Risk Factors Affecting Falls among Old Adults in Community: A Systematic Review

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Abstract

Falls are a marker of frailty, immobility, and acute and chronic health impairment in older persons. This systematic review aimed to provide the best available evidence related to risk factors for falls among community-dwelling older adults. Mixed search methods were used to retrieve English published studies from 2000-2016 through a variety of medical databases. Eligibility criteria specified articles evaluating the association between falls and its risk factors in older adults. A total of 10 studies met inclusion criteria and were included in a systematic review process. All eligible studies were assured of methodological quality prior to data extraction. Data were extracted independently by three reviewers using a written protocol and standardized extraction documentation. Demographic and methodological characteristics of all included studies were initially reviewed and documented. A wide variety of fall risk factors were systematically reviewed including socio-demographic, medical, physical, clinical, psychological, behavioral and environmental factors, and medication use. Based on review, most risk factors were found to be significantly associated with fall occurrence. Moreover, strong associations were found for history of falls, gait problems, walking aids use, vertigo, and antiepileptic drug use. This systematic review identified evidence-based specific falls risk factors by confirming the multi-factorial etiology of falls. Hence, the major findings of this study guide the forthcoming intervention strategies for falls among community-dwelling older adults.

Keywords: Falls, community-dwelling older adults, systematic review

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Introduction

Falls are a common and often detrimental effect on health among older people, particularly causing a tremendous amount of morbidity, mortality, and use of health care services including premature hospitalization (Rubenstein, 2006). Older adults are hospitalized for fall-related injuries five times more often than they are for injuries from other causes (WHO, 2007) Furthermore, falls can be markers of poor health and declining function, and they are often associated with significant morbidity (Fuller, 2000). For prevalence of falls, it is reported that about one-third of community-dwellers over the age of 65 and nearly one-half of institutionalized persons or persons over the age of 80 will fall each year (Berry & Miller, 2008). For its consequences, almost half of fallers will experience a repeat fall within the next year. While most falls result in no injury, 31% of falls result in an injury requiring medical attention or restriction of activities for at least one day. Most of these are minor soft tissue injuries, but 10-15% of falls result in fracture, and 5% of falls result in more serious soft tissue injury or head trauma (Tinetti et al., 1995). Also, most fallers reported the demand for health care utilization, particular treatment as well as decline in functioning as consequences following fallings (Vianda et al., 2004). In addition, many do experience some degree of disability leading to activity restrictions, and many develop a fear of falling, which together reduce dependence and quality of life (Lord et al., 1994).

Unfortunately, falls usually present without clinical attention due to: the patient never mentions the event to a health care provider; there is no injury at the time of the fall; the provider fails to ask the patient about a history of falls; or either provider or patient erroneously believes that falls are an inevitable part of the aging process (Berry & Kiel, 2016). Often, treatment of injuries resulting from a fall does not include investigation of the cause of the fall (Bergland, 2012). Moreover, falls occur as a result of a complex interaction of multiple causes (WHO, 2007). Causes of falls in older people are considered multi-factorial and interrelated, which include lower limb weakness, history of falls, gait or balance disorders, functional and cognitive impairment, visual deficits, depression, and poly-pharmacy (Soriano, DeCherrie & Thomas, 2007). Previous studies have examined the association between falls and a variety of risk factors. These risk factors included old age (Lin et al., 2011), female gender (Bekibele & Gureje, 2010), history of falls

(Chu, Chi & Chiu, 2005), vision problems, depression (Kvelde et al., 2013), and reduced strength and balance (Bergland, 2012). Consistently, from literature review, risk factors for falls are commonly grouped into three main categories: 1) Intrinsic factors, including: poor muscle strength and flexibility, poor balance, reduced physical function and gait speed, reduced cognition and sensory impairment, medical conditions, and related medication. 2) Behavioral factors, including: inadequate diet, use of inappropriate footwear, above moderate alcohol use, and changes in mobility patterns due to fear of falling and 3) environmental factors, including: uneven pavements, slippery surfaces, poor lighting, worn carpeting, and hazardous steps (Berry & Kiel, 2016).

Two previous studies of systematic review were conducted to summarize factors associated with falls in community-dwelling older adults. First, the National Institute of Clinical Excellence (2004) systematically reviewed 28 published studies examining the association between risk factors and falls in community-dwelling older people. The results showed predicting factors for falling including history of falling, gait deficit, balance deficit, mobility impairment, fear of falling, visual impairment, cognitive impairment, urinary incontinence, and home hazards. Second, Deandrea et al (2010) conducted systematic review and meta-analysis of risk factors for falls in community-dwelling older people from 74 studies. The findings revealed risk factors that can be categorized into socio-demographic, mobility, sensory, psychological, medical factors, and medication use. It was also found that the strongest associations were found for history of falls, gait problems, walking aids use, vertigo, Parkinson disease, and antiepileptic drug use. However, several relevant studies have been published later and have not been systematically reviewed yet. Moreover, some contemporaneous studies have not been included in the both aforementioned systematic reviews. The objective of this study is therefore to provide an updated comprehensive systematic review of descriptive studies on risk factors for falls in community-dwelling older adults.

Methods

Search strategy and selection criteria

The search strategy was developed and performed by the authors primarily using a computer-based search. The strategy combined text word terms and appropriate subject headings related to the concepts of fall, risk factors for falls,

and older adults. The key words were further specified under these concepts. The following specified key words including fall, falling, slip, trip, risk factors, associated factors, related factors, predicting factors, older adults, older people, elderly, aging population, and community were used in combination with operators (and, or) through available electronic databases including MEDLINE, EMBASE, PsycINFO, and CINAHL. The reference lists of each included study were reviewed to identify additional relevant studies. However, the authors only considered articles published in English from 2000-2016. Two authors independently reviewed titles, abstracts, and keywords of retrieved records to exclude ineligible studies that did not meet inclusion criteria. Those that appeared to meet inclusion criteria or that could not definitely be excluded based on this initial screen were retrieved in full text. Disagreements that emerged from the initial screen were resolved by discussion and consensus with the rest of authors. The authors selected original primary studies with the following inclusion criteria: 1) the sample of the selected studies aged 60 years or older, 2) the selected studies are correlational descriptive studies in which risk factors were independent variables and the incidence of falls was a dependent variable, 3) the sample of the selected studies lived in the community, and 4) the sample size of the selected studies was greater than 50 subjects.

Data extraction and methodological quality appraisal

For the initial screen, the research screening form which was developed by the authors based on inclusion criteria was used to include eligible studies. For each study included, the full text was retrieved and the required data were extracted using a structural data extraction form. With the process of extracting data, one author abstracted data from included studies. A second and third author reviewed and confirmed the accuracy of extracted data. To assess compliance of studies with the eligibility criteria, data extracted at this stage included details of the overall study characteristics. Data extraction forms included: primary author; publication year; country; study design characteristics; sample characteristics; risk factors for falls as an independent variable; and incidence of falls as a dependent variable. Disagreements that arose about exactly how to extract and record data among the authors were addressed by an unanimity of all authors before a final decision was made on

inclusion based on the consensus reached.

For the study quality assessment, the Newcastle-Ottawa Quality Assessment Scale (N-OS) (Wells et al., 2008) was utilized by two authors in evaluating study quality and avoiding risk of bias. However, the N-OS used for cohort studies was adapted for assessment of the cross-sectional studies by omitting three items deemed not relevant for this design. The result of quality assessment revealed that all included studies had a higher N-OS score indicating less risk of bias.

Data synthesis and analysis

In this study, analysis of extracted data using meta-analysis was excluded due to the entire heterogeneity of all included studies in which study characteristics were not exactly the same across studies. Therefore, narrative synthesis of results was undertaken instead. Narrative synthesis involved the collation, combination, and summary of the findings of individual studies included in the systematic review (Centre of Reviews and Dissemination, 2009). Before starting with narrative synthesis, the authors developed a preliminary synthesis of the findings of included studies as suggested by Cochrane Consumers and Communication Review Group (2013) to identify how best to describe the results so that both the direction of independent and dependent variables would be identifiable and comparable across included studies.

All authors conducted the narrative synthesis which primarily had four steps as suggested by Hubbard et al (2016). First, extracted data of included studies were distributed to all authors. All collected data were visually presented in tabular format. Second, a narrative descriptive summary of all included studies was performed using a data extraction form. Third, the authors collectively identified and discussed patterns between risk factors (independent variable) and falls incidence (dependent variable). The extent to which risk factors might explain variation in the size/direction of falls incidence was discussed. Finally, fourth, an overall assessment of the strengths and limitations of the evidence-base about risk factors for falls in community-dwelling older adults were discussed and summarized by all authors.

Results

The results will first be synthesized descriptively, reporting study characteristics. Searches initially yielded 1253 potentially relevant citations, which was reduced to 947 articles after

removing duplicates. The 217 articles were subsequently identified after reviewing titles and abstracts. Among these articles, 86 full text articles were retrieved and 4 additional articles were identified through reference lists of included studies. Of 90 articles, 10 articles met inclusion criteria, which were systematically and critically reviewed. The process by which search strategies and inclusion of studies were done was presented in Figure 1 which depicts the flow of studies through the review process and reasons for exclusion.

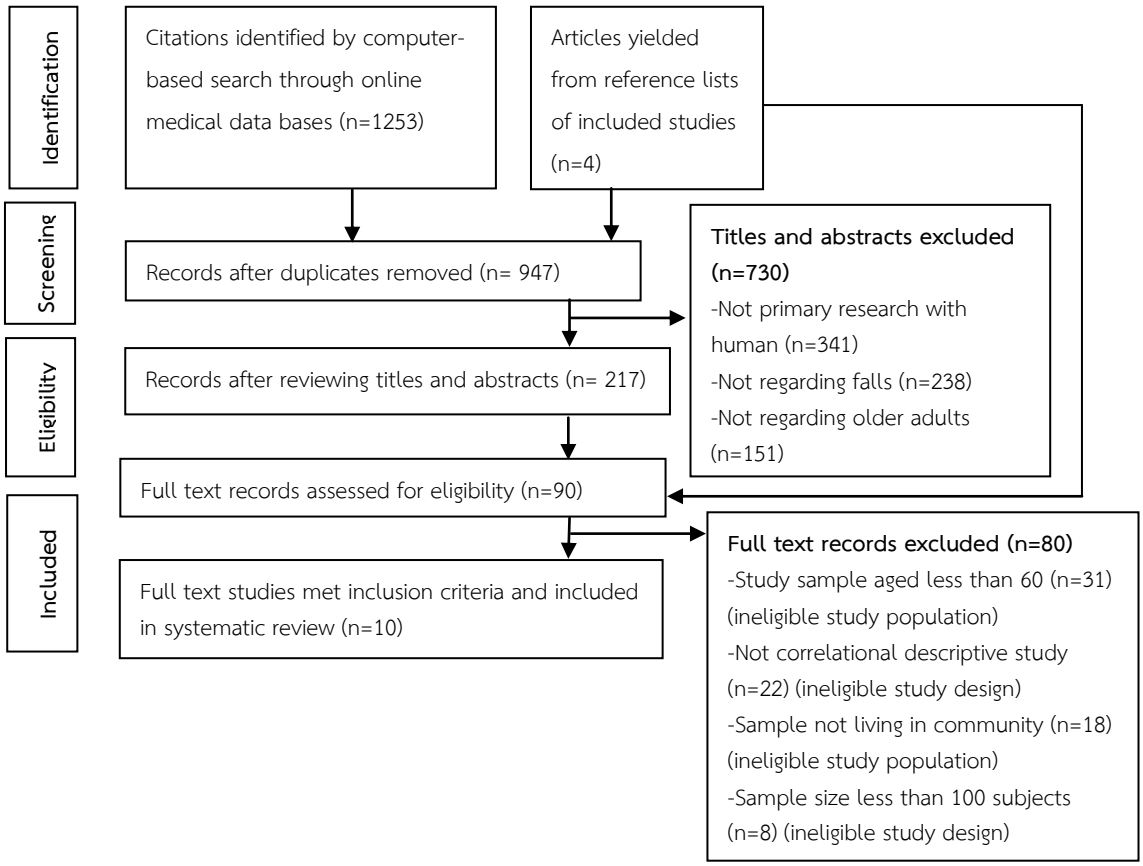

Figure 1. Flow diagram of identification, review, and selection of articles included in the systematic review

For demographic characteristics of included studies, it was found that most studies were conducted in USA, whereas other individual study was conducted in different countries where countries of Asia were most found. All studies were published between 2005 - 2016 and were community-based investigation.

Two studies were published in BMC Geriatrics. The overall demographic characteristics of included studies were shown in Table 1.

Table 1. Demographic characteristics of all included studies (n=10)

Primary author	Year	Location	Setting	Journal
Talbot	2005	USA	community	BMC Public Health
Hilliard	2008	USA	community	Archives of Physical Medicine and Rehabilitation
Muir	2010	Canada	community	Physical Therapy
Buracchio	2011	USA	community	BMC Geriatrics
Lin	2011	Taiwan	community	Plos One
Kuhirunyaratn	2013	Thailand	community	Southeast Asian Journal Tropical Medicine Public Health
Hayashi	2014	Japan	community	Biomed Research International
Mei O	2015	Netherland	community	SAGE Open
Patil	2015	India	community	International Journal of Health and Allied Sciences
Kalula	2016	South Africa	community	BMC Geriatrics

For methodological characteristics of included studies, it was shown that the study design of included studies was predominantly descriptive cross-sectional study. The sample size of those included in the study was relatively large with the number of subjects more than 200. For study participants' characteristics, the majority of participants were women with average age more than 70 years old. Regarding the number of risk factors acting as independent variable of each primary study, the high proportion of studies had more than 10 risk factors to be investigated as shown in Table 2.

Table 2. Methodological characteristics of all included studies (n=10)

Author	Study design	Sample size	Participants	Number of risk factors
Talbot	Descriptive	589	Men 60.95%, mean age 78.2±7.1	14
Hilliard	Cross-sectional	51	Women 74.50%, mean age 73.3±6.3	7
Muir	Prospective cohort	210	Men 70.00%, mean age 79.9±4.7	5
Buracchio	Longitudinal cohort	188	Women 74.10%, mean age 83.2±6.6	6
Lin	Cross-sectional	1,377	Men 51.10%, mean age 74.9±6.8	6
Kuhirunyaratn	Case-control	333	Women 63.06%, median age 69 IQR 11	22
Hayashi	Cross-sectional	90,610	Women 53.70%, mean age 73.9±6.1	12
Mei O	Cross-sectional	4,426	Women 58.00%, mean age 76.9±7.1	16
Patil	Cross-sectional	416	Women 64.40%, age range 60-85	31
Kalula	Cross-sectional	837	Women 76.46%, mean age 74.0±6.2	15

Considering risk factors and their association with falls, the numbers of risk factors were investigated. These risk factors were regarded as a wide range of different factors including socio-demographic, medical, physical, clinical, psychological, behavioral and environmental factors, and medication use. The most investigated risk factors demonstrated their significant association with falls in community-dwelling older adults as presented in Table 3.

Table 3. Summary of data extraction

Author/Year	Studied risk factors	Results of association between risk factors and falls
Talbot/2005	1) ambulating, 2) transferring, 3) running, 4) sports, 5) stairs, 6) accident, 7) collapse, 8) dizziness, 9) balance, 10) wet surface, 11) uneven surface, 12) objects on surface, 13) external forces, 14) icy surface.	All risk factors were significantly associated with falls. Ambulation was most frequently reported as cause of falls.
Hilliard/2008	1) multiple balance recovery steps, 2) sidestep/ crossover step recovery patterns, 3) first step length following motor-driven waist-pull perturbations of ML standing balance, 4) Hip abduction strength, 5) axial mobility, 6) peak isokinetic hip abduction joint torque, 7) trunk functional axial rotation (FAR) range of motion.	Peak isokinetic hip abduction joint torque and trunk functional axial rotation (FAR) range of motion were shown to optimally predict falls.
Muir/2010	1) self-report of balance problem, 2) one-leg stance, 3) tandem stance, 4) limits of stability, 5) unsteady gait.	Self-report of balance problem, one-leg stance, and limits of stability were found to be significantly associated with falls.
Buracchio/ 2011	1) executive function, 2) age, 3) female, 4) health status, 5) prior fall history, 6) Tinetti balance.	Lower executive function was significantly associated with falls
Lin/2011	1) age, 2) gender, 3) waist circumference, 4) acuity, 5) functional status, 6) serum albumin	Older age, female gender, larger waist circumference, poorer visual acuity, lower functional status, and lower serum albumin level were shown to be the significant independent associated factors for falls

Table 3. Summary of data extraction (continued)

Author/Year	Studied risk factors	Results of association between risk factors and falls
Kuhirunyaratn/ 2013	1) hospital admission within the previous year, 2) regular medication use, 3) co-morbidities, 4) depression, 5) hearing problems, 6) vision problems, 7) BMI, 8) mobility, 9) cluttered room, 10) slippery floor, 11) toilet without handrail, 12) insufficient lighting, 13) alcohol use, 14, smoking, 15) energy drink, 16) coffee or tea use, 17) sufficient exercise, 18) walk up and down stairs daily, 19) rapid change in posture, 20) regularly carry heavy objects, 21) wears inappropriate clothing, 22) wears slippers.	regular medication use, depression, sufficient exercise, wears slippers was found to be significantly associated with falls.
Hayashi/2014	1) frequency of participation in sport organization, 2) age, 3) sex, 4) education attainment, 5) equivalent income, 6) present illness related to falls, 7) physical ability, 8) depression, 9) walking, 10) frequency of outings, 11) neighborhood-built environment, 12) population density.	Older age, male gender, low education status, having current medical history, low physical ability, depression, less than 30-minute walking time, having locations difficult for walking close to home, and living in the local government were significantly associated with falls.
Mei O/2015	1) age, educational level, 3) living status, 4) use of sedatives or tranquilizers, 5) alcohol, 6) smoking, 7) physical activity, 8) visual impairment, 9) hearing disability, 10) ADL limitations, 11) BMI, 12) loneliness, 13) emotional loneliness, 14) social loneliness, 15) depression, 16) fear of falling.	Age more than 75 years, educational level, living with someone, use of sedatives or tranquilizers, having visual impairment, ADL limitations, loneliness, and fear of falling were shown to be significantly associated with falls.

Table 3. Summary of data extraction (continued)

Author/Year	Studied risk factors	Results of association between risk factors and falls
Patil/2015	1) on medication, 2) sedative hypnotics, 3) antihypertensive, 4) cardiac medications, 5) NSAIDS, 6) hypoglycemic, 7) tricyclic antidepressants, 8) intake of alcohol, 9) habit of smoking, 10) exercise/physical activity, 11) difficulty with steps/stairs, 12 use of walking stick/aid, 13) use of slippers outside home, 14) difficulty in getting on/off toilet, 15) use of tobacco, 16) joint pains, 17) foot problems, 18) acute illness of less than 3 weeks, 19) backache on walking, 20) dizziness, 21) visual problem, 22) weakness, 23) DM, 24) balance, 25) gait, 26) tremor, 27) cataract, 28) get up and go, 29) visual acuity, 30) ADL, 31) mini mental state examination	NSAIDS, tricyclic antidepressants, backache on walking, difficulty in getting on/off toilet, habit of smoking, visual problem, use of loose slippers outside home, and cataract were found to be significantly associated with falls.
Kalula/2016	1) residents per household, 2) number of drugs, 3) number of medical conditions, 4) cognitive score, 5) self-rated health, 6) perceived worse health than a year ago, 7) Parkinson' s disease, 8) poor urine control, 9) occupation, 10) foot disorder, 11) history of previous fall, 12) dizziness/vertigo, 13) ethnic group, 14) marital status, 15) timed up and go test.	History of previous fall, dizziness/vertigo, and ethnicity, poor cognitive score were significant predictors of falls.

Discussion

The aim of this systematic review is to summarize the available empirical data regarding risk factors for falls among community-dwelling older adults. Ten studies pertaining to factors associated with falls were retrieved through search strategies and included in a review

process from screening to extracting data. Due to variation in analysis and reporting methods, or the limited number of studies evaluating each risk factor, the quantitative summary using meta analysis was virtually precluded. However, a narrative review and synthesis of the results was undertaken instead. The findings of this systematic review were consistent with that of the previous systematic review which identified 31 fall risk factors of older people. These risk factors were categorized into; socio-demographic, mobility, sensory, psychological, medical factors, and medication use (Deandrea et al., 2010). In this systematic review, it is found that fall occurrences in older adults living in the community were associated with multiple risk factors that can be both modifiable and non-modifiable factors. However, in clinical practice, it is essential to explain the cause of falls by considering both the predisposing and situational risk factors. Predisposing risk factors are the intrinsic characteristics of the person that chronically impair stability and may make them more easily fall. The situational risk factors are those host, activity, and environmental factors that are present at the time of the fall (Soriano et al., 2007).

In one-third of falls, the environment is considered the major risk factor; about 17% of falls cite gait and balance as the primary risk and dizziness in 13% of falls (Rubenstein et al 2001). The literature supports that the majority of falls in those living in the community are probably due to environmental factors. Greater than 70% of falls in the community occur in the home. Approximately 10% of falls occur on stairs which represents a high percentage since it is out of proportion of time spent on them (Soriano et al., 2007). Moreover, falling in older adults usually occurs as a result of compounding factors that combine and overwhelm an older person's ability to maintain or regain his or her balance (Public Health Agency of Canada, 2014). The findings from this systematic review were also corroborated by existing knowledge indicating that risk factors associated with falls include intrinsic factors (e.g., age-related physiological changes, impairments to the sensory-nervous system, disorders of the musculoskeletal system, and specific acute and chronic diseases) as well as extrinsic factors (e.g., environmental hazards and obstacles interfering with safe mobility, and medication side effects) (Steinberg et al., 2000; Tideiksaar, 2001). However, the size of the impact environmental factors has

on the risk of falling among older people is uncertain (WHO, 2007). Also, one systematic review of risk factor assessments used in falls intervention trials found that three risk factors provided independent prognostic value in most studies: history of falls, use of certain medications (for example, psychoactive medications), and gait and balance impairment (USPSTF, 2012).

It is important to consider that age, one powerful demographic factor, is recognized as a significantly associated factor of falls in several studies from this systematic review. Most older adults are more likely to fall due to their advanced age than other age groups (Gunn et al., 2013). Age-related falls are taken into account as well as other risk factors. For this, normal gait and postural stability depend on the proper functioning of sensory, neuromuscular, and musculoskeletal systems. Limb proprioceptive and tactile input, visual input, and vestibular input are critical for maintaining the body's center of gravity within its base of support, and these sensory pathways may be compromised by age (Bird et al., 2013) In addition, age-related disturbances in the organization and central neurological integration of sensory and motor functions may impair the speed, effectiveness, and reliability of postural reflexes, leading to falls (Rubenstein, 2006). Furthermore, age-related slowing of postural reflexes may increase the muscular force required for an effective response to postural disturbances, but the strength of skeletal muscles involved in postural control and walking declines with increasing age (Baranzini et al., 2009).

In conclusion, this systematic review using narrative synthesis confirms the clear associations of a range of risk factors with falls in community-dwelling older adults. Most multi-factorial fall risks are preventable and modifiable factors that can be controlled and manipulated through rigorous interventions. Hence, the results of this systematic review guide the future studies that are indicated to reduce the falling rate in older adults.

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