of them were having towel hangers, bath tub and storage facility. It was interesting to note that none of the bathrooms were having grab bars which was very much needed by elderly for the supporting body balance while using bathroom and water closets and to avoid bathroom hazards.

The intensity of natural and artificial light was measured in bathroom and water closet of the selected elderly to study the availability of light. The availability of natural light in maximum number of bathroom and water closets was more than the standard recommended by the BIS (Table 6). But the reverse trend was observed with respect to availability of artificial light, which disclose that the intensity of artificial light in maximum number of bathroom and water closet was less than the standard recommended. These results are in agreement with the findings of Sandhu *et al.* (2005) which discloses that the day light was sufficient in both bathroom and water closet. This was probably because maximum number of selected households used bulbs of low voltage as a source of artificial lighting.

The nutritional status of the selected elderly on the BMI classification scale for Asian adults (2004) revealed that one third and equal percentage of the sample (33.33 %) were lying in the under overweight categories and least percentage of them were lying in normal weight category. This could be because of aging factor and fluctuating health conditions.

Regarding the general health problems among the selected elderly (Table 8) majority of both male and female respondents were facing the problems like general weakness, poor eye sight, pain in knees, pain in legs, diabetes and blood pressure. The results further revealed that health problems were more among male than the elderly females. These findings are on par with the results of Sandhu *et al.* (2002) and Aujala *et al.* (2001) who found that irrespective of gender, weak eye sight, blood pressure, joint pain, problem with teeth and weakness were common health problems among elderly.

Regarding dimensions of the bathroom and water closet the size of maximum number of bathroom and water closet were bigger than the standard recommended. It was good to know that none of the bathroom and water closets were smaller than the standard recommended. These results are on par with the results of Singh (2012) which revealed that in majority of the households the size of the bathrooms was bigger.

Further, the study revealed that none of the bathroom and water closets were having grab bars for the support. The absence of the grab bars was also expressed by elderly as one of the major problem. This was probably because majority of the respondents were facing the health problems *viz.*, pain in knees, diabetes (giddiness and frequent urination), physical limitations, poor eye sight and general weakness. Hence, they expressed need of grab bars for support and balance in bathroom and water closet. It was also revealed from the findings of the study that nine per cent of the falls among elderly in bathroom and water closet was due to absence of non-supports.

'Water facility' was expressed as one of the problem by elderly as they were findings difficulty in operating taps and insufficient force and supply of water. These were ranked as IV and V problem by selected elderly in bathroom and water closet.

Majority of the selected elderly ranked insufficient lighting as IV major problem in bathroom and water closet. This was probably because the intensity of

artificial light in maximum number of bathroom and water closets was lesser than the standard recommended.

Regarding type of water closet, 42.30 per cent of the respondents had Indian toilet in their house and they expressed it as highly problematic to use. This was probably because of the aging factor and the health problems like pain in knees and legs, poor eye sight and arthritis as expressed by them. Another reason may be during old age it was difficult to sit and stand up without any support while using Indian toilet. The elderly respondents under study also expressed slippery flooring and lack of grab bar facility as major problem faced in bathroom and water closet (Table 12).This finding can be supported by the data depicted in Table 4, which disclosed lack of grab bars in water closets. These findings can also be supported by the results of Dekker *et al*. (2005) which disclosed that ageing people in general deal with decrease of physical, psychometric and sensory capacities. Because sitting down and getting up requires postural control, the elderly are likely to have more trouble than younger people. These can also be supported the relationship between health and bathroom and water closet problems among elderly *i.e.* as the age is progressed the extent of problem faced in bathroom and water clos*et al*so increased.

It is interesting to know that age and improper bathroom and water closet conditions had significant relationship with the problems faced by elderly in bathroom and water closets. As the age progressed extent of problems faced in bathroom and water closets is also increased. Similarly, poor bathroom and water closet conditions led to increased problems faced by the elderly.

5.3 Suggestions for the modification of existing bathroom and water closet conditions

Based on the problems faced while using bathroom and toilets, the selected elderly gave the suggestions for modifications. The significant suggestions for the modification of bathroom were provision of non slippery with mat furnished tiles, provision of grip or grab bars to the entire room, provision of solar hot water facility, sufficient intensity of artificial light (Table16). These results can be supported by the findings of Naganand *et al*. (2010), which revealed that bathroom and toilet design must

be as per specific requirement of elderly persons with back rest, hand grip and water jet. It must be spacious with good ventilation, non slippery floors with mat furnished tiles, grip or grab bars to the entire bathroom and hand showers to avoid excessive movement in bathroom.

Similarly the vital suggestions given for the modification of water closet were provision of hand support/grab bars, preference of western toilet and non slippery flooring, free from sharp edges and obstacles (Table 18). These results can be supported by the findings of Dekker *et al*. (2005), which revealed that the elderly people suggested for presence of grab bars in water closet.

5.4 User friendly ergonomic bathroom cum water closet designs for elderly

Based on the problems faced in bathroom and water closets, relevant review of literature and the suggestions given by selected elderly for modifications in bathroom and water closets, two user friendly designs *i.e.* one for bathroom cum Indian style water closet and bathroom cum western style water closet were proposed under the study. The main features of the proposed designs are as follows

Features and advantages of user friendly ergonomic bathroom cum water closet designs for elderly

Problems	**Solutions/Remedies**	**Advantages**
Slippery flooring	• Provision of non-skid flooring in bathing region and use of non-skid mat at sink and water closet region	• To avoid falls/ accidents
Lack of grab bars	• Provision of grab bars at both sides of water closets and shower chair.	• For body balancing and supporting
Difficulty in using Indian toilet	• Provision of grab bars at both sides of water closet at two different levels *i.e.* squatting elbow height and shoulder height level.	• Controls the posture while sitting down and getting up while toileting. • Convenient for sitting and

	• Use of adjustable chair • Provision of wall hung commode.	getting up easily and independently while toileting. • To eliminate squatting posture while toileting. • Convenient for elderly with leg and knee pain and for disabled.
Problems related to water facility	• Provision of solar hot water facility. • Regular maintenance of plumbing system	• Avoids • the bathroom hazards related to gas geyser and boiler. • Helps in avoidance of water supply problems • Eases the operation of taps/faucets.
Insufficient lighting/ventilation and problems related to electrical switches	• Provision of ventilators and exhaust fan. • Use of high voltage bulbs • Bigger size electrical switches at the entrance of bathroom and water closets.	• Avoids bathroom hazards and helps in air movement and avoid suffocation. • Clear visibility
Absence of hand faucet/shower/waterjet	• Provision of hand faucet and waterjet facility in water closet • Provision of hand showers in bathroom	• For easy wash after toileting • Avoids the excessive hand movements. • Convenient and comfortable to use.
Insufficient or improper storage facility	• Provision of sufficient storage facility at comfortable reaches	• Avoids excessive movements • Easy to find and reach the accessories
Lack of shower chair	• Provision of height adjustable shower chair at bathing region	• Comfortable and easy bathing • The height of shower chair can be adjusted as per the convenience.

Need for bathroom cum water closet and preferably attached to bedroom	• Bathing and toileting regions are mounted on a single piece of model.	• Convenient and comfortable to use • User friendly design
Adequate size and easy allowance of movements	• The floor plan is in accordance with the standard dimensions given by Model Building Bye-Laws (2016) • Free from obstacles and sharp edges	• Avoids the space problems • Less expensive and user friendly • Avoids bathroom hazards due to obstacles and sharp edges

6. SUMMARY AND CONCLUSIONS

Old age is the precious time spent by an individual with and around the environment, where it gives the feeling that one has entered to the childhood again. Elderly or old age consists of ages nearing or surpassing the average life span of human beings. The boundary of old age cannot be defined exactly because it does not have the same meaning in all societies. The 'National Policy on Older Persons' (1999) adopted by Government of India defines 'senior citizen' or 'elderly' as a person who is of age 60 years or above. Although retirement from accustomed work is usual at the age of 60, general vitality and interest may continue at the moderate pace for some more years. The first five years may be considered young old, the second five years considered old-old and the years thereafter as oldest-old.

In home, there are areas and rooms like bedroom, kitchen room, bathroom, and toilet room where in the bathroom is the most hazardous room in the house in terms of fall related injury and death. In India 21 per cent of falls occur at home and 18.9 per cent of them occur during bathing (Joshi and Dzouza, 2010). Bathroom hazards include slippery floor, sharp edges, obstacles, unavailability of water, and poor lighting and ventilation, whereas safety features include rubber mats and grab bars and safety practices, *viz.*, bedroom-to-bathroom area free from obstacles and soap that is within reach. Only few studies have emphasized on such fall risk and bathroom hazards. Bathroom safety is important for safe and independent living of elderly. The proper application of ergonomics must be taken into account to overcome these problems.

Keeping this in view the present research study entitled 'An ergonomic approach to interiors of bathroom and water closets for the elderly was under taken with the following objectives:

1. To study the socio economic status and existing housing conditions with special reference to bathroom and water closets of elderly.

2. To study the problems faced by the elderly in relation to existing bathroom and water closet conditions.

3. To develop the user friendly ergonomic bathroom and water closet designs for elderly.

The present study was conducted during the year 2017-2018, in urban areas of Dharwad district. Exploratory research design was used for the investigation. Purposive random technique was used to select the sample. The total sample of 120 elderly respondents aged above 60 years were selected for the study. Self-structured interview schedule was formulated to collect general and research specific information of all the respondents. The physical parameters were assessed by using various equipment such as anthropometric rod and weighing balance, the dimensions and intensity of light available in bathroom and water closets were measured by the equipment such as measuring tape and LUX meter respectively. The socio-economic status of elderly families was assessed by Kuppuswamy scale (2017). Data was collected by personal interview method and it was coded, tabulated and interpreted using suitable statistical parameters. The summary of the findings are presented below.

Demographic profile and socio economic status of the selected elderly

- The data on age of elderly revealed that irrespective of gender, equal percentage (38.33 %) of them belonged to the age group ranging 60-68 years and 69-77 years followed by 23.33 per cent of them belonged to age group of 78-86 years.

- Higher percentage of the elderly (60 %) had studied upto graduation and post graduation followed by high school (19.16 %) and PUC (12.5 %).

- With respect to occupation of the respondents, majority of the respondents (60 %) were retired and 24.10 per cent of female respondents were house wives.

- Majority of both male (78.50 %) and female respondents (82 %) were married.

- Regarding the living arrangements of the respondents, one third of the samples were living with their children and spouse (35.83 %) followed by living with children(26.66 %), living with spouse (25.83 %) and living single (11.6 %).

- About 38.33 per cent of respondents' monthly personal income ranged from Rs. 8,000/- to 15,000/- followed by Rs. 15,001/- to 22,000/- (25 %) and 22001-30000 (17.50 %) income ranges.

- The socio economic status of the respondents as per Kuppuswamy scale (2017) revealed that higher percentage of elderly families belonged to upper class

(43.33 %) followed by upper middle class (19.16 %), lower middle class (16.66 %) and equal percentage (9.16 %) were belonged to lower upper class and lower class.

Existing housing conditions in relation to bathroom and water closet

- Majority of both male (87.10 %) and female respondents (76 %) were living in RCC type and own house.
- In houses of majority of male (77.10 %) and female respondents (80 %), separate bathroom and water closets were present, while bathroom cum water closet was present in 13.30 per cent and 20 per cent houses of male and female respondents respectively.
- Regarding the type of flooring, slightly higher percentage of the respondents had slippery tiles followed by non-slippery and uneven in bathroom (45.74 %), water closet (35.10 %) and bathroom cum water closet (42.30 %)
- Regarding source of hot water facility in bathroom, 26.92 per cent of respondents were using gas geyser followed by electric geyser and boiler.
- Regarding the source of natural lighting, majority of the respondents were having ventilators in their bathroom (74.46 %) and water closet (56.17 %) and bathroom cum water closet (100 %).
- Regarding artificial lighting, majority of the respondents were using bulbs as a source of artificial lighting in bathroom (77.65 %), water closet (88.29 %) and bathroom cum water closet (65.38 %).
- Regarding the type of toilet, majority of selected elderly were having western style (55.83 %) followed by Indian style (44.1 %) of water closet facility in their house.
- The maximum number of bathrooms had the necessary sanitary fittings and fixtures *viz.*, wash basin, water jet, hand faucet, bath tub, soap holder, hand showers, tissue paper holder, corner shelf shower towel hangers, towel and

garment rack and storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories.

- None of the bathroom and water closets had grab bars for the body support and balance.

- The area of maximum number of bathrooms (92.55 %), water closets (71.27 %) and bathroom cum water closets (73.07 %) was more than the standard recommended, while 7.44 per cent of bathrooms, 28.72 per cent of water closets and 26.92 per cent of bathroom cum water closets (26.92 %) were on par with the standard recommended by Model Building Bye Laws, 2016

Health status of selected elderly

- One third and equal percentage (33.33 %) of elderly belonged to underweight and overweight categories of BMI.

- Regarding the physical health problems of elderly, general weakness was found to be a major health problem among both male (64.20 %) and female respondents (66 %).

- Regarding the body pain, majority of both male (75.70 %) and female elderly respondents (86 %) experienced pain in knees**.**

- The findings of physiological disorders of selected elderly revealed that majority of the male respondents (67.10 %) suffered from blood pressure.

Problems faced by selected elderly in bathroom and water closet

- Slippery flooring, lack of grab bars, difficulty in using Indian toilet, difficulty in operating taps, insufficient water supply, insufficient force of water, unsafe hot water facility and not enough natural lighting were the problems faced by majority of selected elderly in bathroom and water closets and these were ranked from 1st to 8th respectively as major problems faced by elderly.

- Majority of the respondents opined using floor mount commode with water jet facility and size of bathroom and water closets as ‘not problematic’.

- The independent variables *viz.*, age of selected elderly and absence of facilities / accessories in bathroom and water closets were positively and significantly related with the extent of problems faced in bathroom and water closets.

- Nearly one fifth of the respondents (19.16 %) had met with fall/accidents in bathroom and water closets, because of health problems, lack of supports, slippery flooring and insufficient lighting.

Suggestions for the modification of bathroom and closet given by selected elderly respondents

- Majority of the respondents (male 97.14 %, female 50 %), suggested the need for the provision of non-slippery floors with mat furnished tiles followed by provision of grip/grab bars to the entire bathroom (male 91.43 %, female 50 %).

- The majority of the respondents (male 92.8 %, female 82 %) suggested preference of western toilet followed by provision of hand support (male 87.1 %, female 100 %), free from slippery, sharp edges and obstacles (male 84.28 %, female 64 %) in water closet.

- The user friendly designs were proposed based on the standards recommended by Model Building Bye Laws, 2016 (width- 1.2, height- 2.1, length-2.3, area-2.8 m^2) and considering the suggestions given by the selected elderly for the modification of bathroom and water closets.

- Ergonomically designed both bathing and toileting regions are mounted on a single piece of model in the proposed designs. These designs are comfortable, safe and user friendly to use. They are suitable for all family members especially for the elderly people and children.

Conclusion:

Elderly or old age consists of ages nearing or surpassing the average lifespan of human beings. The findings of the present study revealed that as the age progressed the health status decreased. The elderly population under the study have expressed many problems related to bathroom and water closets. After identifying all these problems, one should consider the use of ergonomics before planning bathroom and water closets. The proposed bathroom cum water closet design is proposed taking into consideration the suggestions given by elderly for modification and the standards recommended by Model Building Bye Laws, (2016). It is suitable for all the family members especially for elderly and children. Hence it can be adopted by all to avoid bathroom hazards in order to make the life of the elderly comfortable and secured.

Suggestions for future research:

1. The study on opinion and awareness of people regarding availability of user friendly bathroom accessories like supports, grab bars, water jets, anti-skid tiles and squatty potty can be studied.

2. The study on adoption level of the proposed bathroom and water closet designs can be carried out.

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SCHEDULE

AN ERGONOMIC APPROACH TO INTERIORS OF BATHROOM AND WATER CLOSET FOR ELDERLY PEOPLE

PART-I

GENERAL INFORMATION

1) Name of the respondent & address:
2) Age (yrs):
3) Sex: Male/Female
4) Family type: Nuclear/Joint/Extended
5) Occupation of the respondent: Working/Retired
6) Marital status: Married/ Widow/ Widower/Single
7) Living arrangement: a) Living with spouse b) Living with children and spouse
   c) Living with children d) Living single
8) Religion: Hindu/ Muslim/Christian/Others
9) Family composition:

Sl. No.	Name	Age	Relation to respondent	Education	Occupation	Income
1			Self			
2						
3						
4						
5						
6						
7						

PART-II

Socio-economic status of the selected respondents:

Sl. No.	**Particulars**	
1)	Education of head of the family	
a)	Profession or honours	
b)	Intermediate or post high school diploma	
c)	High school certificate	
d)	Middle school certificate	
e)	Primary school certificate	
f)	Literate	
2)	Occupation of head of the family	
a)	Profession	
b)	Semi-profession	
c)	Clerical, shop-owner	
d)	Skilled worker	
e)	Semi-skilled worker	
f)	Unskilled worker	
g)	Unemployed	
3)	Monthly income of family	
a)	> 41430	
b)	20715-41429	
c)	15536-20714	
d)	10357-15535	
e)	6214-10356	
f)	2092-6213	
g)	< 2091	

PART-III

Existing housing conditions with special reference to bathroom and water closet

1) Type of house: RCC / Tiled house

2) Type of owner ship: Rented / Own / Apartment / Any other

3) Year of construction / Renovation of house: ----------

a) If renovated give the details with reference to bathroom and water closet.....

4) Is there a separate bedroom for you: Yes / No

a) If yes, is it attached with bathroom: Yes/No

b) If yes, is the bathroom combined with water closet: Yes/No

5) Dimensions of bathroom and water closet

SL. NO	Dimensions	Bathroom	Water closet	Bathroom cum water closet
1)	Length **(m)**			
2)	Width **(m)**			
3)	Height **(m)**			
4)	Area **(m^2)**			

6) Checklist of existing bathroom and water closet conditions:

Sl. No.	Particulars	BR Present/ Absent	WC Present/ Absent	Bathroom cum water closet Present/ Absent
1	**Floor materials used**			
A	Slippery tiles			
B	Non slippery			
C	Uneven			
2	**Door threshold**			
3	**Non skid mat**			
4	**Source of hot water**			
A	Solar heater			
B	Electric boiler			
C	Electric coil			
D	Gas geyser			

E	Electric geyser			
F	Heating water on gas stove			
g	Both solar and gas greaser			
6	**Source of natural lighting**			
A	Number of windows			
B	Number of ventilators			
7	**Source of artificial lighting**			
A	Compact florescent bulb			
	Bulbs			
	Sanitary fittings and fixtures			
	Indian toilet			
	Western toilet			
	Wall hung commode			
	Floor mount commode			
	Wash basins			
	Water jet			
	Grab bars			
	Hand faucet			
	Bath tub			
	Soap holder			
	Hand showers			
	Tissue paper holder			
	Corner shelf			
	Shower			
	Towel/ cloth rack			
	Towel hangers			
	Grab bars			
	Storage for keeping soap, brush, paste, shaving kit, shampoos and other accessories.			
9	**Others**			
	Shower chairs			
	Dustbin			
	Adjustable chair			

7) Source of artificial lighting with watts in bathroom and water closet

Sl. No.	Source of artificial lighting	BR	TR	Bathroom cum water closet
1)	Compact Florescent Light			
2)	Florescent Light			
3)	Bulbs			

8) Intensity of light (in lux) in bathroom and water closet

		BR			WC			Bathroom cum water closet		
		Morning	After noon	Night	Morning	After noon	Night	Morning	After noon	Night
1)	Natural									
2)	Artificial									

*BR: Bathroom *WC: Water closet

PART-IV

1) Problems among the elderly in relation to bathroom and water closet

a) Nutritional status of elderly

a. Height:----------(m) b. Weight:----------(Kg)

c. Calculated BMI:----------

b) General health problems of the elderly

Sl. No.	Health problems	Problems faced by respondents	
		Yes	**No**
1)	**Physical problems**		
a)	Fatigue		
b)	General weakness		
c)	Poor eyesight		
d)	Loss of hearing		
e)	Loss of appetite		
f)	Physical limitations (back/leg/hands)		
g)	Any other		
2)	**Body pain**		
a)	Pain in the knees		
b)	Pain in legs		
c)	Back pain		
d)	Shoulder pain		
e)	Headache		
f)	Any other		
3)	**Physiological disorder**		
a)	Blood pressure(Low/High)		
b)	Asthma		
c)	Diabetes		
d)	Arthritis		
e)	Coronary heart disease		
f)	Reproductive disorders		
g)	Any other		

2) Opinion of selected elderly towards existing conditions of bathroom

Problems	Opinion of respondents		
	Highly problematic	**Problematic**	**Not problematic**
Using separate bathroom and water closet			
Using Bathroom cum water closet			
Flooring			

Size			
Storage facility			
Lighting			
Ventilation			
Hot water facility			
water supply			
Shower			
Absence grab bars			
Door width			
Door threshold			
Reaches of essential materials			

3) Opinion of selected elderly towards existing conditions of water closet

[Problems	**Opinion of respondents**		
	Highly problematic	**Problematic**	**Not problematic**
Flooring			
Size			
Storage facility			
Lighting			
Ventilation			
Hot water facility			
water supply			
Usage of toilet(Indian style)			
Faucets			
Grab bars			
Door width			
Door threshold			
Commode			
Height of the commode			
Type of commode			
Wall hung			
Floor mounted			
Type of faucet			
Hand faucet			
Water jet			
Position of faucet			
Indian toilet			
Presence of supports			
Tap water			
Flush tank with tap water			

4) Major health problems faced by the selected elderly in relation to bathroom and water closet (Give rankings from 1)

SL.NO.	Particulars	Ranking

5) Mention the frequently faced problems in bathroom and water closet and give rankings from 1.

SL.NO.	Particulars	Ranking

6) Occurrence of falls / accidents in bathroom and water closet

a) Have you met with any accidents in bathroom and water closet? Yes/No

b) If yes, give the reasons for occurrence of accidents

Sl. No.	Accidents	Yes	No
1)	Fall due to health problems(low sugar/giddiness)		
2)	Fall due to no support		
3)	Fall due to slipperiness		
4)	Fall due to insufficient lighting		
5)	Any other (mention)		

c) Give the details of impacts of the accident:

PART-V

Suggestions for modification of existing bathroom / water closet with reasons (Give ranking from 1)

a) Bathroom

Sl. No.	Suggestions for modification	Yes	No
1)	Provision for sitting with back rest		
2)	Provision of hand grip		
3)	Provision of water jet		
4)	Must be spacious		
5)	Must be good ventilated		
6)	Must be free from slippery and sharp edges		
7)	Provision of non slippery floor with mat furnished tiles		
8)	Provision of grip or grab bars to the entire bathroom		
9)	Provision of solar hot water facility		
10)	Sufficient intensity of artificial light		
11)	Requirement of hand showers to avoid excessive movement		
12)	Bedroom should be with night lamp to ease night walking to the bathrooms		
13)	Provision of bigger size electrical switches at a comfortable height		
14)	Provision two way switches near bed		
15)	Exhaust and ordinary fans to maintain temperature and to dry the bathroom		
16)	Need of shelf to keep hand towels, napkin and garments		
17)	Need for storage for keeping soap, brush,paste,shaving kit, shampoos and other accessories		
18)	Need for convenient reaches of shelves and storage facilities		
19)	Provision of temperature controlled faucet		
20)	Any other (mention)		

b) Mention the major suggestions suggested in bathroom and give rankings from 1.

Sl. No.	Particulars	Ranking

c) Water closet

Sl. No.	Suggestions for modification	Yes	No
1)	Preference of western toilet		
2)	Adjustable chairs for seating in Indian toilets		
3)	Provision for sitting with back rest		
4)	Provision of hand supports		
	a) Front support		
	b) Side support		
	c) Vertical support		
5)	Free from slippery, sharp edges, and obstacles		
6)	Provision of sufficient artificial light		
7)	Need of Squatty potty for western toilets		
8)	Any other (mention)		

d) Mention the major suggestions suggested in water closetand give rankings from 1.

SL.NO.	Particulars	Ranking

AN ERGONOMIC APPROACH TO INTERIORS OF BATHROOM AND WATER CLOSETS FOR THE ELDERLY

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ABSTRACT

The present study was conducted during the year 2017-2018 to study the problems faced by elderly in existing bathroom and water closet conditions and to develop the user friendly ergonomic bathroom and water closet designs for the elderly. The sample consisted of 120 elderly population aged 60 years and above residing in Hubli and Dharwad cities. Exploratory research design and self structured interview schedule were used to conduct the study. The results revealed that higher percentage of the elderly family belonged to upper class (43.33) followed by upper middle class (19.16). Majority of the respondents suffered from health problems viz., pain in knees (80%) followed by diabetes (66.6%) and general weakness (65%).According to mean scores the existing water supply condition in the bathroom was considered as highly problematic (2.50) followed by slippery flooring (2.2), lack of grab bars(2.15), difficulty in using Indian toilet (2.15), lighting (2.09). The independent variables viz., age of selected elderly and absence of facilities/ accessories in bathroom and water closets were positively and significantly related with the extent of problems faced in bathroom and water closets. Nearly one fifth of the respondents (19.16%) had met with the falls/accidents in bathroom and water closets because of slippery flooring and lack of grab bars. Majority of the respondents (male 97.14%, female 50%), suggested the need for the provision of non-slippery floors followed by provision of grip/grab bars to the entire bathroom (male 91.43%, female 50%). Hence, to avoid falls/accidents in the bathroom and water closets, two ergonomically designed floor plans and 3D model designs of bathroom cum water closets were proposed keeping in mind the safety, convenience and the standards recommended model building bye laws (2016).