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Does Fear of Falling Influence Spatial and Temporal Gait Parameters in Elderly Persons Beyond Changes Associated With Normal Aging?

Melissa E. Chamberlin, Brandy D. Fulwider, Sheryl L. Sanders, and John M. Medeiros

School of Physical Therapy, Pacific University, Forest Grove, Oregon.

Background. Limited research exists on fear of falling and its affect on gait parameters. Studies have shown a relationship between fear of falling and restriction of activities. The purpose of this study was to determine if a fear of falling in elderly persons was associated with changes in spatial and temporal gait parameters, independent of a history of falls. It was hypothesized that, in elderly persons, gait changes would be associated with a preexisting fear of falling.

Methods. Ninety-five community-dwelling adults, aged 60–97 years (mean age = 74, standard deviation = 8.5) participated in this study. Participant scores on the Modified Falls Efficacy Scale determined an individual's placement into the ''fearful'' or ''fearless'' category. Spatial and temporal gait parameters of speed, stride length, step width, and double limb support time were assessed using the GAITRite system, a computerized electronic walkway.

Results. The fearful group had a significantly slower gait speed ($p < .05$) and shorter stride length ($p < .05$) when compared to the fearless group. Stride width was significantly longer ($p = .05$) and double limb support time was significantly prolonged ($p < .05$) in the fearful participants when measured against the fearless participants.

Conclusions. The results of this study support the hypothesis that fear of falling does influence spatial and temporal gait parameter changes in elderly persons. Slower gait speed, shorter stride length, increased stride width, and prolonged double limb support time were found to be associated with a preexisting fear of falling.

IN the elderly population, fear of falling is a monumental obstacle for some and can limit activities and mobility. Changes in spatial and temporal gait parameters have been reported as early as age 60 (1). Studies have reported that increasing age is associated with decreased stride length and speed and increased stride width and double support time (2–4). However, other studies contradict this, reporting that aging is not the primary factor for declines in gait parameters (5–8). Studies have shown changes in gait patterns with age-related changes; pathological changes; fear of falling; stereotypes of aging, e.g., believing that senility is inevitable; and other factors (2,6,7).

Fear has been shown to affect aspects of people's mental and social lives. Bandura's theory of self-efficacy (9), which is supported by the findings of Tinetti and colleagues (10), postulates that a person's perceived capability or level of confidence determines performance of a behavior, as well as true capability. However, can fear affect a person's gait pattern? According to Walker and Howland (11), fear of falling ranked first when compared with other common fears in elderly persons, such as robbery, financial difficulties, or forgetting an important appointment. Falls, which can cause injury, disability, and death in elderly persons, usually happen because a combination of factors occurs together (12). For example, environmental factors—such as the presence of throw rugs; poor judgment; decreased vision, hearing, proprioception, and strength; neurologic and cardiovascular deficits; and polypharmacy—may contribute to a fall (12).

Studies have shown that fear of falling is associated with decreased quality of life, depression, and increased frailty (13,14). In two studies, from 27% to 50% of elderly participants had a fear of falling, depending on whether they were categorized as ''non-fallers'' or ''fallers,'' respectively (11,15). Tinetti and Powell (15) defined fear of falling as ''a lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing'' or ''low self-confidence.'' According to Walker and Howland (11), fear of falling can compromise quality of life among elderly persons by diminishing the sense of well being, limiting mobility, and reducing social interaction. Fear of falling becomes a risk factor for falls due to decreased movement and reduced physical conditioning.

Walker and Howland (11) reported that fear of falling appeared to contribute to reduced activity independent of other risk factors. According to several studies, falling and fear of falling are highly correlated (10,11,13). Changes in spatial and temporal gait parameters have been similar for elderly persons who have experienced falls and for those who fear falling; a decreased stride width and speed and an increased double limb support time have been associated with both falling and fear of falling (7,16). However, some reports have suggested that fear of falling may not be a risk for falling because the fear can be present without a history or risk of falls (7,17). Howland and coworkers (18) found that fear of falling was a stronger predictor of non-participation in social activities than was a history of falls.

The idea that fear of falling can lead to restriction of activity emphasizes the need to study the affects that such fear has on elderly persons, independent of a history of falls. The purpose of this study was to determine if fear of falling in elderly persons is associated with spatial and temporal

Table 1. Distribution of Participants Within Fall Categories

Fearless (*N* = 72)	Average Age ± *SD*	Fearful (*N* = 23)	Average Age ± *SD*
Male (23)	71.6 ± 7.6	Male (5)	79.6 ± 80
Female (49)	74.3 ± 8.0	Female (18)	75.8 ± 10.2

Note: *SD* = standard deviation.

gait parameter changes. It was hypothesized that gait changes such as decreased speed and stride length, and increased stride width and double limb support time, would all be associated with a preexisting fear of falling.

Methods

Participants

Ninety-five community-dwelling adults, 28 males and 67 females, served as participants. They ranged in age from 60 to 97 years (mean of 74 ± 8.5 standard deviation years). They were recruited from retirement homes, churches, senior centers, and assisted living facilities in California and Oregon. Participants were able to: (a) stand unaided, (b) walk 20 meters without assistive devices, (c) follow simple instructions, and (d) complete, either written or verbally, a brief survey relating to their level of confidence with certain activities of daily living. Participants who had lower extremity joint-replacement surgeries, a leg-length difference, or stroke were excluded. Leg length was measured to ensure that participants were free of leg-length discrepancy (±1.9 cm) as defined by Subotnick (19). After obtaining Institutional Review Board approval, each participant signed an informed consent and a photograph release. Assignment of participants to the ‘‘fearful’’ and ‘‘fearless’’ groups was based on results obtained from the Modified Falls Efficacy Scale (MFES). Data were gathered from June 2001 through January 2002.

Instrumentation

Spatial and temporal gait parameters of speed, stride length, step width, and double support time were assessed using the electronic GAITRite system (Clifton, NJ). As the patient ambulates across the GAITRite mat, the system scans the footfall patterns, and computes the temporal and spatial gait parameters (20).

Procedure

Prior to gait analysis, participants were asked to complete the MFES. Participants who obtained a mean falls efficacy score of 8 or lower on the MFES were considered fearful of falling, and those who scored above 8 were considered fearless, based on a study by Hill and colleagues (21).

‘‘Start’’ and ‘‘stop’’ lines were placed 10 feet in front of and past the GAITRite mat to ensure that participants were walking at their comfortable walking speed when they reached the electronic walkway and that they did not decelerate before leaving the recording area. Participants were asked to look at a visual target placed at eye level in front of the gait mat to minimize distractions that might affect gait parameters, then, wearing their own shoes, they were requested to walk at their natural pace. Each participant walked across the GAITRite mat four times; the first was a trial run with no data collected.

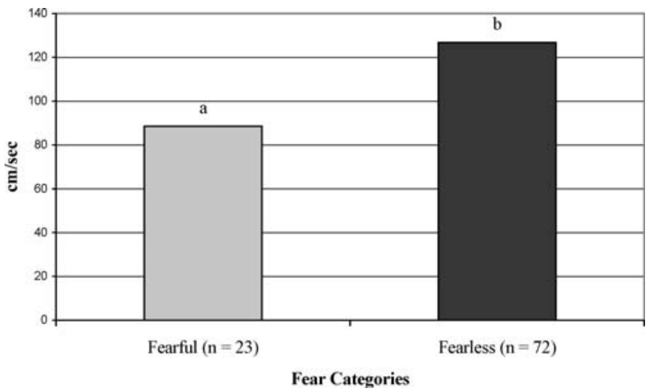

Figure 1. Mean gait speed for fearful and fearless categories measured in centimeters per second. a and b: Significant differences ($p < .05$) between categories.

Data Analysis

Statistics were calculated by the data gathered from the GAITRite software program. Four separate unpaired *t* tests with unequal variances were performed on the data. Data were analyzed with Microsoft Excel software (Redmond, WA), and statistical significance was established at $p \leq .05$.

Results

MFES

Participants were separated into two fall categories: fearful and fearless, based on the results of the MFES; 72 of the 95 scored in the fearless group and 23 scored fearful. The fearless 72 participants included 23 males (age 71.6 ± 7.6) and 49 females (age 74.3 ± 8.0). The 23 fearful participants included 5 males (age 79.6 ± 8.0) and 18 females (75.8 ± 10.2) (Table 1).

Gait Speed

The group mean scores with standard deviations for gait speed were 88.6 ± 33.0 and 126.7 ± 23.1 cm/s for the fearful and fearless groups, respectively (Figure 1). The group means were significantly different ($p < .05$). The fearful group had a significantly lower gait speed than did the fearless group.

Stride Length

The group mean scores with standard deviations for stride length were 100.2 ± 30.2 and 131.5 ± 20.5 cm for the fearful and fearless groups, respectively (Figure 2). The group means were significantly different ($p < .05$). The fearful group had a significantly lower stride length than did the fearless group.

Stride Width

The group mean scores with standard deviations for stride width were 11.1 ± 3.8 and 9.2 ± 2.4 cm for the fearful and

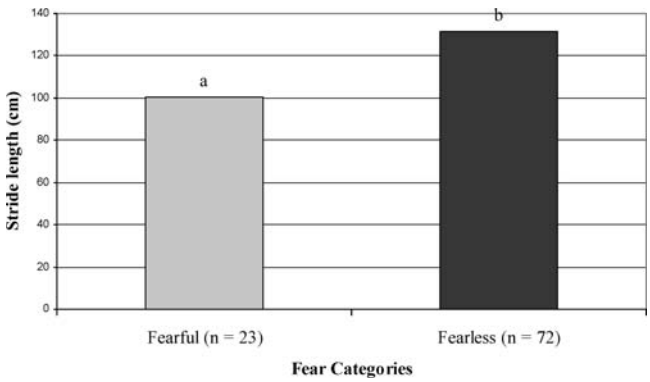

Figure 2. Mean stride length for fearful and fearless categories measured in centimeters. a and b: Significant differences ($p < .05$) between categories.

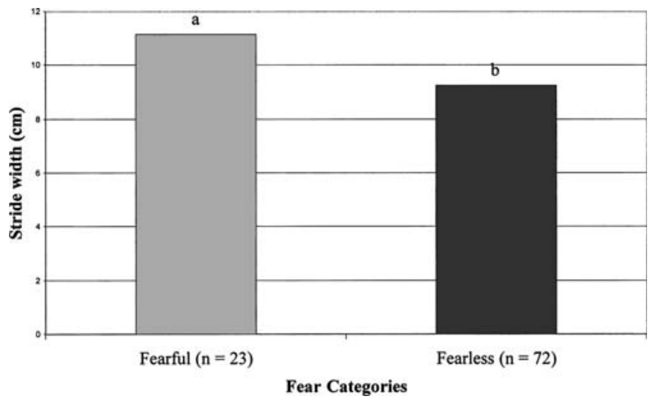

Figure 3. Mean stride width for fearful and fearless categories. a and b: Significant differences ($p = .05$) between categories.

fearless groups, respectively (Figure 3). The group means were significantly different ($p = .05$). The fearful group had a significantly higher stride width or base of support than did the fearless group.

Double Limb Support Time

The group mean scores with standard deviations for double limb support time were 31.1 ± 9.4% and 25.2 ± 4.7% for fearful and fearless groups, respectively (Figure 4). The group means were significantly different ($p < .05$). The fearful group had a significantly higher double limb support time than did the fearless group.

Discussion

Many studies have shown that gait abnormalities can predispose an individual to reduced mobility and an increased likelihood of falling (2,11,14,22,23). The results of this study support the hypothesis that fear of falling influences spatial and temporal gait parameter changes in elderly persons. Slower gait speed, shorter stride length, increased stride width, and prolonged double limb support time were found to be associated with a preexisting fear of falling. Our results were consistent with the findings of Maki (7) in which decreased gait speed, decreased stride length, and increased double limb support time were shown to be significantly associated with such fear. In contrast to the present study, however, Maki did not find a significant difference between fearful and fearless groups in relation to stride width (7). This difference might be attributed to the fact that Maki used inkpads on the bottom of the participants' slippers to mark each step, whereas we used the electronic GAITRite system. The present study supported the findings of Selby-Silverstein and Besser (24) in which both temporal and spatial gait parameters were assessed by the GAITRite system.

Our study was similar to the Maki investigation (7) that looked at fear of falling and its relation to gait changes. However, a major difference between the two studies was our use of the MFES to place participants into fearful and fearless groups. In contrast, Maki used the participants' responses to the question, ''Are you afraid of falling?'' to place them in such groupings (7). A fear of falling can either be conceptualized as a dichotomous state (yes or no) or it can be assessed using the concept of ''self-efficacy'' where participants rate their ability to complete a certain activity. Tinetti and Powell (15) noted that a person with low confidence in performing certain activities tends to avoid them. Answering ''no'' to the fear-of-falling question might have occurred because the person avoids all activities that cause fearfulness. By definition, the person is in fact fearful of falling because they have a ''low self-confidence'' in completing activities of daily living (15). Similarly, a person may answer ''yes'' to the fear-of-falling question because he/she chooses to engage in sports or other activities that presents an increased risk of falling, but does not necessarily have a fear of falling within the context of daily tasks such as answering the telephone or doing the laundry. By using the MFES in our study, fear of falling became less subjective and could be more closely related to activities of daily living. Although self-efficacy plays an important role in fear of falling, available evidence suggests that these constructs, although similar, are not identical (25).

One inherent limitation when studying fear of falling is that people might be afraid to admit, verbally or in writing,

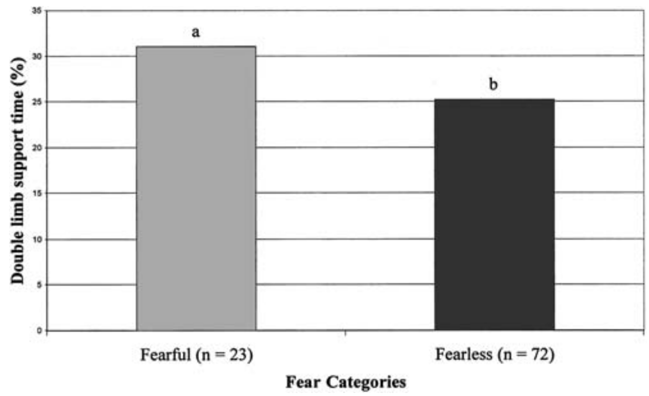

Figure 4. Mean double limb support time for fearful and fearless categories. Bars represent the percentage of time that a participant spent standing on two limbs while walking along the gait mat. a and b: Significant differences ($p < .05$) between categories.

that they are fearful. In this study, 5 of 28 males (17.9%) compared to 18 of 67 females (26.9%) were placed in the ‘‘fearful of falling’’ group. In a study identifying the characteristics of elderly people who develop a fear of falling, Vellas and colleagues (22) found that more women than men reported a fear of falling after experiencing at least one fall. Through a 2-year study of 219 individuals (74% women, 26% men), 70 (32%) reported a fear of falling after experiencing a fall (22). This raises the question of whether the difference between sexes in fear of falling is actually because of perceived fear, or because males may be more reluctant to admit that they are fearful of falling. This is an interesting psychosocial issue to explore as it may give insight into how fear of falling manifests itself differently by sex.

The sex differences in our study, 28 males and 67 females, might also impact the results obtained from the MFES. Questions that ask for a participant's confidence level in doing ‘‘light gardening or hanging out washing’’ or ‘‘preparing a simple meal’’ may be hard to answer if the participant does not normally perform these tasks. Other questions may be slightly sex-specific; e.g., females may perform ‘‘light housekeeping’’ more frequently than males. Although Hill and coworkers (21) found no significant difference in MFES scores between sexes, future studies may necessitate more sex-neutral tasks for use on the MFES.

Another limitation of our study is the possibility that individuals with the most fear of falling may be less likely to participate in such a study; Maki identified the same problem (7). The number of participants in our groups (24% fearful vs 76% fearless) supports this. Individuals who are truly fearful of falling would be apprehensive about walking across a mat on which they are not used to walking. We tried to avoid this by carefully concealing all loose electrical cords and taping down areas where people could stumble.

The MFES has been found to be valid and reliable for assessing fear of falling (21,26). However, the biggest challenge of the present study was explaining the MFES to participants. Most participants understood the survey as being 14 questions rated along a visual analog scale from ‘‘not confident’’ to ‘‘completely confident.’’ However, a few participants marked directly under the headings ‘‘not confident,’’ ‘‘fairly confident,’’ or ‘‘completely confident,’’ possibly not fully understanding the scale as being a continuum. A numbered scale, such as from 0 to 10, might have been easier to use. Also, not placing the titles ‘‘not confident,’’ ‘‘fairly confident,’’ and ‘‘completely confident’’ along the top of the analog scale might have lessened the confusion of where to mark the survey.

It has been suggested that the adaptations that individuals make in their gait patterns secondary to a fear of falling are used to reduce their risk of falling (7,23). A suggestion for future studies is to examine the intensity of fear of falling on spatial and temporal aspects of gait. Further studies could also explore the efficacy of specific procedures used to treat patients who express this fear.

The results of our study, in conjunction with those reported by Tennstedt and colleagues (23), show promise for future clinical use. Physical therapists who see elderly patients with gait deviations may be able to address fear of falling within traditional therapeutic techniques to help their patients resume a more functional gait pattern.

Conclusion

This study found a statistically significant difference between fearful and fearless groups in four separate gait parameters for a community-dwelling elderly population. Fearful participants were shown to have a significantly slower gait speed, shorter stride length, longer stride width, and prolonged double limb support time when compared to the fearless participants. Measures of gait parameters are an important part of clinical assessment. This study has shown that fear of falling can change a patient's gait parameters to abnormal when compared to individuals of the same age who do not fear falling. It then becomes important to transfer this knowledge to the clinical setting and address fear of falling with all elderly patients who show gait abnormalities.

Fear of falling and its affects on gait parameters have not been extensively studied. As physical therapists and health care professionals, we strive to achieve the highest level of functioning for all patients; further research is needed to assess the complex relationship between fear of falling and ambulation in the elderly population.

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Address correspondence to Sheryl L. Sanders, PhD, School of Physical Therapy, Pacific University, 2043 College Way, Forest Grove, OR 97116. E-mail: sanderss@pacificu.edu

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