

SYSTEMATIC REVIEW

FALLS IN THE ELDERLY: A CONTEMPORARY 'HEALTH EPIDEMIC'? A DISCUSSION PAPER

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Abstract

Introduction: Increased life expectancy has risen in most parts of the world, indicating an improvement in public hygiene, diet and healthcare. Yet, the elderly remain a relatively frail population susceptible to a wide range of physical risks. The purpose of this review is to investigate the causes and risks of falls in the elderly. **Method:** A literature search was carried out using systematic reviews and research articles in the following databases: MEDLINE, CINAHL and MEDICAL-CHECK, as well as in individual Greek scientific journals. The search terms used were combinations of the following terms: 'falls', 'elderly', 'nursing', 'falls prevention', 'falls assessment', 'falls risk', as well as the corresponding terms in Greek, during the last twenty years. Results: The systematic search yielded 400 articles in English and 9 in Greek. Of these, 102 were included and the rest rejected because they did not meet the entry criteria. In particular, 60 articles were found in MEDLINE, 40 in CINAHL and 2 in Google scholar. Finally selected for critical discussion 20 articles. The findings were categorized in the following four major subgroups and elaborated accordingly: Exogenous factors, Endogenous factors, Financial burden of falls and Prevention and education. **Discussion:** As falls are a frequent and dangerous phenomenon for the elderly, healthcare professionals should be able to assess the capabilities of older people, especially in terms of balance and recommend suitable exercise programs. A simple exercise program should aim at the best possible outcome by involving a combination of activities, which include walking, cycling, aerobic drills and other resistance exercises. Such an exercise protocol can therefore be used to improve the static and dynamic balance of the elderly. **Conclusions:** In conclusion, as the number and percentage of elderly people continue to increase worldwide, new approaches to preventing falls are imperative. It is more difficult to treat the consequences of falls than prevent them. Causes need to be identified and programs designed to promote health and prevention of falls which should be implemented through both hospital and community services in a seamless way.

Keywords: falls, elderly, nursing, falls prevention, falls assessment, falls risk

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INTRODUCTION

The elderly account for a large and growing proportion of the population especially in the Western world but this brings with it an increased risk of possible falls.¹ These cause a great deal of morbidity, with a considerable physical, psychological and economic impact on the elderly and on their families and hence prevention is very important issue for both individuals and the healthcare system alike in order to reduce co morbidity and mortality.² Nevitt et al., (1991)³ define a fall as "*falling all the way down to the floor or ground, or falling or hitting an object like a chair or stair*".

Increased life expectancy has risen in most parts of the world, indicating an improvement in public hygiene, diet and healthcare. Globally, the number of people over the age of 65 today is estimated to be 650.000.000 and is projected to reach 2 billion by 2050.⁴ Those >65 are the fastest growing age group in the USA, where in 1990, those >65 were 13% of the total population and in 2050, this figure is expected to almost double to 23%. Every year, one in three elderly people falls in the United States and of these 20-30% sustain modest to serious injuries leading to a considerable reduction in mobility and independence.^{5,6}

In 1997 almost 9,000 people aged over 65 died from fall-related injuries and in 2005 this number rose to 16,000.⁷ In the United States, falls and accidents are the main causes of fatal injuries. Mortality rates increase over the age of both sexes and in all racial and ethnic groups. The proportion of hospitalized elderly due to fall injuries is five times higher than for injuries from other causes. Furthermore, women over the age of 65 show a greater chance of mortality due to falls compared to men.⁸⁻¹¹

According to Hartholt et al., (2011)¹² who carried out a falls survey in a Dutch Emergency Department, the main injuries to elderly patients related to falls were: fractures: 70%, surface injury: 21% and open wounds: 9%. In Italy, according to the results of a study carried

out on 2,273 elderly, 651 had fallen, of which 43.1% fell more than twice a year, while 390 of those who fell reported falls in the house, whether due to medical reasons or environmental.¹³ In Germany, falls are considered a major problem for the elderly population. In a survey conducted at an outpatient's medical center on 673 elderly attendees, 23% had one fall and 13.7% more than one in the previous year. Of those who fell, 15% suffered considerable physical harm.¹⁴

Falls are also common in hospitals and nursing homes. In the United Kingdom between 2004 and 2005, about 275,000 falls were reported to occur in hospitals. The elderly in nursing homes were recorded as falling between two and six times a year. As a result, 20% of admissions to hospitals due to accidental injuries come from nursing homes.¹⁵

Globally, there are notable physiological changes with aging which can affect walking gait and mobility patterns. Hormonal and other metabolic changes occurring during aging can be detrimental and often lead to poor mobility, risk of falls, fracture risk and age-related degenerative diseases such as osteoarthritis and osteoporosis.^{16,17} The spine and the skeleton provide support and structure for the body and joints are sites where the bones have flexibility in movement so when these stiffen falls become a greater risk. At the same time, bone loss is observed with aging, especially in women, after menopause as bones lose calcium and other minerals making them fragile.¹⁸

AIM

The purpose of this review is to investigate the causes and risks of falls in the elderly.

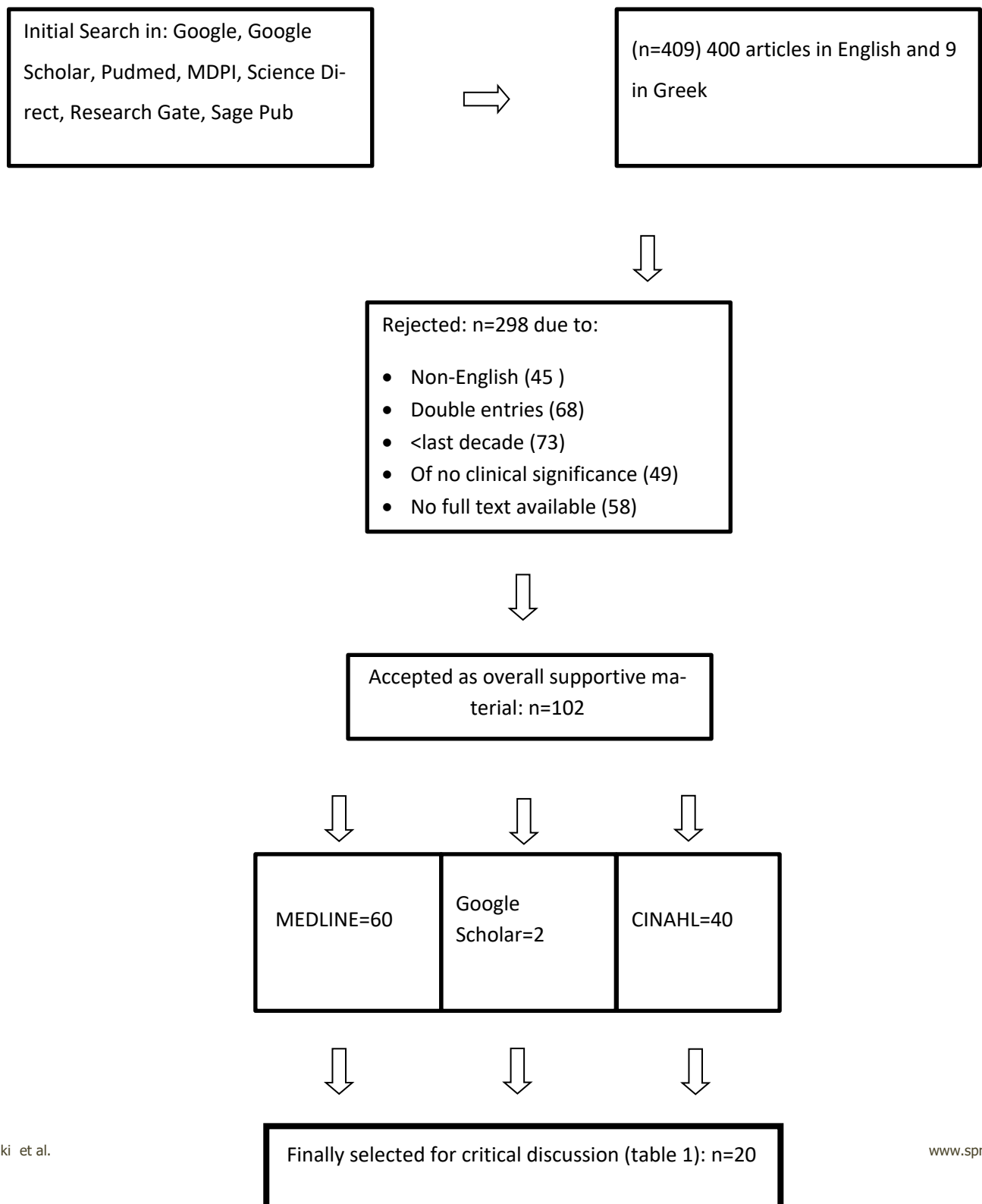
METHOD

A literature search was carried out using systematic reviews and research articles in the following databases: MEDLINE, Google Scholar, MDPI, Science Direct, Re-

search Gate, Sage Pub and CINAHL, as well as in individual Greek scientific journals. The search terms used were combinations of the following terms: 'falls', 'elderly', 'nursing', 'falls prevention', 'falls assessment', 'falls risk', as well as the corresponding terms in Greek, during the last twenty years.

The systematic search yielded 400 articles in English and 9 in Greek. Of these, 102 were included and the rest rejected because they did not meet the entry criteria. In particular, 60 articles were found by MEDLINE, 40 in CINAHL and 2 in Google Scholar (figure 1).

Figure 1: Systematic Search Flow Cart



RESULTS

The findings were categorized in the following four major subgroups as shown in table 1 were five indicative

papers per category are cited and elaborated accordingly: Exogenous factors, Endogenous factors, Financial burden of falls and Prevention and education.

Table 1: causes and risks of falls in the elderly

<i>Authors</i>	<i>Paper</i>	<i>Method</i>	<i>Results</i>	<i>Conclusions</i>
Exogenous factors				
Bleijlevens M, Diederiks J, Hendriks M, Haastregh J, Grebolder H. 2010	Relationship between location and activity in injurious falls: an exploratory study.	An exploratory, cross-sectional study design was used to identify injurious fall types. The study population comprised 333 community-dwelling Dutch elderly people aged 65 years or over who attended an accident and emergency department after a fall.	4 injurious fall types were identified: 1) Indoor falls related to lavatory visits (hall and bathroom); 2) Indoor falls during other activities of daily living; 3) Outdoor falls near the home during instrumental activities of daily living; 4) Outdoor falls away from home, occurring during walking, cycling, and shopping for groceries. These injurious fall types were significantly related to age, cause of the fall, activity avoidance and daily functioning.	The face validity of the injurious fall typology is obvious. However, we found no relationship between the injurious fall types and severity of the consequences of the fall. Nevertheless, there appears to be a difference between the prevalence of fractures and the cause of the fall between the injurious fall types.
Horgan N, Crehan F, Bartlett E, Keogan F, Grady A, Moore A, Donegan C, Curran M. 2009	The effects of usual footwear on balance amongst elderly women attending a day hospital.	Crossover trial with a quasi-randomized allocation.	the mean BBS was 39.07 (SD 9.14) with shoes on and 36.54 (SD 10.39) with shoes off ($P < 0.0001$). Balance scores were significantly higher with shoes on for 10 of the 14 Berg subcategories. Lower barefoot BBS scores were associated with a greater beneficial effect of footwear on balance ($P < 0.001$). Shoe characteristics were not associated with change in the BBS score.	Wearing their own footwear significantly improved participants' balance compared to being barefoot. The greatest benefit of footwear was seen in those with the poorest balance. Further studies should investigate whether particular types of footwear are associated with greater benefit.

Authors	Paper	Method	Results	Conclusions
Sherrington C, Menz H. 2003	An evaluation of footwear worn at the time of fall-related hip fracture.	95 older people (average age 78.3 years, SD 7.9) who had suffered a fall-related hip fracture were asked to identify the footwear they were wearing when they fell. Footwear characteristics were then evaluated using a standardised assessment form. Information was also collected on the type and location of fall.	The most common type of footwear worn at the time of the fall was slippers (22%), followed by walking shoes (17%) and sandals (8%). Few subjects were wearing high heels when they fell (2%). The majority of subjects (75%) wore shoes with at least one theoretically sub-optimal feature, such as absent fixation (63%), excessively flexible heel counters (43%) and excessively flexible soles (43%). Subjects who tripped were more likely to be wearing shoes with no fixation compared to those who reported other types of falls [chi(2)=4.21, df=1, P=0.033; OR=2.93 (95%CI 1.03-8.38)].	many older people who have had a fall-related hip fracture were wearing potentially hazardous footwear when they fell. The wearing of slippers or shoes without fixation may be associated with increased risk of tripping. Prospective studies into this proposed association appear warranted.
Elley C, Robertson M, Kerse N, Mckinlay E, Lawton H, Campell A. 2007	Assessment clinical Trial (FACT): design, interventions, recruitment strategies and participant characteristics	Two recruitment strategies were used - waiting room screening and practice mail-out. Intervention participants received a community based nurse assessment of falls and fracture risk factors, home hazards, referral to appropriate community interventions, and strength and balance exercise programme. Control participants received usual care and social visits.	312 participants were recruited (69% women). Of those who had fallen, 58% of people screened in the practice waiting rooms and 40% when screened by practice letter were willing to participate. Characteristics of participants recruited using the two methods are similar ($p > 0.05$). Mean age of all participants was 81 years (SD 5). On average participants have 7 medical conditions, take 5.5 medications (29% on psychotropics) with a median of 2 falls (interquartile range 1, 3) in the previous year.	The two recruitment strategies and the community based intervention delivery were feasible and successful, identifying a high risk group with multiple falls. Recruitment in the waiting room gave higher response rates but was less efficient than practice mail-out. Testing the effectiveness of an evidence based intervention in a 'real life' setting is important.

Authors	Paper	Method	Results	Conclusions
Prabhakaran K, Gogna S, Pee S, Samson D, Con J, Latifi R. 2020	Falling Again? Falls in Geriatric Adults-Risk Factors and Outcomes Associated With Recidivism	The Nationwide Readmission Database for 2010 was evaluated and identified the patients (≥ 65 years) who were admitted after falls, and from that subset, further analyzed patients with ≥ 1 FRRs. Multivariable logistic regression was used to identify predictors of readmission in geriatric patients after controlling for covariates.	A total of 358,581 initial fall-related admissions in geriatric adults were identified, and of these, 21,713 experienced ≥ 1 FRRs (6.06% risk of repeat fall-related admission). Females outnumbered males, and female gender was identified as an independent predictor of FRR (OR 1.10 95% CI 1.07-1.14 P = 0.000). The other independent predictors significantly associated with FRR were age (OR 1.007, 95% CI 1.005-1.009), depression (OR 1.25, 95% CI 1.21-1.30), drug abuse (OR 1.37, 95% CI 1.15-1.63), liver disease (OR 1.25, 95% CI 1.15-1.43, P < 0.001), psychosis (OR 1.16, 95% CI 1.09-1.23), valvular heart disease (OR 1.07, 95% CI 1.02-1.12), chronic pulmonary disease (OR 1.10, 95% CI 1.06-1.13), and number of chronic conditions (OR 1.022, 95%CI 1.016-1.29). Patients admitted emergently or urgently had higher odds of FRR (OR 1.44, 95%CI 1.36-1.52).	Given the high burden of fall-related injuries and FRRs to patients and the health care system, it is essential to identify those who are at risk. This study provides a comprehensive list of high-risk predictors as well as the impact on patient outcomes, and hence a chance to intervene for patients with FRRs.
Endogenous factors				
Olij B, Erasmus V, Kuiper J, van Zoest F, van Beeck E, Polinder S. 2017	Falls prevention activities among community-dwelling elderly in the Netherlands: A Delphi study.	A two-round online Delphi study among health experts was conducted. The panel of experts (n=125) consisted of community physiotherapists, community	Respectively 68% (n=85/125) and 58% (n=72/125) of the panel completely filled in the 1st and 2nd round questionnaires. According to the panel, regular detection of fall risk of community-	This Delphi study showed clear directions for improving falls prevention activities and how to increase participation rates.

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		nurses, general practitioners, occupational therapists and geriatricians, from all over the Netherlands. The median and Inter Quartile Deviation (IQD) were reported for the questions with 5-point Likert scales, ranging from 'least' (1) to 'most' (5).	dwelling elderly with an increased risk of falling hardly takes place (median=2 [hardly]; IQD=1). Furthermore, these elderly are reluctant to participate in annual detection of fall risk (median=3 [reluctant]; IQD=1). According to 73% (n=37/51) of the panel, 0-40% of the elderly with an increased risk of falling are referred to exercise programs. In general, the panel indicated that structural follow-up is often lacking.	
Gazibara T, Kurtagic I, Kistic-Tepavcevic D, Nurkovic S, Kovacevic N, Gazibara T, Pekmezovic T. 2017	Falls, risk factors and fear of falling among persons older than 65 years of age.	A total of 354 persons older than 65 years of age were recruited at a community health centre. Characteristics of the most recent fall were obtained through detailed interviews with study participants. The Falls Efficacy Scale was used to quantify fear of falling.	Frequency of falling was 15.8%. Falls occurred most often while walking (49%). One-half of fallers (49.1%) sustained an injury. Head haematomas and soft tissues contusions were the most common consequences of falls. The average Falls Efficacy Scale score was significantly higher in fallers ($P = 0.001$). Multiple logistic regression analysis showed that having a fear of falling (odds ratio = 4.14, 95% confidence interval: 1.22-14.08, $P = 0.02$) and being a woman (odds ratio = 2.10, 95% confidence interval: 0.97-4.53, $P = 0.05$) were independent risk factors for falling among older persons.	The frequency of falls among older people was similar to those in other populations. These results could be used to help select older persons who should be enrolled in fall prevention programmes.

Authors	Paper	Method	Results	Conclusions
Kalyani R, Stein B, Valiyil R, Manno R, Mayhard J, Crews D. 2011	Vitamin D treatment for the prevention of falls in older adults	Systematic review and meta-analysis.	Of 1,679 potentially relevant articles, 10 met inclusion criteria. In pooled analysis, vitamin D therapy (200-1,000 IU) resulted in 14% (relative risk (RR)=0.86, 95% confidence interval (CI)=0.79-0.93; I(2)=7%) fewer falls than calcium or placebo (number needed to treat =15).	Vitamin D treatment effectively reduces the risk of falls in older adults. Future studies should investigate whether particular populations or treatment regimens may have greater benefit.
Oliver D, Papaioannou A, Giangregorio L, Trabane L, Reizgys K, Foster G. 2008	A systematic review and meta-analysis of studies using the STRATIFY tool for prediction of falls in hospital patients: how well does it work?	A systematic literature review of prospective validation studies of STRATIFY for falls prediction in hospital inpatients.	41 papers were identified by the search, with eight ultimately eligible for inclusion in the systematic review and four for inclusion in the meta-analysis. The predictive validity of STRATIFY, using a random-effects model, for the four studies involving geriatric patients was as follows: SENS 67.2 (95% CI 60.8, 73.6), SPEC 51.2 (95% CI 43.0, 59.3), PPV 23.1 (95% CI 14.9, 31.2), NPV 86.5 (95% CI 78.4, 94.6). The Q((3)) test for homogeneity was not significant for SENS at P = 0.36, but it was significant at P < 0.01 for SPEC, PPV and NPV. TPA across all four studies varied from 43.2 to 60.0.	There is a relatively high NPV and low PPV and TPA for the STRATIFY instrument, suggesting that it may not be optimal for identifying high-risk individuals for fall prevention. Further, the study demonstrates that population and setting affect STRATIFY performance
Lord S, Menz, H. 2000	Visual contributions to postural stability in older adults.	Tests of visual function, peripheral sensation, strength, reaction time and sway were administered to 156 community-dwelling men and women aged 63-90 years. The visual tests	On the firm surface, sway was significantly associated with only one sensorimotor measure: proprioception in the lower limbs. In contrast, on the compliant surface, sway was associated with all of the visual measures,	The study findings confirm the importance of vision, in particular contrast sensitivity and stereopsis, in the control of posture under

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		included high- and low-contrast visual acuity, contrast sensitivity, depth perception, stereopsis and lower visual field size.	quadriceps strength and reaction time. Multiple regression analysis revealed that contrast sensitivity, stereopsis and quadriceps strength were significant independent predictors of total sway when subjects stood on the compliant surface.	challenging conditions, and suggest some mechanisms for the association between impaired vision and falls in older people.
Financial burden of falls				
Woolcott J, Khan K, Mitrovic S, Anis A, Marra C. 2012	The cost of related presentations to the ED: a prospective, in-person, patient-tracking analysis of health resource utilization.	We prospectively collected data from seniors (>70 years) presenting to the Vancouver General Hospital ED after a fall. Unit costs of health resources were taken from a fully allocated hospital cost model.	Data were collected on 101 fall-related ED presentations. The most common diagnoses were fractures (n = 33) and lacerations (n = 11). The mean cost of a fall causing ED presentation was \$11,408 (SD: \$19,655). Thirty-eight fallers had injuries requiring hospital admission with an average total cost of \$29,363 (SD: \$22,661). Hip fractures cost \$39,507 (SD: \$17,932). Among the 62 individuals not admitted to the hospital, the average cost of their ED visit was \$674 (SD: \$429).	Among the growing population of Canadian seniors, falls have substantial costs. With the cost of a fall-related hospitalization approaching \$30,000, there is an increased need for fall prevention programs.
Davis J, Robertson M, Ashe M, Liu-Ambrose T, Khan K, Marra C. 2010;	International comparison a cost of falls in older adults living in the community: a systematic review.	This is a systematic review of reporting estimates for the cost of falls in people aged >60 in papers published between 1945-2008 in cost of falls in older adults.	17 studies met our inclusion criteria. Studies varied with respect to viewpoint of the analysis, definition of falls, identification of important and relevant cost items, and time horizon. Only 2 studies reported a sensitivity analysis and only four studies identified the viewpoint of their economic analysis. In the USA, non-fatal and fatal falls cost US	The economic cost of falls is likely greater than policy makers appreciate. The mean cost of falls was dependent on the denominator used and ranged from US \$3,476 per faller to US \$10,749 per injurious fall and US \$26,483 per fall

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			\$23.3 billion (2008 prices) annually and US \$1.6 billion in the UK.	requiring hospitalization.
Walther L, Kleeberg I, Rejmanowski G, Hansel J, Lunderhausen D, Horman K, Schnupp T, Lohler J. 2011	Falls and fall risk factors: are they relevant in ENT outpatient medical care?	A multicentre study was performed in six outpatient facilities based on a survey of falls and fall risk factors in patients living at home (n = 673) aged 60 years and older.	A total of 23% had one and 13.7% >1 fall within the previous year. Of these, 15% suffered injury, while only 13% used some form of fall prevention. Joint pain and problems of the hip and lower extremities (42.6%), abnormal gait (41.3%), dizziness and balance disorders (38%) as well as impaired activities of daily living (35%) are the most common risk factors for falls and multiple falls in all age groups.	Falls are a frequent problem in patients in ENT outpatient medical care. Fall prevention is advisable in the context of an interdisciplinary approach.
Hartholt K, Beeck E, Palinder S, Veide N, Lieshault E, Panneman M, Cammen T, Patka P. 2011	Societal consequences of falls in the older population: injuries, health costs and long term reduced quality of life.	Data on fall-related injuries in persons aged >65 were retrieved from the Dutch Injury Surveillance System, and a patient follow-up survey conducted between 2003- 2007. Injury incidence, discharge rates, healthcare costs, & quality of life measures were calculated.	Fall-related injuries were to the upper or lower limb in 70% of cases and consisted mainly of fractures (60%), superficial injuries (21%), and open wounds (8%). Falls led to a total healthcare cost of €474.4 million, which represents 21% of total healthcare expenses due to injuries. Both admitted and non-admitted patients reported a reduced quality of life up to 9 months after the injury.	Fall-related injuries in older adults are age and gender related, leading to high healthcare consumption, costs, and long-term reduced quality of life. Further implementation of falls prevention strategies is needed to control the burden of fall-related injuries in the aging population.
Wu S, Keeler E, Rubenstein L, Maglione M, Shekelle P. 2010	A cost-effectiveness analysis of a proposed national falls prevention program.	The authors used meta-analytic findings on the effectiveness of fall prevention interventions to determine cost-effectiveness of a proposed Medicare fall prevention program for people who experience a recent fall.	The authors constructed a population-based economic model and estimated that, in the base case, the program could prevent a half million people from falling again within a year. From the model, under most cir-	Paying for a fall prevention program to increase the use of evidence-based interventions would be a cost-effective use of Medicare dollars.

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			cumstances the cost-effectiveness ratio is less than \$1500 per person prevented from experiencing a recurrent fall.	
Prevention and education				
Binder S. 2002	Injuries among older adults: the challenge of optimizing safety and minimizing untended consequences.	Summary and synthesis of selected literature	About 39.000 adults aged 65 and older die each year in the United States from injuries; worldwide this annual toll is about 946 000 persons. The top three causes of injury related death in this age group in the United State are falls, those related to motor vehicle crashes, and suicide. Effective strategies exist for preventing fall related injuries and deaths.	As the number and percentage of older adults continues to rise in the US, new approaches to preventing injuries will be critical. Interventions will need to operate at multiple levels-directed at the individual, at interpersonal relationships, and at the community level.
Loke M, Yen Gan L, Islahudin F. 2018	Awareness of medication related falls and preferred interventions among the elderly	A cross-sectional survey among the elderly patients in a tertiary hospital.	86 patients were interviewed. 23.3% of the elderly had a history of falls over the past 6 months. Majority of the elderly considered falls as a major concern (80 patients, 93%) and is preventable (55 patients, 64%). Patients with a medical condition reported a significantly greater number of falls within the past 6 months ($p < 0.001$). Approximately 69% (59 patients) were aware of their medication and associated risk of falls.	The knowledge of falls, medication related falls and intervention strategies in the elderly were minimal.
Chehuen Neto J, Braga N, Brum I, Gomes G, Tavares P, Silva R, Freire M, Ferreira R.. 2018	Awareness about falls and elderly people's exposure to household risk factors.	The FRAQ-Brazil questionnaire was used on 473 elderly people as well as a questionnaire on elderly people being exposed to 20 household risk	The age range was between 60 and 95 years with the average being 70.6 years. The majority of those interviewed were female (58.4%) who were earning 2 minimum wages (46.3%). The average amount of correct answers given with the use of the FRAQ-Brazil questionnaire was 19.5 out	The majority of the elderly population displayed little knowledge on falls and were exposed to a variety of daily risk factors. Individuals who were more advanced in years and

Authors	Paper	Method	Results	Conclusions
		factors. Associations between the variables were analyzed using the chi-squared test with a confidence interval of 95%.	of 32 points and the elderly participants were, on average, exposed to 7.8 household risk factors. 180 of them stated that they had already received information on falls.	who had more knowledge on falls, were exposed to less household risk factors. This may well have been due to the adoption of preventative measures through changing domestic environment.
Huang T. 2005	Home environmental hazards among community-dwelling elderly persons in Taiwan.	An assessment was made of the home environments of 1212 people aged 65 years and older, chosen by cluster sampling from registered households in northern Taiwan.	Significant predictors of potential home environmental hazards were: living in an urban area (OR = 4.36, 95% confidence interval (CI)=3.29, 5.76), poor awareness of one 's health status (OR=1.86,95%CI=1.31,2.64), family dysfunction (OR= 1.77,95%CI=1.21, 2.59), fear of falling (OR=1.65,95%CI=1.19, 2.28) , being older (>/=75years, OR=1.47, 95 % CI =1.11, 1.96) , poor gait (OR=10.76, 95 % CI=4.48, 25.84) and poor balance (OR =3.03, 95% CI=1.14, 8.09).	Most elderly persons do not live in a risk-free home environment. The recognition and removal of environmental hazards is imperative to the well-being of the elderly.
Teresi L, Ramirez M, Remler D, Ellis J, Boratgis G, Silver S, Kong J, Eimicke J, Dichter E. 2011.	Comparative effectiveness of implementing evidence-based education and best practices in nursing homes: effects on falls, quality-of-life and societal costs.	A quasi-experimental design, a variant of a cluster randomized trial of implementation research examining transfer of research findings into practice, was used to compare outcomes among three groups of residents in 15 nursing homes per group.	The main finding was of a significant reduction of between 5 and 12 annual falls in a typical nursing home. While both intervention groups resulted in fall reduction, the larger and significant reduction occurred in the group without surveyor training. A significant reduction in negative affect associated with training staff and surveyors was observed. Net cost savings from fall prevention was estimated.	A low cost intervention targeting dissemination of evidence-based best practices in nursing homes can result in the potential for fall reduction, and cost savings.

Exogenous factors

The causes of falls are attributed to various risk factors. Although no single risk factor usually causes falls, the greater the number of risk factors to which a person is exposed, the greater the likelihood of a fall. Falls either at home, in hospital, or in the community are a result of interaction between the environment, personal stress and levels of physical activity.¹⁹ Below are some key risk factors for falls in the elderly population, divided into endogenous and exogenous.²⁰⁻²²

With regards to extraneous agents, the causes are mainly identified by the surfaces with which the elderly come into contact. A surface is considered dangerous when it is wet, slippery, as well as uneven or faulty-shaped. Research has shown that most falls have occurred in areas where older people are active most of their day with the bathroom being the most dangerous area for a fall. The kitchen, living-room and bedrooms follow.^{23,24} According to Bleijlevens et al., (2010)²⁵, the most precarious fall areas are considered to be the internal spaces of a house and the external spaces and activities in the surrounding environmental activities (gardening, walking, cycling or shopping).

According to a study carried out in Taiwan by Huang (2005)²⁶, who aimed at investigating domestic fall risks in 1,212 citizens over 65 years of age, the greatest risk environment for falls was homes (60,4%) mostly occurring in the bathrooms. More specifically, the main risk factors were poor lighting, (31,8%), slippery floors (18,2%), stored objects (14,6%), carpets (14,6%) and absence of safety handles (13 %).

A study by Fritsch & Shelton., (2019)²⁷ showed that the absence of handles in the shower or bathtub was especially dangerous for the elderly who had a problem in walking and balancing but even for those who did not have a disability. Moreover, in homes of elderly with balance problems, the presence of objects on the floor is a major contributor for a fall along with unsuitable footwear e.g. poorly fitting slippers. Various types of foot-

wear were tested by Lord & Menz (2000)²⁸ who concluded that low shoes and bare feet offered a better balance. In contrast, Horgan et al (2009)²⁹ found that the elderly wearing shoes had a better balance than those using other types of footwear.³⁰

Endogenous factors

Endogenous factors contributing to falls, include age, gender (women are more prone), physical and mental state including cognitive changes.³¹ Furthermore, changes in balance capabilities, dysfunctions of the nervous, muscular, or skeletal system and periods of inactivity result in gait or walking problems.³² Studies have found that more than a third of the elderly over 65 years of age fall every year with the main risk factor being muscle weakness which may be linked to vitamin D deficiency, common among the elderly.³³

It is worth mentioning that osteoporosis is considered a significant risk factor for falls including osteopenia and osteoarthritis. As a rule of thumb, prediction of osteoporosis includes age, gender, family history, immobility and low weight.^{34,35} Furthermore, vitamin D deficiency plays an important role in the development of osteoporosis with the ultimate consequence of a fracture following a fall.^{36,37} Thus, poor bone status is directly related to falls. Fractures in the spine may also occur in people with osteoarthritis, even if they have high bone density, which also increases the likelihood of falling.³⁸ This leads to loss of autonomy which a significant risk factor is leading to further falls.

Another important point is that over time, there is a generalized decrease in visual function, which is associated with an increasing risk of falls.³⁹ Visual disturbances, although not routinely evaluated, are considered a significant risk factor. Along these lines, assessment of visual functions, such as visual acuity, contrast sensitivity and depth perception can identify elderly people at risk of falling.⁴⁰

Taking medication may significantly affect the elderly and may lead to a risk of falling.⁴¹ Among these,

are antihypertensives, antiarrhythmics, anticholinergics, antidepressants, diuretics, and all psychotropic agents that cause irritation, somnolence, agitation and disrupt mental functions such as concentration, balance and perception. The combination of alcohol consumption and the use of psychotropic medicines or other substances may also increase the risk of falling.⁴² Finally, multiple medication use, i.e. the use of four or more medicines, even on a prescription from a doctor, increases the predisposition of elderly people to falls and other accidents.^{43,44}

Another important risk factor is hypotension which accounts for 10-30 % of falls. It can stem from many factors, such as autonomic dysfunction, low cardiac output and certain medications such as antidepressants, tranquilizers and antihypertensives. Syncope, vertigo, and "drop attack" are other factors which may contribute to a fall. Syncope is defined as a sudden loss of consciousness resulting from reduced brain blood flow. Vertigo is another common symptom among the elderly but it is a non-specific symptom and can reflect problems such as hyperventilation, drug side effects, anxiety or depression. Drop attack is defined as a sudden fall which occurs without an external physical trigger, such as tripping over something, typically lasting around 15 seconds. It does not involve any loss of consciousness and equilibrium is regained quickly if the individual is not hurt during the fall.⁴⁵

Within all of the above risk factors, there is also the factor of fear as falling and fear are interconnected problems. Many elderly people who fall, regardless of whether they get hurt, gradually become afraid of adapting and thus end up with limited activity, degradation of living standards, physical weakness, reduction in mobility, depression and rapid risk escalation resulting in a fall. Research has shown that women over 75 years of age on low incomes are most afraid of falling.⁴⁶

Financial burden of falls

Falls among the elderly are a public health problem due to their frequency and negative consequences in terms

of high morbidity, mortality, quality of life and the impact on health care systems.⁴⁷⁻⁵¹ They also place a heavy burden on both the individual and his family. In addition, falls can lead to head injury, hospital care and an increase in the cost of healthcare.⁵²⁻⁵³

In the United States, more than 2.6 million over the age of 65, suffer a drop attack every year requiring intense medical treatment with costs exceeding 19 billion USD. The average cost of accidental fall injuries without hospitalization ranges from \$3,476 to \$10,749 per case and the cost increases to \$26,483 for those hospitalized.⁵⁴ In the United Kingdom, 650,000 over the age of 65 who fall annually need hospitalization with costs amounting to 1 billion GBP.⁵⁵

In Canada, the average cost per fall treatment in the emergency department was \$11,408. When patients were admitted to the hospital the cost averaged \$29,363.⁵⁶ In Australia, the minimum cost of health care per fall was estimated at \$841 and a maximum of \$1024. In China, 25,000,000 elderly fall every year. Of the total 60-80 billion yuan allocated to the Chinese healthcare system, 5 billion yuan is spent on fall related expenses.⁵⁷

It is important to mention that maintaining physical activity reduces many risk and disease factors and therefore can play a vital role in the general prevention of falls and lead to a reduction in the cost of healthcare.⁵⁸

An even more significant consequence of the financial cost of falling is the effect of injury on the general life of the individual and his family. Falling may lead to loss of independence, reduced quality of life, agitation and depression.⁵⁹

Falling and fear of falling are interrelated problems. Many elderly people have a fear of 'after falling', i.e. when they have already fallen once and fear that this will happen again. This 'after-fall' syndrome leads to further restricted movement, limiting activities of daily life, reduced sociability, depression and even increased risk

of falling again. As a result, falls have a wider impact on both physical and psychological functions.⁶⁰⁻⁶³

Prevention and education

Falls are a major public health problem in the elderly population and interventions that reduce the risk of falling should be implemented.⁶⁴⁻⁶⁶ Interventions should operate at multiple levels including environmental changes, exercise programs, medication treatment review and education. However, in order to achieve better results, the risk factors of falling should first be detected.^{67,68} Once the environmental risk factors within homes and the community are established and tackled there may be a chance for reducing fall incidence overall.⁶⁹

Older people should be guided to inspect their living environment. This can be further achieved by having a community nurse, physiotherapist or occupational therapist visit and assess their living environment aiming at identifying environmental hazards, such as worn blankets, unstable furniture, electronic cables, low lighting, unsmooth floor, rugs, and remove them accordingly.⁷⁰ In addition, adequate lighting, safe ramps, shower rails or a mechanism to increase or reduce the height of the bed should be foreseen and installed. An alert system should also be provided to facilitate elderly people in need. Such interventions have the effect of preventing falls and reducing the proportion of elderly people needing subsequent hospitalization.⁷¹⁻⁷²

DISCUSSION

As falls are a frequent and dangerous phenomenon for the elderly, healthcare professionals should be able to assess the capabilities of older people, especially in terms of balance and recommend suitable exercise programs. An exercise program should aim at the best possible outcome by involving a combination of activities, which include walking, cycling, aerobic drills and other resistance exercises.⁷³ Stress drills to increase muscle strength can be carried out either in an aquatic environ-

ment or in a non-aquatic environment. Such an exercise protocol can therefore be used to improve the static and dynamic balance of the elderly.⁷⁴

In addition, walking sticks and other aids may be used for patients with disorders of gait and balance. Yet, advice on shoes may also help reducing falls. Most importantly, however, older people who have problems with their balance should start a training course under the direct supervision of a physiotherapist. The performance of simple and well-designed balancing exercises at least three times a week can improve balance and reduce the rate of falls in the elderly.⁷⁵⁻⁷⁷

Another important factor contributing to a loss of balance is orthostatic hypotension. Various techniques can be of benefit for the elderly with orthostatic hypotension due to autonomous dysfunction. These include sleeping with the head in a lower position than the legs and feet (tredelburg position), and avoiding intense exercises, especially in hot weather. In addition, support socks or stockings minimize the venous blood concentration in the lower legs.⁷⁸⁻⁸²

Prevention of falls associated with osteoporosis in the elderly is another goal that should be tackled. There is considerable evidence that suggests providing vitamin D and calcium supplementation can decrease fall rates.⁸³⁻⁸⁷ Thus, daily administration of 800 IU of vitamin D may significantly reduce the fall incidence. In addition, vitamin E and Magnesium are shown to improve balance and help the elderly conduct their daily tasks more easily.⁸⁸⁻⁹⁰

In hospitals, studies have shown that the best way to prevent falls is to provide a program containing multilevel interventions. These may include risk assessment, healthcare planning, fall-related medical diagnosis, removal of physical constraints, exercise, and training programs.⁹¹⁻⁹⁴ However, this program is not effective in the elderly whose hospital stay is a short one. These multilevel prevention programs have a positive effect on the elderly in hospitals, but they come with a

high cost. Therefore, such interventions need to continue within the community where the cost would be lower.⁹⁵⁻⁹⁹

Under the light of the current Covid-19 pandemic, health care professionals need to 'think outside the box' and find ways of engaging the elderly, especially as it is currently more difficult for them to visit overstretched health care settings. Kannan et al., (2019)¹⁰⁰ supported the viability of online delivery of self-management strategies in Multiple Sclerosis. They suggested that their intervention may help prevent falls in patients with Multiple Sclerosis. Bourne et al., (2017)¹⁰¹, devised an online pulmonary rehabilitation programme. This was proven to be an evidenced-based and guideline-mandated intervention for patients with COPD with functional limitation. Therefore, after a 6-week programme of online-supported pulmonary rehabilitation, the intervention was found to be as effective as a conventional model delivered in face-to-face sessions in terms of effects on distance, and symptom scores and was safe and well tolerated. In these lines, Srikesavan et al., (2018)¹⁰² devised an online Hand Exercise Intervention for Adults with Rheumatoid Arthritis (mySARAH). This is the first

online exercise for rheumatoid arthritis of the hands which involves target users at the ease of their homes. The intervention's usability ensures that the patients' needs and preferences were met.

CONCLUSIONS

Older people and their related health problems are increasingly attracting interest from different interest groups. Globally, falls in the elderly are considered as a major medical and social challenge. Especially as falls in this age group contribute to high morbidity and mortality rates. As in most cases, multiple factors contribute to a fall, thus, prevention should be achieved through a review of medication, exercise and consequent modification of the environment and educational needs.

In conclusion, as the number and percentage of elderly people continue to increase worldwide, new approaches to preventing falls are imperative. It is more difficult to treat the consequences of falls than prevent them. Causes need to be identified and programs designed to promote health and prevention of falls which should be implemented through both hospital and community services in a seamless way

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