Falls in the toilet environment: a study on influential factors

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S.N.Buzink, J.F.M. Molenbroek, E.M. Haagsman, R. de Bruin, Th.J.J. Groothuizen. Falls in the toilet environment: a study on influential factors. Gerontechnology 2005; 4(1): 15-26. Limitations accompanying advanced age can result in a variety of problems in the toilet environment. Falls are responsible for the majority of serious injuries amongst elderly people. The Friendly Rest Room (FRR) project focuses on increasing the quality of life for elderly people by making toilet facilities better suited to their individual needs. This study within the FRR project is carried out to determine the need for more appropriate fall preventive measures and create a knowledge base for design criteria to be implemented in the future FRR. **Methods** Information was obtained by a literature search, semi-structured interviews with elderly people (n=10) and with nursing professionals (n=6). **Results** Current fall prevention measures do not decrease the number of fall accidents in the toilet environment sufficiently. When assessing toilet environments on potential fall risks, the toilet environment should be regarded as a whole. Elderly people are currently accustomed to adapt their toilet routine to the supports present, which can result in hazardous situations. **Discussion** Using the findings in literature, the interviews and the authors insight the FRiTA Model is created. The model is used to identify basic toilet activities with an increased fall risk within the Dutch toilet ritual and reveal potential problem areas within the toilet environment. **Conclusion** Future research should focus on optimal support solutions and user preferences.

Keywords: elderly, falls, rest room, toilet, handicapped

Average life expectancies strongly increased worldwide over the past century. People are getting older and elderly people represent an increasingly growing group within the population[1,2]. Social structures change and elderly people expect to enjoy a more active lifestyle and benefit from better living conditions[1-3].

Gerontological phenomena, physical as well as cognitive limitations, can introduce a variety of problems into the toilet routine of elderly people. Elderly people are highly motivated to preserve their independence in this area. For many people the moment when assistance is needed to use the toilet represents a turning point in their perception

of personal limitations[4,5]. Toilet facilities often do not meet the specific needs of many elderly persons. In unfamiliar public situations these may form obstacles of such magnitude that the use of such facilities is avoided altogether[5].

THE FRR PROJECT[6]

For this reason the Friendly Rest Room project (FRR)[6] was initiated within the European Union's Fifth Framework 'Quality of Life and Management of Living Resource' programme and Key Action 6: The Ageing Population and Disabilities. The project focuses on making toilet facilities better suited for the elderly and people with disabilities, thus increasing their quality of life. The 10 partners of the consortium, located in 7 different European countries, initiated the 3-year project in 2002.

The multidisciplinary consortium partners vary in expertise: rehabilitation, social sciences, end-user associations, institutes focusing on design ergonomics, industrial and public design, and the sanitary industry. An ethical review committee is involved in the project to verify and assist in what is asked of the participating users and what is done with the results[5,7].

Instead of designing tools to overcome the flaws of existing sanitary, a more user-friendly lay-out of the room is to be combined with easy-to-use sanitary modules and recent technical innovations. The smart toilet environment developed within the FRR project will compensate the special needs of the user in a friendly way by adjusting itself to the pre-programmed settings on the smart card the user carries with him. To achieve this goal, a user-centred approach plays a key role in all stages of the project[5-7].

This study

Falls are responsible for the majority of home accidents causing serious injuries amongst elderly people[8-11]. More than one out of three people older than 65 years and about half the elderly over 85 years falls at least once a year[12-17]. Falls often affect the mental, social and physical condition of an elderly individual and have a strong impact on their daily life[8-10,13,14].

Current fall prevention measures are not always sufficient in bringing down the number of fall accidents in toilet environments. Therefore, a study on this specific topic was carried out within the FRR project. The objective of this study is to create a knowledge base on aspects related to falls of elderly people due to perturbations in balance in toilet environments. The study was also done to determine the need, as well as to create a knowledge base for design criteria for more appropriate fall-preventive measures to be implemented in the future FRR design. The focus within this specific study is mostly on the influence of environmental factors on falls in rest rooms.

The study is part of a masters thesis on the research and conceptual design of a fall prevention system for elderly people for the toilet environment[18]. As it is seen as a preliminary project within the overall FRR project, the decision was made to focus on the Dutch situation first.

METHODS

For this study information was obtained by a profound literature search. Furthermore, expert heuristics were used to acquire additional information. Semi-structured interviews were conducted with content experts and people from the focus group about their experiences with falls and fall risks in toilet environments. The objectives of the interviews were to obtain a first hand impression on the specific subjects and to

complement and confirm findings in literature.

Nursing professionals from several nursing homes were approached randomly by phone to participate. If so, an appointment was made for a face-to-face interview at their work environment. Six nursing professionals (three professional nurses and three ergotherapists) were interviewed. One of the interviewed nurses approached autonomously living elderly people within the facility she worked at, asking them to participate in the study. Ten elderly people were interviewed. The interviews with the elderly took place in their own home.

The interviews were held using printed interview guides with open questions, one created specifically for the nursing professionals and one specifically for the elderly interviewees. Due to the semi-structured nature of the interviews, the questions were not always asked in the same order during all interviews. The interviews were recorded on audiotape after permission from the interviewees. After some general questions, questions were asked about falls in general, (problems during) toilet use in general, and about falls in the toilet environment. For example, which activities within the toilet routine they considered as most dangerous and how to prevent falls during the toilet routine.

Table 1. Characteristics of elderly interview participants (n=10)

Age	Mean 77.8 years (sd 5.1) (range 69-85)
Gender	7 females 3 males
Living alone	4 females

Results

Fall accidents carry a large variety of consequences for elderly people. Literature states that for elderly people 25-50% of falls cause some kind of physical injury[9,19,20]. Falls by elderly people are a major cause of accidental deaths in this age group[14,17,21-23]. According to Spirduso (1995), more than half of the elderly hospitalised due to a fall die within one year[14]. Fuller (2000) additionally reports that approximately 25% of the elderly with a fractured hip as result of a fall die within six months[22]. In the Netherlands (16 million inhabitants), approximately 7,500 people visit the hospital emergency room each year following an accident in a bathroom or toilet environment[24,25]. The percentage of these accidents resulting in hospital admittance is significantly higher, with a higher level of average direct medical costs compared to accidents in general[25].

Risk factors

The extent and presence of a fall risk is determined by multiple, intrinsic or extrinsic, factors. Some factors contribute to the stimulus that causes a loss of balance, while others concern the inability to react properly and to promptly recover balance[14]. In most cases, fall accidents occur due to a combination of several factors[9,10,12,14-17, 22, 26, 27]. In these multi-factorial falls, some factors are responsible for the initiation of a loss of balance, others (or sometimes even the same) affect the ability to restore it properly[14]. Interaction between risk factors can intensify the fall risk, many times creating a vicious circle eventually leading to a fall accident[14,16,17,22].

Falls themselves can increase the fall risk considerably as well, especially when multiple falls occur within one year[9,28]. In many cases, a fear to fall leads to loss of confidence and stiffening of movements, and subsequently to self-inflicted functional restrictions and

a growing social isolation of the elderly person[8-10,14, 20, 26, 28].

Ageing and the toilet ritual

The process of visiting the toilet is built up of many different smaller activities (also see table 2). While performing these activities, numerous movements are made, different postures adopted and positions frequently changed. From early childhood onwards, all these merge into one activity, in which all separate steps are carried out unconsciously, almost automatically: the toilet ritual. When visiting a public toilet, the ritual is slightly altered to fit the situation.

This changes when people get older. In most situations, the ageing process starts by affecting only a few movements and postures within the toilet ritual, which become more difficult to perform. Movements or postures formerly without any fall risk can eventually change into hazardous ones[29,30]. The toilet ritual becomes a series of multiple, separated activities (it splits up and is again made up of multiple, more detached activities). In most cases, elderly people will first try to compensate and slightly alter their ritual or use objects already present for support to accommodate geriatric complaints, before relying on any additional assistive device[3,27,31].

Interviews with nursing professionals

Six nursing professionals (three professional nurses and three ergotherapists), were interviewed. The most interesting results and remarks made during the interview sessions are reported below.

Transferring onto or from the toilet itself are claimed to be the most dangerous activities within the toilet routine by all interviewees (6/6). Especially the part where one turns in front of the toilet costs a lot of energy and effort for elderly people (6/6), walking or shuffling backwards to correct an improperly assessed or performed turn appears to be extremely difficult for many. Undressing and dressing are also considered activities during which falls occur frequently (5/6).

Slippery floors and tripping objects are important extrinsic causes for falls (2/6). Next to bath rugs, protruding and straight vertical frontal parts of toilet bowls were also mentioned (2/6) as major tripping objects, as feet, rollator wheels, and wheelchair foot supports get caught easily behind these obstacles while making a turn.

All objects within reach are seen as supports by the elderly, and will be used accordingly (1/6). The presence of a support in front of the toilet, in addition to or instead of a support alongside the toilet, eases standing up a lot (4/6). Four of the interviewees often see elderly people placing their rollator in front of the toilet, such that they can benefit from its support when (un)dressing, sitting down or rising from the toilet.

Items like toilet paper and the flush button should be within close reach (2/6). Elderly people often scrutinize their clothing because they fear to have stained their clothing or to be improperly dressed after using the toilet. While doing so, they often twist their upper body backwards, during which balance is easily lost. A full-size mirror should be present to facilitate easy assessment of clothing (2/6). Extra high toilet bowls can create difficulties for short women, as they often cannot reach the floor with their feet while seated, which is necessary to ease defecation (2/6). Wall plinths in the same colour as the floor create difficulties for elderly people with decreased vision, as these can deceptively be perceived as enlarging a room (1/6).

Due to fall-related fears, elderly people often decide not to lock or even not fully close the rest room door, not even in semi-public areas (2/6). The fear to end up locked inside being severely injured, unable to call for help, or even to die inside, is stronger than the awkwardness of having a stranger enter the room while toileting.

Interviews with elderly people

Ten elderly people were interviewed. In the interviews, 7 of 10 people stated to seldom or never visit a (semi-)public toilet. Half of the subjects (5/10) claim to consciously perform toilet activities extra carefully and well thought over, avoiding activities like reaching or bending down. Often they seek for extra stability by holding on to objects nearby, whether these objects were designed for this purpose or not. The rollator also provides support during the toilet routine. The elderly interviewees see rising from the toilet (3/10), (un)dressing (3/10), and turning as the most difficult activities within the toilet routine, during which they prefer to have support for maintaining balance. One subject mentioned that the nursing staff taught her how to execute some activities safer. Another subject wears skirts and no longer trousers to alleviate (un)dressing when using the toilet.

The heightened toilet bowl, a standard provision in the residence of all interviewees and used by eight of the interviewees, causes problems for some (3/10). In one home (two elderly interviewees) a standard toilet bowl even had replaced it. Two other subjects stated that the toilet is almost too high to reach the floor with their feet to apply pressure to ease defecating. Next to toilet rails installed in three homes (five of the interviewees), a small washbasin was additionally installed next to the toilet in one home, and a rotating plate on the floor with grips in another.

Current fall prevention strategies

Different types of fall prevention strategies currently exist, which were the subject of several studies[10,12-14,16,17,32-34]. The first major step to take in all strategies is creating awareness amongst elderly people of possible fall risks within their direct living environment. All further interventions have to be tailor-made per individual, as the potential effect of interventions depends strongly on the personal situation[10,13,16,17,34]. A multi-faceted approach, in which the intrinsic (personal) and extrinsic (environmental) factors are both investigated and customised, appears to be the most effective[10,13,16,17,34].

After mobility aids, supports in toilet environments are the second most frequently used type of assistive devices[35]. Fortunately, the usage of assistive devices in toilet environments seems to be less affected by the often shown reluctance to use other assistive devices, like rollators for example[8,29]. The washbasin, though, still remains the most often mentioned product assisting people in their toilet routine[27,31]. Other assisting products often used in the toilet environment and mentioned in the interviews, are for example: supports alongside the toilet, the rollator, high toilet bowls and a rotating plate on the floor to ease turning in front of the toilet.

Experiencing the toilet environment

Kira (1976) tells us that activities connected to urination and defecation are generally considered very intimate and private[31]. Thoughts of our own toilet ritual already raise some negative, uncomfortable feelings; those of strangers are even seen as unpleasant. The more publicly accessible a toilet and the less familiar the people who use it, the more important it becomes that the environment appears hygienic and as if never used before. In different ways this is

connected to the perception of the toilet environment and the behaviour of people during a toilet visit[31].

The ambience and design of a toilet environment could be of strong influence on the usage of it and subsequently on any present fall risks, as the perception of the toilet environment determines the extent to which a person feels at ease. People will most likely adjust their behaviour to the environment. A person will move, for instance, much more cautiously in an unhygienic rest room, avoiding physical contact as much as possible and thus influencing the fall risk negatively.

Analysis of the results

Fall accidents in the toilet environment

From both literature and interviews it becomes clear that the risk to fall in the toilet environment not only lies in extrinsic factors, but also in the activities performed by the elderly person within the toilet ritual.

Extrinsic fall risk factors within the toilet environment can be divided into two categories: fixed objects (floor, sanitary fittings, etc.) and additional objects (floor carpets, etc.). First of all, the size of the toilet environment is important and should be sufficiently large[18,31,36,37]. Although a confined toilet space offers more support against walls that are close by, it very much limits the mobility of the user and possible assistants, and getting up after a fall becomes almost impossible[31,36, 37].

The slipperiness of the floor is important as well[36]. The appropriate level of slip resistance also depends on a persons gait and footwear, as combinations suitable for some can be hazardous for others[14,23]. The floor should be level and without any kind of trip objects, wall-mounted toilet bowls are to be preferred[14,18,36]. The fact that some elderly rather leave the door unlocked due to fear of ending up locked inside, was also found by Plante (2002)[31].

The design of the visual environment is mentioned both in the interviews as well as in literature as very important for fall prevention as well. Colours, contrasts, surfaces and lighting are important aspects, as elderly people often experience difficulties in distinguishing objects[2,3,12,14]. Blinding or disorientation due to too bright illumination or glittering and reflecting surfaces should be avoided[12,28,36]. Presence of visual balance support like a row of wall tiles in a contrasting colour, at eye height or above, can help elderly people in maintaining postural balance notably[12]. Visual depth perception of the elderly has often decreased[14]. The frequently present row of floor tiles as wall plinth could have an adverse effect, as nursing professionals also described (Figure 1).

Both in literature and interviews, transfers onto and from the toilet are described as one of the most difficult

Figure 1. Examples of the toilet bowel as trip object (A), lack of contrast (B), visual balance support (C) and a deceptively continuing floor (C)

personal care activities to perform for elderly people[13,27,29,35,38]. This also applies to difficulties many elderly people experience during standing up, standing still, as well as turning around, and during (un)dressing and reaching[31,35,37,39]. In accordance with Kira (1976), the interview results also describe difficulties, like constipation, that can arise due to high toilet seats[29]. Additionally, literature describes the risk of falling after standing up due to prolonged sitting on a too high toilet seat, because in the meantime, legs have fallen asleep[29,36]. The interviewed nursing professionals moreover, described the inspection of clothing afterwards as high-risk activity.

Usage of assistive devices in the toilet environment

Presence of assistive devices within the toilet environment and in the vicinity of the toilet bowl does not necessarily result in (proper) usage by elderly people[27,30,35,37]. Literature and the experience of nursing professionals give multiple explanations such as installation out of reach[27,30,37], for example, or grip bars not being recognised as such, but rather as towel rack[27]. Yet another explanation is the necessary muscle force to use particular supports, as interviewed nursing professionals stated that elderly people often do not have sufficient strength to push themselves up on toilet rails.

Supports are currently often installed at average positions recommended by standards and regulations. This could introduce hazardous situations, as user groups like elderly people have very diverse demands regarding anthropometrics and ergonomics. Where average values may be acceptable for most general consumer groups, for elderly people this is certainly not the case, as large numbers of users will likely be excluded from comfortable use[2].

The Fall Risks in Toilet Activities (FRiTA) model

To obtain a more complete image of all separate steps within the toilet ritual activities and to identify potential fall risks within them, the Fall Risks in Toilet Activities (FRiTA) model was created, using the findings in literature, the interviews and the authors insight.

When looking closely at the toilet ritual, it can be divided into a large number of smaller and very diverse activities, ranging from manoeuvring through the room, sitting down, reaching for toilet paper, using a toilet brush, to washing hands, also see table 2. In the FRiTA model these sub-actions are divided in basic toilet activities and more situation-bound toilet activities (e.g. applying sanitary towels).

The various movements made within the toilet ritual activities and the intensity and dimension of the movements differ a lot. Among the large variety of movements walking, standing still, balancing on one foot, turning, reaching, stooping, sitting down, standing up, and moving the head down were identified to contain the highest fall risk[2,9,29,26,37,40]. In the FRiTA model an assessment can be made of the occurrence of these movements within the toilet ritual.

The FRiTA model was used to identify basic toilet activities with an increased fall risk within the Dutch toilet ritual, which can be divided into more than 40 smaller activities. As the occurrence of toilet activities and movements within the toilet ritual is strongly dependent on cultural aspects, it was decided to not further discuss here the separate activities and movements that build the Dutch toilet ritual, but to use it purely as a visual example.

The assessment revealed that many

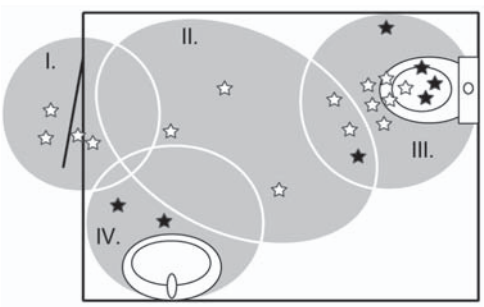
Table 2. Using the FRiTA model to identify basic toilet activities with an increased fall risk within the Dutch toilet ritual

Activities	Movements													
	Walking	Standing still	Balancing on one leg/foot	Turning around	Moving arm	Moving hand(s)/finger(s)	Pushing/pulling	Reaching	Stooping	Lifting	Sitting down	Sitting	Standing up	Moving head down
Walk to toilet environment	x													
Open door	x	x						x						
Switch on light		x						x						
Close door	x	x		x				x						
Lock door		x						x						
Go to toilet bowl	x	x		x										
Hold still in front of toilet bowl		x												
Lift toilet lid		x						x	x					x
Lower/lift toilet seat		x						x	x					x
Clean toilet seat		x						x	x					x
Remain standing		x												
Urinate standing		x												
Turn in front of toilet bowl		x	x	x										
Undress		x	x											x
Sit down		x		x							x			x
Urinate/defecate seated														
Grasp toilet paper								x						x
Tear toilet paper								x						
Wet toilet paper								x						
Wipe with toilet paper			x					x	x					x
Dispose of toilet paper								x						x
Get sanitary/incontinence towel								x	x					x
Apply sanitary/incontinence towel														x
Stand up		x											x	x
Dress		x	x											x
Check clothing		x	x											x
Turn in front of toilet bowl		x	x	x										
Inspect faeces		x		x					x					x
Flush toilet		x						x						
Grasp toilet brush		x						x	x					x
Apply toilet brush		x						x	x					x
Place toilet brush back		x						x	x					x
Lower toilet seat		x						x	x					x
Lower toilet lid		x						x	x					x
Go to washbasin	x			x										
Open faucet		x						x						
Wash hands		x												
Close faucet		x						x						
Dry hands		x												
Look in mirror		x												x
Go to door	x			x										
Unlock door		x						x						
Open door	x	x						x						
Switch off lights		x						x						
Close door	x	x						x						
Walk away from toilet environment	x			x										

Basic toilet activity	Basic toilet activity
	Activity including movement
x	Activity including movement with an increased fall risk

activities within the toilet ritual include movement(s) with an increased fall risk. As combinations of hazardous movements are more difficult to deal with for elderly people[9], those activities including several hazardous movements were labelled as activities with a severe fall risk. Next, potential problem areas within the toilet environment with the basic toilet activities with a severe fall risk could be identified.

The overall toilet environment can be split up into four different sub-regions: I. the door region, II. the open floor space, III. the area around the toilet bowl, IV. the region of the washbasin. The largest number of basic toilet activities with an increased fall risk takes place in the vicinity or on the toilet bowl, as can be seen in Figure 2 (representing a typical lay-out of a Dutch toilet environment accessible for wheelchairs).



Identified basic toilet activities
with (☆) and with (★) increased fall risk)

☆Open door	★Flush toilet
☆Close door	☆Stand up
☆Walk to toilet bowl	☆Get dressed
☆Turn around	☆Check clothing
☆Undress	☆Walk to washbasin
☆Sit down	★Wash hands
★Urinate/defecate	★Dry hands
★Get toilet paper	☆Walk to door
☆Wipe buttocks	☆Open door
★Throw paper away	☆Close door

Figure 2. Sub regions and basic toilet activities

Discussion

This study was carried out with the objective to gather sufficient knowledge to determine the need for more appropriate fall-preventive measures and to create a basis for the development of design criteria. The knowledge obtained in literature was complemented with the expertise of nursing professionals and the elderly themselves via interview sessions. The number of interviewees was limited, but sufficient to provide first-hand information on the problems experienced by elderly people with falls in general and in the toilet environment, and fall prevention. The semi-structured set-up of the interviews ensured discussion of key topics, while still allowing in-depth exploration of issues mentioned by interviewees.

Biomechanical research by Kapandji (1980) supports the theory mentioned by the interviewed nursing professionals, that the muscle power a person has to push himself up is limited as compared to other directions[41]. It is plausible that the overall muscle power decreases due to ageing and affects the available muscle power in the downward direction such that it quickly becomes increasingly difficult or impossible for elderly people to push themselves up. In addition to this, several other sources found that rising from the toilet is an activity preferably executed by a pulling movement, in some cases combined with some pushing support[31,35,37].

Furthermore, in the interviews it was also found that elderly people hold on to all kind of objects in their surrounding and often place their rollator in front of the toilet to provide support during the toilet routine. Most users appear to be accustomed to adapt their movements and toilet ritual to the supports present. Next to this, the opinion and knowledge of the interviewees (both the elderly and the professionals) on fall

risks and prevention is influenced by how and what they were taught and told before. These factors could affect their actual perception of fall risks related to the performance of toilet activities and thus affect the model in different ways. To filter out these influences and possible prejudices though, a behavioural observational study of how elderly people cope with falls and fall prevention in the toilet environment would be necessary, which will be extremely difficult to accomplish.

Conclusions

The main conclusion of this study is that multiple factors, intrinsic as well as extrinsic, affect the occurrence of fall accidents in toilet environments. It is possible to reduce the influence of these factors by applying appropriate fall-preventive measures.

The foremost need for assistive devices in the toilet environment therefore involves products that support the user during a broader range of activities within the toilet ritual. They should better suit movements made by the user, without hindering or complicating the use of the toilet in any way, physically or mentally.

At present, many risk factors are often overlooked in evaluations of fall risks in toilet environments. A combined, broad approach will be most effective. Installing a grip bar next to the toilet still is ineffective when the floor remains slippery and the toilet seat too low. Some of the smaller activities with an increased fall risk could be diminished by applying technical modifications, like cleaning facilities and flush control within reach for seated and standing individuals. A full-size mirror should be present to facilitate easy checking of clothing for all users.

When designing a toilet environment, the desired style and perception of the rest room should be considered as well, as they strongly influence the well-being of visitors and thereby the behaviour and fall risk.

Inclusion of all influential factors to fall risk in regulations on rest room design is an important step in order to reduce the number of fall accidents in toilet environments. A fall risk index or quantitative model, for example, could be used to evaluate and compare toilet environments on the fall risk present in them.

Recommendations for future research

Little information was found on the actual use of assistive products in toilet environments and optimal grip positions for different types of supports during the toilet ritual. Most studies found focused on the appliance of existing assistive devices, without questioning if these supports create the best suitable support solution. Therefore, more research is considered necessary on user preferences regarding support solutions and the interaction patterns with different types of support within the toilet environment. A preliminary study into this will be included in the FRR project.

It would also be interesting to expand the knowledge on toilet rituals for different cultures and (fall) risks for elderly people within those, as shown in table 2 for the Dutch situation.

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