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Review Article

Fear of Falling and Gait Variability in Older Adults: A Systematic Review and Meta-Analysis

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A B S T R A C T

Background: Fear of falling (FOF) and increased gait variability are both independent markers of gait instability. There is a complex interplay between both entities. The purposes of this study were (1) to perform a qualitative analysis of all published studies on FOF-related changes in gait variability through a systematic review, and (2) to quantitatively synthesize FOF-related changes in gait variability.
Methods: A systematic Medline literature search was conducted in May 2014 using the Medical Subject Heading (MeSH) terms "Fear" OR "fear of falling" combined with "Accidental Falls" AND "Gait" OR "Gait Apraxia" OR "Gait Ataxia" OR "Gait disorders, Neurologic" OR "Gait assessment" OR "Functional gait assessment" AND "Self efficacy" OR "Self confidence" AND "Aged" OR "Aged, 80 and over." Systematic review and fixed-effects meta-analysis using an inverse-variance method were performed.
Results: Of the 2184 selected studies, 10 observational studies (including 5 cross-sectional studies, 4 prospective cohort studies, and 1 case-control study) met the selection criteria. All were of good quality. The number of participants ranged from 52 to 1307 older community-dwellers (26.2%–85.0% women). The meta-analysis was performed on 10 studies with a total of 999 cases and 4502 controls. In one study, the higher limits of the effect size's confidence interval (CI) were lower than zero. In the remaining studies, the higher limits of the CI were positive. The summary random effect size of 0.29 (95% CI 0.13–0.45) was significant albeit of small magnitude, and indicated that gait variability was overall 0.29 SD higher in FOF cases compared with controls.
Conclusions: Our findings show that FOF is associated with a statistically significant, albeit of small magnitude, increase in gait variability.

Gait disorders are highly frequent in adults aged 65 years and older with a prevalence estimated at approximately 35%.[1,2] They may be separated into neurological and non-neurological disorders.[1–3] Until recently, it was considered that neurological gait disorders result from focal to diffuse lesions occurring in the neural pathways linking the cortical motor centers to the peripheral neuromuscular systems.[1–5] Nowadays, there is growing evidence that a part of neurological gait disorders is caused by impairment in the highest levels of gait control (ie, subcortical and cortical levels) without any brain lesion identifiable.[3–6] For instance, it has been reported that individuals with neuropsychiatric disorders, such as anxio-depressive symptoms, have slower gait and are less steady when walking compared with healthy individuals.[7,8]

Fear of falling (FOF) is defined as the lack of self-confidence that activities of daily living may be performed without falling is a cause of cautious gait.[9,10] FOF is common in older adults with a high prevalence estimated to be more than 20%[6,9,10] and has been described as a cause of gait disorders due to impairment in cortical level of gait control.[6] Most previous studies focused on unspecific FOF-related

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changes in gait performance and reported mild-to-moderate slowing, reduced mean stride length, and widening of the base of support, whereas variability of gait parameters has been reported as a better phenotype of cortical gait control than mean values of spatio-temporal gait parameters.[6–15]

Movement variability is a marker of motor coordination and reflects the control of the sensorimotor system.[11,12] Variability represents a central issue for the study of motor control.[13,14] It has been shown that gait variability, defined as the stride-to-stride fluctuations in walking, is a relevant marker of gait stability and cortical gait control.[13–21] The general assumption is that there is an inverse association between gait variability and gait stability. Low gait variability reflects an efficient gait control and safe gait patterns.[3,18–21] FOF-related increase in gait variability has been questioned.[21,22] Studies reported mixed results, as some showed a significant association whereas others did not,[22–24] underscoring a complex interplay between FOF and gait variability. Thus, the first question to better understand the relationship between these entities is to determine whether or not FOF may influence gait variability among older adults. No structured critical evaluation of previously published studies has been performed. A systematic review could be helpful to provide an answer to this question. The purposes of this study were (1) to perform a qualitative analysis of all published studies on FOF-related changes in gait variability through a systematic review, and (2) to quantitatively synthesize FOF-related changes in gait variability.

Methods

Literature Search

A systematic Medline literature search was conducted in May 2014 without restriction of date and language, using the Medical Subject Heading (MeSH) terms “Fear” OR “fear of falling” combined with “Accidental Falls” AND “Gait” OR “Gait Apraxia” OR “Gait Ataxia” OR “Gait disorders, Neurologic” OR “Gait assessment” OR “Functional gait assessment” AND “Self efficacy” OR “Self confidence” AND “Aged” OR “Aged, 80 and over.” An iterative process was used to ensure all relevant articles had been obtained. A further hand search of bibliographic references of extracted papers and existing reviews was also conducted to identify potential studies not captured in the electronic database searches.

Study Selection and Analysis

Titles and abstracts of identified references were screened by a member of the team (FA) and obtained articles deemed potentially relevant. Initial screening criteria for the abstracts were as follows: (1) article written in English or French; (2) involvement of human participants aged 65 and older; (3) absence of neurological, rheumatologic, and ocular diseases; (4) observation and intervention studies (cohort, case-control, and cross-sectional studies were included); (5) FOF and gait as outcomes; and (6) quantitative measures of spatio-temporal gait parameters using biomechanical methods for assessment (eg, electronic walkways, footswitches systems). Studies that used only a questionnaire or the Time Up and Go test or another clinical test for gait assessment were excluded. If a study met the initial selection criteria or its eligibility could not be determined from the title and abstract, the full text was retrieved. A second study screening was performed. The full text was assessed for inclusion status. In case of disagreements, the articles were discussed with 2 of the authors (OB and CA). Final selection criteria were applied when gait variability was an outcome, or alternatively when the association between FOF and gait variability was examined. The study selection is shown on a flow diagram (Figure 1).

Of the 2184 originally identified abstracts, 199 (9.1%) met the initial inclusion criteria (see Appendix 1). Following thorough examination, we excluded 189 (94.9%) of those 199 studies because gait variability or the association between FOF and gait variability was not an outcome. The remaining 10 studies were included in this review.[6,10,21–28] The quality of each study was assessed using the Newcastle–Ottawa Scale,[29] a validated technique for assessing the quality of case-control and nonrandomized cohort studies. The instrument uses a star system to evaluate observational studies based on 3 criteria: participant selection, comparability of study groups, and assessment of outcome or exposure (see Appendix 2). Articles selected for the full review had the following information extracted: authors, date of publication, study design, settings and study population, assessment methods of FOF and gait, gait variability (ie, SD or coefficient of variation [CoV] of gait parameters), and result of the association between FOF and gait variability (Supplementary Table 1).

Definition of Outcomes

We examined gait variability as measured by the SD or CoV of stride time or stride length, as these measures are generally accepted as reliable indicators of the control of the walking-related rhythmic stepping mechanism.[11,18–20] When a study reported these parameters, only stride time variability was used for meta-analysis, because this gait parameter was reported to be the best biomarker of cortical gait control.[12–16] Low variability values of both of these spatio-temporal gait parameters reflect the reliability of limb movements and the automated regular rhythmic feature of gait and are associated with safe gait.[11,12] The study population of cases was estimated as the number of participants with FOF, regardless of the severity, duration, or management of the FOF. Controls presented no FOF. For this purpose, in the study of Herman et al,[6] we considered the group of patients with high-level gait disorders as the group of participants with FOF and the group of controls as those without FOF. Indeed, selected participants in this study were free of morbidities able to influence gait variability. They had self-reported walking difficulties that could not be attributed to any specific disease or medical condition.

Meta-analysis

All results were expressed in terms of a bias-corrected “effect size” of the difference between gait variability in cases and controls. Because mean value and SD of stride time was not provided in 3 articles, a request was successfully formulated to the first authors.[6,26,28]

An effect size calculator worksheet was used to derive bias-corrected effect sizes from mean, SD, and size of each group (Coe’s Calculator retrieved November 16, 2013, from http://www.cemcentre.org/evidence-based-education/effect-size-calculator). Qualitative descriptors of the effect sizes obtained were less than 0.3, small; 0.4 to 0.8, moderate; and greater than 0.8, large.[30] Individual study data were then pooled using an inverse-variance method. Heterogeneity between studies was assessed using Cochran’s chi-squared test for homogeneity (Chi2), and amount of variation due to heterogeneity was estimated by calculating the I2.[31] As heterogeneity was invariably high, fixed but also random-effects meta-analyses were performed on the estimates to generate summary values (Review Manager version 5.1; The Nordic Cochrane Centre, Copenhagen, Denmark). Results are presented as a forest plot.

Results

All studies were judged of good quality using the Newcastle-Ottawa Scale (see Appendix 2). Supplementary Table 1 summarizes the 10 studies included in this review and meta-analysis.[6,10,21–28] Data