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Transitioning to a Narrow Path: The Impact of Fear of Falling in Older Adults

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Abstract

Background—Everyday ambulation requires navigation of variable terrain, transitions from wide to narrow pathways, and avoiding obstacles. While the effect of age on the transition to a narrow path has been examined briefly, little is known about the impact of fear of falling on gait during the transition to a narrow path. The purpose was to examine the effect of age and fear of falling on gait during transition to a narrow path.

Methods—In 31 young, mean age = 25.3 years, and 30 older adults, mean age = 79.6 years, step length, step time, step width and gait speed were examined during usual and transition to narrow pathway using an instrumented walkway.

Findings—During the transition to narrow walk condition, fearful older adults compared to young had a wider step width (.06 m vs. .04 m) prior to the narrow path and took shorter steps (.53 m vs .72 m, $p < .001$). Compared to non-fearful older adults, fearful older adults walked slower and took shorter steps during narrow path walking (gait speed: 1.1 m/s vs .82 m/s, $p = .01$; step length: .60 m vs .47 m, $p = .03$). In young and non-fearful older adults narrow path gait was similar to usual gait. Whereas older adults who were fearful, walked slower (.82 m/s vs .91 m/s, $p = .001$) and took shorter steps (.44 m vs .53 m, $p = .004$) during narrow path walking compared to usual walking.

Interpretation—Changes in gait characteristics with transitioning to a narrow pathway were greater for fear of falling than for age.

Keywords

gait; fear of falling; aging; falls; older adults

Introduction

Everyday ambulation for the community-dwelling adult requires navigation of variable terrain, including transitions from wide to narrow pathways, walking on uneven surfaces, and avoiding obstacles.¹ Gait adaptations become increasingly more difficult to perform as

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individuals' age, thus placing them at greater risk for falls.² During the transition from a wide to narrow pathway, older adults wait until the transition step to narrow their base of support, while younger adults narrow their base of support prior to the transition step.³

Fear of falling, or a low confidence regarding one's balance ability in a given situation, impacts gait and balance.⁴⁻⁸ Fear of falling is associated with depression, decreased quality of life, and limited activity and is linked to slower gait speed, shorter stride length, increased stride width and increased time in double limb support during usual path walking.^{5,7} While the effect of age on the transition to a narrow path in older adults has been examined briefly, little is known about the impact of fear of falling when older adults are confronted with a challenging walking task, such as transition to a narrow path.

The aims of this study were 1) to examine the impact of age and fear of falling on gait characteristics during a transition to a narrow path and 2) to compare usual path gait characteristics to those exhibited during a narrow path transition in young, fearful, and non-fearful older adults. We hypothesize that older adults will walk slower, take shorter steps and have a wider step width than younger adults, and that fearful older adults will exhibit a more "cautious" gait pattern, defined as slow gait speed, short step lengths and wide base of support,^{9,10} than non-fearful older adults during the transition to a narrow path.

Methods

Study Participants

This was a cross sectional study including a group of 31 healthy young adults and a group of 30 older adults. The young adult volunteers were between the ages of 18 and 50 and recruited through fliers posted around the University of Pittsburgh. Young subjects had no diagnosed neuromuscular, cardiopulmonary or orthopedic conditions that would affect walking. The older participants were chosen from an ongoing longitudinal study of mobility in older adults. Subjects were included in the longitudinal study if they were 65 years and older, had intact cognition (i.e. Mini-Mental Status Exam score ≥ 24), could provide informed consent, and had the ability to walk a minimum of a household distance without the assistance of another person. Subjects were excluded if they had any neuromuscular disorders that impair movement, cancer with active treatment within the past six months, non-elective hospitalization for a life-threatening illness or major surgical procedure in the past 6 months, severe pulmonary disease requiring supplemental oxygen or resulting in difficulty breathing at rest or with minimal exertion, and chest pain with activity or a cardiac event such as heart attack within the past six months.

Procedures

Older adults were classified as fearful or non-fearful based on their response to the question: "Are you afraid of falling?" This yes/no question allowed us to place participants into either fearful or non-fearful groups and has been used in several other studies to determine fear of falling.^{11,12} The GaitMat II system was used to measure gait characteristics for all subjects during usual gait and during transition from a wide to narrow pathway. The GaitMat II system consists of four sections, each measuring approximately 96 cm in length and 59 cm in width, which are connected to a Windows-based computer. Two additional sections were placed at each end to allow for acceleration and deceleration phases during normal gait.¹³

For the transition to narrow path condition, a narrow pathway was constructed using two pieces of foam placed on either side of the normal GaitMat II pathway (Figure 1). The foam was placed 35 cm apart, halfway down the pathway to allow for the transition from a wide to narrow pathway.

Outcomes

Subjects completed two practice passes on the GaitMat prior to data collection. Participants then completed four passes at a usual, self-selected pace and 1 pass on the narrow pathway for data collection. For this study, we focused on the following gait characteristics: gait speed, step length, step width, and step time. Gait speed was determined by dividing the distance traversed by the time between the first and last step (eg switch closure) and was recorded in meters/second (m/s). Step length was defined as the space between the first switch closure at heel strike to the first switch closure of the next contra lateral heel strike. Step width was defined by the space between the innermost switch closure of one foot and the innermost switch closure of the contra lateral foot, and step time was measured as the amount of time from the earliest switch closure at heel strike to the earliest switch closure at the next contra lateral heel strike (Figure 2).

Narrow pathway data collection usually included two steps on the wide part of the pathway, one transition step, and two steps on the narrow part of the pathway. However, due to the small number of young adults that completed five steps in the pathway, only three steps were used for data analysis: approach step, transition step, and narrow step. A step was considered the transition step if any part of the foot crossed midline of the GaitMat II, into the narrow part of the walkway. The step before the transition step was termed approach step one and the step after narrow step one (Figure 1).

Statistical Analysis

SAS® version 9.2 (SAS Institute, Inc., Cary, North Carolina) was used for all statistical analyses. We compared subject characteristics among the young, old non-fearful and old fearful subjects using Fisher's exact and analysis of variance tests, as appropriate (Table 1). Using the SAS® MIXED procedure, we fit a linear mixed model with each of the gait characteristics as the dependent variable; subject group (young/old non-fearful/old fearful), condition (usual/approach/transition/narrow) and their interaction as fixed effects of interest; and a subject random effect to account for multiple measurements from the same set of subjects (Figure 2). This approach is equivalent here to a well-known repeated measures analysis of variance (ANOVA), but the linear mixed models allow for greater flexibility to fit a larger class of experiments. For analysis of gait speed, only usual and narrow conditions were available for fitting the model (Table 2). We then used appropriately constructed contrasts to compare gait characteristics among the three subject groups under each of the walking conditions, and to make comparisons among different walking conditions within each of the three subject groups. These specific post hoc contrasts were constructed by assigning coefficients of +1 and -1 for specific groups to be compared and coefficients of 0 for the remaining groups. Statistical significances of post hoc comparisons were obtained using the Fisher's least significant difference method.

Results

The mean age of the young subjects was 25.3 ± 4.3 years and for the older nonfearful and fearful subjects it was 80.1 ± 6.2 and 80.5 ± 4.0 years. Both young and older subjects were primarily white and female. Seventeen of the 30 older subjects (57%) reported being fearful of falling (Table 1). Fearful older adults significantly decreased walking speed when faced with the transition to a narrow path condition compared to their usual gait speed (0.94 vs 0.86 m/s; $p < 0.01$). During the transition to narrow path, young adults (1.31 vs 1.33 m/s; $p = 0.25$) and non-fearful older adults (1.13 vs 1.15 m/s; $p = 0.27$) did not have a significant change in walking speed compared to usual walking speed (See Table 2).

Transition to a narrow path

During the transition to the narrow path walk, young subjects had the longest step lengths (0.715 m) and the fearful older adults, the shortest step lengths (0.480 m; $p < 0.01$; figure 3A). During the transition to the narrow path, the approach step width was similar for the young and the non-fearful older adults ($p = 0.2$); however, the fearful older adults had a significantly wider approach step than the younger adults (0.064 vs 0.036 m; $p < 0.01$; figure 3B). The transition and narrow step widths were similar for the three groups ($p = 0.13$). Likewise, the step times during the transition to a narrow path were similar for all three groups ($p = 0.13$; figure 3C).

Comparison of usual and narrow path walking

Young adults had similar step lengths and step times during usual and transition to a narrow path walking (figure 3A and C). The only gait characteristic that differed between usual and narrow path walking was step width, in that the young adults narrowed their steps in the narrow portion of the walkway, as expected (figure 3B). Older non-fearful adults had similar step lengths during usual and narrow path walking (0.616 vs 0.599 m; $p = 0.27$), but compared to usual path walking, they took faster steps (i.e. shorter step times; 0.557 vs 0.528 s; $p < 0.01$) during the narrow path walk (figure 3A and C). Older fearful adults took significantly shorter (0.536 vs 0.480 m; $p < 0.01$) and faster steps (step times 0.581 vs 0.547 s; $p < 0.01$) during the narrow path walk compared to usual path walking (figure 3A and 3C). Though not statistically significant, when approaching the narrow path walkway, both fearful (0.064 vs 0.056 m; $p = 0.24$) and non-fearful older adults (0.050 vs 0.038 m; $p = 0.14$) had a slightly wider step width than demonstrated during usual path walking (figure 3B).

Discussion

Changes in gait characteristics with transitioning to a narrow pathway were greater for fear of falling than for age. The transition to a narrow pathway impacted all gait characteristics (gait speed, step length, step width, and step time) in the fearful older adults; whereas it only impacted step width and step time in the non-fearful older adults, and only step width in the young adults.

Compared to young adults, the older adults in our study had a wider step width prior to the transition step when walking a narrow path. This finding is somewhat similar to a previous study of narrow path walking in young and old adults, which shows that older adults only narrow their step width when negotiating the transition step while young adults narrow their step width prior to the transition step.³ By comparing narrow path walking to usual walking, we observed that older adults actually widen their step width (compared to usual path walking) prior to the transition step. Interestingly, fearful older adults widened their step width even more than the non-fearful older adults. This could possibly be in preparation for the challenging tasks that is approaching (i.e. narrow path walking). Other studies have found that when faced with a challenging task or postural threat, older adults alter the movement patterns and gait characteristics differently than younger adults.^{2,4} The present study adds to these studies by demonstrating that fearful older adults alter their gait differently than non-fearful older adults.

Fearful older adults had a significantly slower gait speed and shorter step lengths when confronted with narrow path walking compared to usual walking, which is characteristic of a “cautious” gait pattern.^{9,10} Conversely, when faced with the narrow path, the non-fearful group of older adults did not exhibit a slower gait speed and showed gait characteristics similar to their usual walking. This finding is supported by a similar study examining older adults’ gait adjustments while stepping over obstacles.² Rosengren et al.² found that older

adults with lower gait efficacy approached obstacles with slower gait speed and shorter approach steps, much like our study. Chamberlin et al.⁷ also found that older adults with a preexisting fear of falling exhibited slower gait speed, shorter stride length, increased stride width, and prolonged double support time during usual path walking.

There are several limitations to this study. First, due to the length of the GaitMat II system, we were only able to measure a limited number of steps during the transition to a narrow path. Those participants with longer step lengths sometimes only had three steps within the GaitMat. As a result, we only were able to use data from three steps: approach step, transition step and narrow step. In addition, this study used data collected from one pass in the transition to narrow pathway. This is a potential limitation, but using only one pass allowed us to observe older adult's behavior when exposed to a novel challenge without the chance of a learning effect. Secondly, fear of falling was measured by a single direct question which may introduce an element of bias into the study. Also, our sample included 31 younger adults, and 13 non-fearful and 17 fearful older adults. Due to this small sample of volunteers from the Pittsburgh area, the generalizability to the overall population may be questionable. However, this study was one of the first to examine the impact that fear of falling may have on older adults when introduced to a narrow pathway, which is an everyday walking task for community-dwelling older adults.

The differences in gait characteristics while maneuvering to a narrow path were greater by fear of falling (ie older adults fearful of falling compared to older adults not fearful) than by age alone. Fear of falling can be deleterious to quality of life, balance, and gait in older adults and should be taken into account when evaluating and treating older adults for mobility problems so that there is no unwarranted restriction in function.^{5,8} Future work is needed to explore other aspects, such as vision, cognition, number of medications and peripheral sensation, which may all have an effect on gait characteristics while walking in “real world” environments. In conclusion, although each group (young, non-fearful older adults and fearful older adults) differed from their usual gait characteristics when faced with narrow path walking, fearful older adults were most impacted as demonstrated by a decrease in gait speed, shorter and faster steps and a wider step width when approaching the narrow path.

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Figure 1.
GaitMat II Pathway used for Data Collection

Figure 2.
Step-width and step-length measures.

Figure 3. Gait Characteristics during usual and transition to a narrow pathway walking in young (●), non-fearful older adults (●), and fearful older adults (●). A = step length, B = Step width, C= Step time

Table 1

Demographics of study participants, mean (SD)

	Young Adults N = 31	Non-fearful Older Adults N = 13	Fearful Older Adults N = 17
Age (years)	25.3(4.3)	80.0(6.2)	80.5(4.0)
% Female	67.7%	60.0%	81.3%
% White	90.3%	90.0%	93.8%
Height (m)	1.71 (.10)	1.66 (.11)	1.63 (.11)
Weight (lbs)	155.0(38.0)	180.7(33.0)	173.7(52.3)

Table 2

Usual and Narrow Gait Speeds, mean (SD) in all Groups

	Usual Gait speed (m/s)	Narrow Gait speed (m/s)	p
Young Adults	1.31(.14)	1.33(.14)	0.25
Non-fearful Older Adults	1.08(.21)	1.10(.20)	0.27
Fearful Older Adults	.91(.27)	.82(.29)	<0.01