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Review Article

Frailty as a Predictor of Future Falls Among Community-Dwelling Older People: A Systematic Review and Meta-Analysis

Gotaro Kojima MD *

Japan Green Medical Centre, London, United Kingdom

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A B S T R A C T

Background: Although multiple longitudinal studies have investigated frailty as a predictor of future falls, the results were mixed. Thus far, no systematic review or meta-analysis on this topic has been conducted.
Objective: To review the evidence of frailty as a predictor of future falls among community-dwelling older people.
Methods: Systematic review of literature and meta-analysis were performed using 6 electronic databases (Embase, Scopus, MEDLINE, CINAHL Plus, PsycINFO, and the Cochrane Library) searching for studies that prospectively examined risk of future fall risk according to frailty among community-dwelling older people published from 2010 to April 2015 with no language restrictions.
Results: Of 2245 studies identified through the systematic review, 11 studies incorporating 68,723 individuals were included in the meta-analysis. Among 7 studies reporting odds ratios (ORs), frailty and prefrailty were significantly associated with higher risk of future falls (pooled OR = 1.84, 95% confidence interval [95% CI] = 1.43–2.38, $P < .001$; pooled OR = 1.25, 95% CI = 1.01–1.53, $P = .005$, respectively). Among 4 studies reporting hazard ratios (HRs), whereas frailty was significantly associated with higher risk of future falls (pooled HR = 1.24, 95% CI = 1.10–1.41, $P < .001$), future fall risk according to prefrailty did not reach statistical significance (pooled HR = 1.14, 95% CI = 0.95–1·36, $P = .15$). High heterogeneity was noted among 7 studies reporting ORs and seemed attributed to difference in gender proportion of cohorts according to subgroup and meta-regression analyses.
Conclusions: Frailty is demonstrated to be a significant predictor of future falls among community-dwelling older people despite various criteria used to define frailty. The future fall risk according to frailty seemed to be higher in men than in women.

Older people are a highly heterogeneous population. Although people generally develop diseases and disabilities as they age, the trajectory and rate of change in health and functional status vary widely in each individual and persons with the same chronological age can have very different biological ages.[1] Therefore, it is challenging to measure the heterogeneity of the aging process in the elderly.

One of the potential concepts to quantify the overall health diversity of older people is frailty. Frailty is a biological syndrome characterized by reduced reserve capacity in multiple physiologic systems and increased vulnerability to stressors due to age-related cumulative deficits.[2] In general, people are more likely to develop frailty as they get older.[2,3] Prevalence of frailty among community-dwelling people aged 65 years and older is widely variable depending on settings, ranging from 4.0% to 59.1%.[3] Frailty has been shown to be associated with multiple adverse health outcomes, including disability, falls, hospitalization, institutionalization, and death.[2] Among these, fall is a leading cause of mortality in older people.[4] Fall is not only associated with a wide range of negative consequences, such as disabilities, fear of falling, and impaired quality of life,[4,5] but also associated with increased health care burden and costs.[6] Incidence of fall is high among older people; one-third of elderly aged 65 and older fall every year, and the incidence of falling increases up to 50% among those 80 years and older.[7] Given the expanding elderly population worldwide, preventing falls has been a major public concern of authorities in many countries.[4,8,9] One of the important key issues for preventing falls is identification of risk factors for falling.

Weakness, impaired balance, and abnormal gait are major components of physical frailty[2,10] and are likely to increase the risk of

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* Address correspondence to Gotaro Kojima, MD, Japan Green Medical Centre, 10 Throgmorton Avenue, London EC2N 2DL, UK.
E-mail address: gotarokojima@yahoo.co.jp.

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falling in older people. Furthermore, frail older people may be at high risk of falling because of decreased functional reserve capacity in maintaining position, balance, and coordination, and increased vulnerability to such stressors as accidents, disease symptoms, or adverse drug reactions. The evidence of frailty as a predictor of falls in community-dwelling older people comes from prospective cohort studies with mixed results. Most of the studies demonstrated that the frail elderly were more likely to fall than the nonfrail,[10–17] but a few showed nonsignificant results.[18–20] Thus far, no systematic review or meta-analysis studies on this topic have been conducted in the literature. Therefore, the objectives of this systematic review were (1) to identify and compare prospective cohort studies examining frailty as a predictor of future falls among community-dwelling older people, and (2) to combine those data to synthesize pooled risk estimates of frailty for future falls.

Methods

This study was conducted according to a protocol developed with adherence to Meta-analysis of Observational Studies in Epidemiology (MOOSE)[21] statements by a clinician researcher who was trained for internal medicine and geriatric medicine and is currently working as a general practitioner.

Data Sources and Search Strategy

A systematic search of the literature was performed in April 2015 using Embase, Scopus, MEDLINE, CINAHL Plus, PsycINFO, and the Cochrane Library for studies written in any languages and published from 2000 through present. The search terms used included (Accidental falls (Medical Subject Heading (MeSH))) OR (Falling (MeSH)) OR (Falls (MeSH)) OR (Fall*) AND (Frailty) using an explosion function if available. PubMed and reference lists of relevant studies were also hand searched.

Study Selection

Prospective cohort studies examining frailty as a risk factor for future falls were selected using the following inclusion criteria:

1. Prospective study design.
2. Community-dwelling individuals.
3. Sample size at least 100 individuals.
4. Individuals aged 60 years or older or mean age of 70 years or older.
5. Frailty was defined by criteria originally designed to measure frailty and validated in population-based studies or its modified versions.
6. Adjusted or unadjusted odds ratio (OR), risk ratio (RR), or hazard ratio (HR) as a risk measure reported or able to be calculated from available data.

Studies were excluded if they substituted other measures, such as disability or walking speed, to define frailty or used selected samples with certain conditions or diseases. If multiple studies used the same data or cohort, a study with the largest number of individuals was selected.

Data Extraction

A standardized data collection tool was used to collect data from the eligible studies. The data extracted included the following: first author, year of publication, location, sample size, proportion of male individuals, age, frailty criteria, outcome, follow-up period, frequency of fall monitoring, and effect measure. When single fallers and recurrent fallers were used as separate outcomes and data of any fallers (single fallers + recurrent fallers) were not available, calculation of an OR of any fallers compared with nonfallers was attempted, or the data of only recurrent fallers were used. Some frailty criteria define “prefrail” or similar terminology, which is an intermediate frailty status between frail and nonfrail/robust, and these data were also collected and used for meta-analyses if available. When 2 or more frailty criteria were used in a study, the most commonly used Fried phenotype criteria or its modified versions were selected if available or criteria less modified from the original were selected.

Methodological Quality Assessment

Eligible studies were further examined for methodological quality using the Newcastle-Ottawa scale for cohort studies. This scale has 9 criteria to examine the methodological quality of cohort studies. Each of the included studies was assessed using this scale and considered to have adequate quality to be included for meta-analysis if it met 5 or more items out of 9.

Statistical Analysis

OR, RR, and HR along with 95% confidence interval (95% CI) of future fall risk for frailty or prefrailty compared with nonfrailty/robust were extracted directly from the articles or calculated based on raw numbers shown in the articles. All analyses were performed using StataIC 13 (Stata Corp, College Station, TX), Review Manager 5 (Computer program, Version 5.2; The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark), and Comprehensive Meta-Analysis version 3.3 (Biostat, Englewood, NJ).

OR, RR, and HR were log-transformed. SEs of the log-transformed OR, RR, and HR were calculated by dividing the difference between log-transformed upper and lower limits of 95% CI by 3.92. These data of each study were entered into the Review Manager and Comprehensive Meta-Analysis to perform meta-analysis and meta-regression analysis. The χ^2 test was used to assess heterogeneity across the studies, and heterogeneity was considered present when P value was less than 0.10. I^2 statistic was used to quantify the degree of heterogeneity and I^2 values of 25%, 50%, and 75% were considered as low, moderate, and high heterogeneity, respectively.[22] When high heterogeneity was observed, subgroup analyses and random-effects meta-regression were performed to identify possible causes of heterogeneity. Publication bias was assessed by visually inspecting the funnel plots.

Results

Selection Processes

Figure 1 shows a flow chart of the literature search and study selection with numbers of studies at each stage. Of 2245 citations identified by the systematic review of the literature using 6 electronic databases, 1306 duplicated articles were excluded and 920 articles were excluded through review of titles and abstracts. One additional article[18] was found by manual search and added, leaving 20 articles for full-text review. Of these, 9 articles were excluded because they were review articles (n = 2), did not classify frailty and nonfrailty status (n = 2),[23,24] included non–community-dwelling populations (n = 2), and used the same cohort (n = 1). Neither abstracts nor full texts were able to be obtained for 2 studies. Eleven articles were left and confirmed that they met the inclusion criteria.[10–20] Eleven articles provided data for 68,723 community-dwelling older people and these were included in this systematic review. These studies were then assessed for methodological quality using the Newcastle-Ottawa