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Environmental Factors Influencing the Prevalence of Falls in South Korea

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Objective: This study is a systematic review conducted to analyze the environmental factors that cause falls in the older adult.

Design: Systematic review

Methods: The study was conducted by searching the Research Information Sharing Service (RISS), Korean studies Information Service System (KISS), and Data Base Periodical Information Academic (DBpia) databases for literature published in South Korea up to July 2020. A total of 12 studies were selected for analysis based on the inclusion and exclusion criteria.

Results: The results of the analysis revealed that all the selected literature were surveys and the study subjects were 65 years of age and above. The sample size ranged from a minimum of 95 subjects to a maximum of 3,278. A total of eight tools were used to measure the environmental factors associated with falls. The prevalence and recurrence of falls increase with age and deterioration of health. Older adult individuals who experience falls encounter difficulties in recovering from impaired physical function and disability; moreover, in severe cases, falls may lead to death. Falls are largely associated with a combination of intrinsic and extrinsic (i.e., environmental) factors. The purpose of this study was to assess potential extrinsic risk factors for falls. Falls occur in indoor environments, such as washrooms, bathrooms and living rooms, and outdoor environments, including roads and stairways, depending on the season, time of day, and use of ambulatory aids. In such environments, falls are mainly caused by slipping and stuttering.

Conclusions: Therefore, as the rate of fall is influenced by several factors, extrinsic factors should be improved by developing comprehensive accident prevention programs that address the improvement of environmental risk factors around places of residence to reduce risk factors among the older adult, who, especially, are at a high risk for falls.

Key Words: Older adult individuals, Environmental risk factors, Falls, Systematic review

Introduction

The most serious complication associated with globally aging populations is the health problems caused by changes in body function, with falls representing one of the most frequently reported health issues among the older adult [1]. Falls refer to events in which the body drops to a lower position due to unintended changes in posture and, in general, where a part of the body, other than the sole of the foot, touches the ground due to a loss of balance [2]. Globally, approximately 28%–35% of older adult individuals aged >65 years experience falls every year; however, this rate increases to 32%–42% in those aged >70 years [3-5]. The frequency of falls increases with age and deteriorates the health status. It has been reported that 30%–50% of older adult individuals in nursing facilities experience falls every year, 40% of who experience recurrent falls [6].

The most significant consequence of falls among the

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older adult population is poor recovery from impairment and disability in physical function, and complications of fall-related injury are severe and may lead to death [2]. Thus, falls that threaten the lives of the older adult are a socially and economically important problem; as such, identifying factors that contribute to falls and their effects is fundamental. Previous studies have demonstrated the complexity of intrinsic and extrinsic factors related to falls [7]. Intrinsic factors include experience of falls, decreased gait and balance ability, decreased muscle strength, decreased vision, depression, dizziness, and other comorbid diseases [8]. Extrinsic factors are as important as intrinsic factors, and most are related to physical and environmental factors such as floor condition, dim lighting, inadequate shoes, improper furniture design, improper toilet and bathtub design, and inappropriate use of equipment [9]. In previous studies, extrinsic factors, such as inappropriate lighting, slippery floors, and the absence of handrails in the bathroom or bathtub, were responsible for >20%–22% of falls among the older adult [10-12]. Moreover, Fonda et al. [13] analyzed fall data in wards housing older adult patients over a 3-year period to assess the cause(s) of falls and reported that equipment (e.g., beds), furniture (e.g., chairs), lighting, and floor surfaces were significant contributors. Those who experienced falls had >1 risk factor for falls at their place of residence [14], and washrooms and personal rooms, where the older adult spend much of their time, are considered to be at an even higher risk of falls [15,16]. Therefore, research and interest in home modification/renovation services are increasing in the United States, Canada, and Australia to prevent falls among the older adult [17,18].

The purpose of this study was to assess potential extrinsic risk factors for falls. We analyzed previous studies that investigated external factors influencing falls among the older adult to assess preventable/modifiable external factors and to provide basic data for the design and implementation of fall intervention programs for the older adult.

Materials and methods

Literature inclusion and exclusion criteria

This study is a systematic literature review conducted to analyze the environmental factors that cause falls in the older adult. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [19] and National Evidence-Based Healthcare Collaborating Agency (NECA) [20] guidelines suggested by the Cochrane Collaboration. The current literature on the environmental factors that cause falls in the older adult were searched based on the core questions of Participants, Intervention, Comparisons, Outcomes, and Study Design (PICO-SD), which is the technical form of systematic literature review. The databases were searched based on the participants and the outcomes to select studies fulfilling the inclusion and exclusion criteria. The inclusion criteria for this systematic literature review were as follows, (1) studies targeting the older adult, (2) studies associated with the environmental factors causing falls, and (3) studies where the full text of the literature was available. The exclusion criteria were studies that (1) targeted patients, (2) had causative factors that were not environmental, and (3) did not provide the full text.

Search and selection of literature

Two researchers independently searched for thesis and academic literature published in South Korea until July 2020, in the Research Information Sharing Service (RISS), Korean studies Information Service System (KISS), and Data Base Periodical Information Academic (DBpia) databases. Each researcher conducted the search twice. In order to prevent omission of other relevant literature, Google Scholar, a prospective citation search method, and the related references were manually searched for studies not listed in the aforementioned databases. The main keywords for the search included ‘older adult,’ ‘falls,’ and ‘environment,’ based on which, a total of 1480 papers were identified. The papers were organized into a list and a bibliographic management program (EndNote X7) was used to remove 53 duplicated documents. After eliminating the duplicated documents, the titles and abstracts were read to determine relevance with the environmental factors causing falls in the older adult. Consequently, 1394 studies were removed, and 33 were selected in the first stage. The 33 studies were investigated to confirm their suitability for this review. E-mails were sent to the corresponding author to request for the original paper when it was difficult to determine the

suitability. The search for and selection of literature were conducted independently by two researchers. In case of a disagreement between the researchers during the literature selection process, the text was reviewed together based on the data inclusion and exclusion criteria to reach a consensus. A total of 12 studies were selected in the final stage to be included in this review. The process of literature selection for analysis is presented in Figure 1.

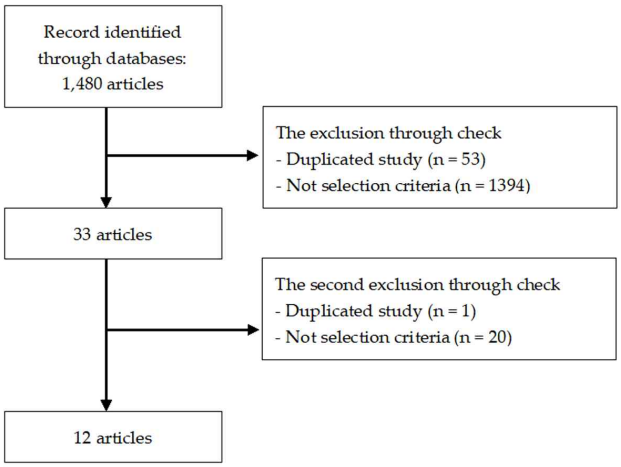

Figure 1. Flow diagram of research selection

Literature quality evaluation

In order to evaluate the quality of the 12 studies included in this review, an analysis model to identify the hierarchy of evidence for evidence-based practice was used, alongside the five-level classification method for levels of evidence by Arbesman et al. [21]. The five-level classification method begins from level I and goes up to level V, with the higher numbers indicating lower quality of the study. This analysis model classifies studies as Level I (randomized controlled experimental study, systematic review, meta-analysis), which has the highest research quality and the highest level of evidence, level II (nonequivalent study with two groups), Level III (nonequivalent study with a single group), Level IV (research study, individual experimental study), and Level V (case study). The results of quality analysis of the 12 studies included in this review are presented in Table 1. All the 12 included studies (100.0%) corresponded to Level IV (research study).

Results and Discussion

General characteristics of the literature

The characteristics of the 12 studies analyzed in this review are presented in Table 2. The 12 studies included in the final analysis included a total of 6,513 subjects. The publication year of the included literature ranged from 2002 to 2016, with two studies each published in 2004 and 2010, and one study each published in 2002, 2005, 2006, 2008, 2011, 2013, 2014, and 2016. All the studies were surveys, and the average age of the subjects was 65 years or older. The sample size ranged from a minimum of 95 subjects to a maximum of 3,278. A total of eight tools were used to measure the environmental factors associated with falls. The most commonly used tools were the 'Checklist for home fall hazard' and 'Home-environmental checklist,' which were used in three papers. This was followed by the 'Residential environment questionnaire,' 'Residential environmental risk scale,' 'Home fall prevention checklist,' 'MDS-environmental scale,' 'Environmental characteristics,' and 'Environmental factors,' which were used once for a study each.

Table 1. Level of quality among each study (n=12)

Level of evidence	Definition	Frequency n(%)
I	Randomized controlled trials	0 (0.0)
II	Non randomized two group studies	0 (0.0)
III	Non randomized one group studies	0 (0.0)
IV	Single experimental studies	12 (100.0)
V	Case studies	0 (0.0)
Total		12 (100.0)

Table 2. Characteristics of included studies (K = 12, N = 6,513)

No.	Author (year)	Sample size (n)	Group (n)	Age (year)	Gender (M/F)	Outcome
1	Kim (2016)	95		≤65	26/69	Residential environment questionnaire
2	Lee et al. (2014)	227	Non faller (122) Faller (105)	77.08 ± 7.08 77.86 ± 7.20	17/105 13/92	Residential environmental risk scale
3	Park et al. (2013)	299		≤65	83/216	Home fall prevention checklist
4	Yoo (2011)	104	Single faller (58) Recurrent faller (46)	≤65	11/47 17/29	MDS-environmental scale
5	Choi et al. (2010)	246	No Falls (123) Falls (123)	75.9 ± 5.4 76.5 ± 5.9	24/99 24/99	Checklist for home fall hazard
6	Kim et al. (2010)	435	65-74 (168) 75-84 (208) ≤85 (59)	≤65	59/109 65/145 16/43	Home-environmental checklist
7	Kim et al. (2008)	3,278		72.86 ± 6.43	1,255/2,023	Environmental characteristics
8	Jang et al. (2006)	477	Fall (218) Non-Fall (259)	72.8 ± 6.7	55/163 98/161	Checklist for home fall hazard
9	Park (2005)	222		≤65	88/134	Home-environmental checklist
10	Park (2004)	218	Fall (113) Non-Fall (105)	≤65	32/81 53/52	Home-environmental checklist
11	Cho et al. (2004)	460		≤65	199/261	Environmental factors
12	Jang et al. (2002)	452		≤70	179/273	Checklist for home fall hazard

K: number of studies, N:number of participants, M: male, F: female, MDS: minimum data set.

Falls and risk factors in indoor environments

Indoor environments, where most falls occur, are addressed first. In a study by Lee and Cho [22] investigating older adult individuals residing at home, falls most frequently occurred in personal rooms where the older adult engage in the highest levels of activity, followed by washrooms, bathrooms, front entrances, and kitchens. Among older adult individuals residing in rural regions, Cho and Yoon [23] reported that falls most frequently occurred in the living room, stairways, front entrances, and washrooms in descending order, while Kim [24] reported that falls most frequently occurred in the washroom and bathroom, followed by personal rooms, kitchens, and living rooms. Among the older adult residing in urban and rural regions, Park and Moon [16] reported that the risk of falls was the highest in the bathroom, followed by the front entrance, kitchen, living room, and stairways. Additionally, the risk of falls was the highest in bathrooms and washrooms among many residential features [25]. In general, falls occurred in the washroom, bathroom, personal room(s), living room, front entrance, kitchen, and stairways, and the risk factors in each of these locations are addressed below.

Park and Moon [16] reported that floor materials, safety devices, furniture, and lighting in indoor

environments are risk factors for falls. The condition of floor materials (e.g., loose mats, wet floors, electrical cords and exposed wires, torn mats, inadequately maintained mats, and slippery floors) increased the risk of falls among the older adult [26]. Risk factors involving floor materials include the front door mat, washroom and bathroom mats, kitchen mats, and door sills, which cause the older adult to slip or trip [27]. In particular, door sills and slippery floors increased the risk of falls by a factor of 2.56 and 1.71, respectively [28]. Park [27] suggested that bathtub knobs (safety devices) and shower chairs (safety devices) in the bathroom are risk factors for falls. Hwang [29] reported no correlation between safety handles and falls. However, Park and Shroyer [26] analyzed the relationship between environmental design factors and fall risk awareness among the older adult and reported that the older adult considered safety handles in the bathtub as the lowest risk factor. Paek et al. [30] also suggested that safety handles in the bathroom have indirect effects on preventing falls by significantly reducing the fear of falls, and Kim [31] reported that safety lock devices for bathroom doors may also prevent falls. Sattin et al. [32] demonstrated that the risk of falls increased by a factor of 3.7, when no safety handle(s) was installed in the bathroom. Other main causes of falls among the older adult include beds and Western-style dining tables. The bed height and low safety of chairs are the main causes of falls [33], with many studies suggesting chairs as a risk factor for falls [27,34]. In previous studies, dim lighting was also suggested to be a risk factor for falls [33]. Park and Moon [16] reported that dim lighting can increase the risk of falls on indoor stairways and bedrooms. A previous study reported that the absence of lighting or only dim lighting on indoor stairways and bedrooms, and the absence of light switches in bedrooms near the bed were risk factors for falls [25]. Moreover, the risk of falls increased by a factor of 1.5, when the light switch in bedrooms was located distant from the bed, and frequent falls caused by falling from the bed or tripping on stairways in the dark suggest that lighting in the bedroom or indoor stairways needs to be improved [32].

Choi and Lee [15] reported that older adult individuals with stroke and diabetes, which are significantly associated with falls, cannot lift their feet properly while walking and exhibit a reduced sense of position of their feet and are more likely to experience falls caused by elevated door sills and differences in the height of rooms. In addition, walking and balance dysfunction caused by decreased muscle strength render the older adult more vulnerable to loss of balance on slippery floors, and lack of handrails and inconsistent stair heights can easily lead to falls among the older adult. Therefore, environmental safety measures, such as the removal of door sills, and installation of antislip floor materials and stair handrails, must be provided for older adult individuals with stroke or diabetes. In addition, risk factors in residential environments can, in large part, be solved by modifying or renovating the environment [35]. It is recommended that the older adult use appropriate assistive devices (hearing aids, canes) according to the progress of aging and changes in sensory organs, and receive education about the use of assistive devices and factors such as door sills, bathroom/washroom floors, and handrails. Moreover, it would be necessary to provide fall prevention education and support for environmental improvement to supportive family members of the older adult.

Falls and risk factors in outdoor environments

Unexpected falls among the older adult may occur during outdoor activities due to external environment factors. In a study by Cho and Yoon [23], older adult individuals experienced falls most frequently in the yard, followed by roads, rice paddies, and farms. In a study by Kim et al. [36], falls mostly occurred on roads, followed by trails, personal rooms, stairs, washrooms, and the kitchen. Similarly, Jang and Kim [37] reported that the greatest number of falls occurred on roads, followed by the yard, personal rooms, stairs, and farm fields. Lee and Cho [22] reported that outdoor falls occurred most frequently on roads among older adult individuals residing at home. In general, outdoor falls most commonly occur on roads and sidewalks, which are caused by uneven ground conditions and damaged sidewalk blocks. Additionally, falls occurred in alleys, icy roads in front of the house, and curbs while using public transportation [24]. Fall frequency was also affected by the condition

of floors, especially concrete surfaces (sidewalk blocks, asphalt), followed by floor paper, tiles, marble, soil, and others (e.g., icy roads) [24]. In a study by Jang and Kim [37], the floor materials that caused the greatest number of falls was concrete, followed by soil, floor paper, wood, and tiles. Various outdoor environmental risk factors have been described in previous studies. Because improving or eliminating all outdoor environmental factors is often difficult [38], it is necessary to provide education about safety, improve balance in the body, and strengthen muscles of the lower extremity to prevent and manage chronic diseases that may contribute to an increased frequency of falls [39].

Falls and seasonality

The prevalence of falls in different regions and facilities varies according to the season. In a study of urban areas by Kim and Suh [39], falls mostly occurred in the spring, winter, autumn, and summer, in descending order. Kim [24] reported that falls occurred most frequently in winter, followed by autumn, spring, and summer. Eom [40] reported that more than half of all falls occurred in winter, followed by spring, autumn, and summer. In a study of rural regions by Jang and Kim [37], falls mostly occurred in the summer, followed by spring, winter, and autumn. Cho and Yoon [23] reported that falls most frequently occurred in the order of winter, spring, autumn, and summer, and Kim [41] reported that the number of falls was the highest in spring. In long-term care facilities, the number of falls was the highest in summer [42]. Kim et al. [36] also reported that falls were most frequently observed in summer, followed by spring, autumn, and winter. Among older adult individuals who resided at home, falls mostly occurred in the spring [31,43]; similarly, Eom [40] reported that older adult patients in university hospitals most often experienced falls in the spring.

In summary, data from previous studies suggest that the rate of falls is the highest in winter in urban regions. In rural regions, the rate of fall is the highest in spring when farming begins. In long-term care facilities, the number of falls is the highest in summer, and older adult individuals residing at home and in hospitals experience falls mostly in the spring, suggesting that the prevalence of falls in regions and facilities varies depending on the season.

Falls and time of day

Differences in the level of activity at different times of the day reflect the varying prevalence of falls. In a study by Kim and Suh [39], falls most frequently occurred during the active hours of the morning (06:00 –12:00) and midday (12:00–18:00), followed by the evening (18:00–0:00) and dawn (0:00–06:00). Cho and Yoon [23] reported that falls occurred mostly in the evening, followed by the afternoon, morning, and late night. Lee and Do [44] reported that the number of falls was the highest in the afternoon (12:00–18:00), followed by morning (06:00–12:00), evening (18:00–0:00), and dawn (0:00–06:00). It is believed that the increased volume of activity and outings after lunch increases the risk of falls. In the spring, falls mostly occurred in the morning (06:00–12:00) while in the summer, the number of falls was the highest in both morning (06:00–12:00) and afternoon (12:00–18:00). In autumn and winter, the rate of falls was the highest in the afternoon (12:00–18:00), suggesting that falls mostly occurred in the afternoon, after lunch, regardless of season. In contrast, the number of falls was the highest in the morning in spring, which was different from that in other seasons. Thus, the findings of previous studies suggest that falls generally occur the most between 06:00 and 0:00 when levels of activity are increased.

Falls and extrinsic (i.e., environmental) situations

In a study by Kim et al. [36], extrinsic situations in the order of decreasing effects on falls included tripping, slipping, dizziness, and lack of lower extremity strength, and extrinsic factors had greater effects on falls than intrinsic factors. Cho and Yoon [23] reported that environmental factors, such as tripping and slippery floors, led to a high rate of falls. On the other hand, anxiety and unfocused thoughts were suggested to be the causes of physical problems. Kim and Suh [39] suggested that stuttering, slipping, and loss of balance were the main causes of falls, with

stuttering and slipping being the most common. Lee and Cho [22] reported that dizziness was the main cause of falls, followed by stuttering, tripping, and slipping, while Kim [24] reported that the main causes of falls were, in decreasing order, slipping, tripping, and stuttering. In summary, previous studies have reported that external situations, such as stuttering, slipping, and tripping, cause falls. The most common cause of falls was stuttering in the spring, autumn and winter, and slipping in the summer.

Therefore, it is suggested that older adult individuals experience falls while walking because of their decreased quickness and muscle strength. Environmental factors, such as season, affect falls; however, movements and activities in daily life are the main causes of falls among the older adult [44]. In addition, falls are caused by both intrinsic and extrinsic factors. Thus, specific intervention methods, such as precautionary education to prevent physical risk factors among many intrinsic factors and assessment of residential risk factors, such as slippery floors, to prevent extrinsic risk factors for falls are recommended [45].

Falls and ambulatory aids

Chai [46] recommended the use of ambulatory devices and protective equipment as interventions to prevent falls. However, Iwarsson et al. [47] suggested interventions based on the assessment of residential risk factors and reported that the indoor use of canes or crutches is a risk factor for falls. Although ambulatory aids are necessary to prevent falls, incorrect use of these aids can lead to an increased risk of such accidents; thus, correct use of the aids is required. In a study by French et al. [48], the risk of falls was higher in those who used ambulatory aids. If locks on wheelchairs are not used, or canes and ambulatory aids do not meet the physical specifications of the patient, the chance for falls may increase. Therefore, older adult individuals who use canes or other ambulatory aids must consult with experts to select those that best suit their needs to reduce the risk of falls, and education on the correct selection and safe use of ambulatory aids would be essential to use the appropriate ambulatory aids suitable for the physical condition of the older adult individual [28,38].

The frequency of falls varies according to the type of shoe. Those who wore slippers, sneakers, dress shoes, no shoes, and rubber shoes experienced falls in decreasing order [24]. Similarly, Jang and Kim [28] reported that those who wore slippers experienced the most falls, followed by those who wore rubber shoes, no shoes, sneakers, and dress shoes, suggesting that the older adult should refrain from wearing slippers.

Falls were also affected by the use of glasses and hearing aids. Those who needed glasses or hearing aids, but could not use them, experienced a higher prevalence of falls compared to those who used or did not need glasses or hearing aids. Vision and/or hearing loss is considered a natural course of aging. Although glasses are commonly available, the general public is not aware of the need for hearing aids, the costs of which can be prohibitive, which limits the purchase of hearing aids by this patient population [49].

Perception of fall-related environmental risk

As adults develop an objective view of the world and themselves through past experiences and learning with their own level of awareness, they understand, modify, and structure sensory information gathered from the environment [50]. Such perceptions influence human behavior and help people engage in healthy behaviors. The practice of healthy behaviors has been reported to be influenced by all components of health belief, including an individual's perceived possibility of developing an illness, the severity of that illness, perceived benefits that lead to healthy behaviors, cost needed to engage in such healthy behavior, disability from the illness, and other behavioral motivations [51]. From this perspective, the perception of fall risk for older adults influences their engagement in fall prevention behaviors [52].

Braun [53] reported that community-dwelling older adults consider falls as preventable and understand the importance of fall-related risk factors, but they do not perceive themselves as vulnerable to falls. Furthermore, Hughes et al. [54] observed that more than 60% of older adults perceive themselves to be at a low risk of falling. Thus, older adults with a low perceived fall risk were found to have a perception that they did not need fall prevention measures and

thus were not keen to participate in fall prevention interventions [55]. Thus, a low level of perception of fall risk has a negative impact on their participation in fall prevention programs [52].

Hughes et al. [54] reported that the perception of fall risk was low among younger and male individuals, those with spouses, those with health insurance, those who considered themselves to be in good health, and those without a history of falls. In addition, people with a low perception of fall risk are less likely to improve their living environment or wear safe shoes, and older individuals were found not to practice what they advise others about fall prevention [55]. Aminzadeh and Edwards [56] found that people who believed that they were not in need of assistive devices, despite the effectiveness and safety of these devices, were at a higher risk of falls. In other words, while it is not certain whether the perception of the need for assistive devices for walking is related to social perception, ensuring proper use of the appropriate assistive device in individuals would be important in establishing an appropriate perception of fall risk and fall prevention intervention. A previous study reported that fall prevention exercises with individual education and counseling about environmental risks were highly effective in preventing falls [57], helping older adults to establish a correct perception of fall risks and the need for fall prevention activities by having experts continuously encourage fall prevention exercises. In addition, managing fall-prone environments would be effective for fall prevention.

When devising fall prevention interventions for older adults, the fact that older adults have an appropriate perception about fall risk may be a crucial factor that increases health behaviors, reduces the fear of falls, and motivates fall prevention efforts. Thus, examining the level of perception of fall risk among older adults and exploring fall prevention intervention measures based on the results would be an effective approach.

Assessment of environmental risk factors of falls

The environmental risk factors of falls include interactions with the surrounding environment, such as the individual's physical conditions, risks at home, and risks in public environments. While these risk factors themselves cannot be concluded as causes of falls, they become definite risk factors when they interact with other factors or when people are exposed to a dangerous environment. The environmental risk factors for falls include narrow stairs, slippery surfaces of stairs, inappropriately fixed mats, and insufficient lighting. Additionally, indoor bumps or stairs, slippery floors, slippery shoes, electric cords, and raised doorways are also environmental risk factors for falls [6].

The fall prevention guidelines for older adults by the American Geriatrics Society and British Geriatrics Society [58] mention that detecting and ameliorating environmental risk factors for falls are recommended in several successful fall prevention programs, and it is also necessary to assess, follow-up, and improve home environments for older adults with a history of falls or at risk for falls. In addition, they recommended contents for these programs such as professional assessment of risk factors at home, alleviation or elimination of risk factors, installation of safety measures (handrails on staircases, horizontal bars in the bathtub), and improvement of lighting. While the effectiveness of home fall risk assessment or intervention alone in fall prevention among community-dwelling older adults was inconsistent, studies still reported that these were clearly effective as a part of a multifactorial intervention. In a randomized controlled trial of an intervention including diagnostic home visits, home fall risk assessment, advice on possible changes, supply of equipment needed to improve the home environment, and training for the use of assistive devices for frail older adults in the community, such interventions led to statistically significant differences in fall experiences [59]. As shown here, fall-related environmental risk assessment is helpful for detecting and ameliorating fall-related risk factors, and assessing the exact risk factors present in the living environment may be critical when developing fall prevention interventions for older adults [45]. Lim et al. [60] described eight criteria for home fall risk assessment: lighting, hardwood floor and linoleum floor, bathtub/shower and toilet, kitchen, heating and air conditioning, house entrance, and room doors. Although the necessary home fall risk factors can be chosen at the discretion

of the researcher, as done here, in general, the Home Environmental Checklist developed by Tideiksaar [61] and the checklist of home fall hazards developed by Josephson et al. [62] are widely used. The Home Environmental Checklist by Tideiksaar [61] comprises 49 items in seven categories: house entrance, inside the home, staircase, bathtub and shower, bedroom, and kitchen. On the other hand, the checklist of home fall hazards developed by Josephson et al. [62] comprises 24 items in six categories: entire home, kitchen, bathroom, master bedroom, stairs and hallway, and outside the home. Recently, the Fall Environmental Risk Assessment Scale for community-dwelling older adult, which is widely used, was developed considering the structural and functional features of Korean home environments, such as a sedentary lifestyle. This scale comprises 52 items in six categories: frequently used stairs near the home (9 items), roads near the home (5 items), area around the gate (5 items), inside the home (15 items), bathroom and toilet (9 items), and environment around the kitchen (9 items) [63].

Falls in older adults occur as a result of a combination of biological, behavioral, socioeconomic, and environmental risk factors. In particular, environmental risk factors have a significant impact on falls in this age group. Thus, fall-related environmental risk assessment tools should be used to assess environmental risk factors for falls in older adults, and tailored educational approaches and fall prevention interventions, such as improving the environment and facilities and providing assistive device rentals, should be planned.

Conclusion

Based on data from previous studies, the present investigation analyzed risk factors in indoor and outdoor environments, season, time of day, cause(s) of falls, ambulatory aids, and extrinsic factors of falls. It was concluded that a combination of extrinsic and intrinsic factors influenced the prevalence of falls. These factors increase the prevalence of falls and, thus, extrinsic factors must be improved to reduce the risk of falls among the older adult, who, especially, are at a high risk for falls. In particular, continuous preventive education must be provided to the older adult to increase their knowledge of falls to increase awareness and adapt to fall prevention behaviors to decrease the prevalence of falls. Moreover, comprehensive accident prevention programs, including the improvement of environmental risk factors around places of residence, need to be developed and implemented. Therefore, it is important to provide support at the national and community levels, as well as focused management systems for the older adult with a high risk for falls and evaluate these risk factors to adopt appropriate intervention programs. Falls is a multifactorial syndrome, and additional studies investigating the effects of detailed assessment and comprehensive recurrent fall prevention programs on the prevalence of falls through multifaceted evaluation are warranted.

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Conflict of interest

The authors declared no potential conflicts ofinterest with respect to the research, authorship, and/orpublication of this article.

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