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Stepping through fear: analysing postural control in elderly women during transitional locomotor tasks

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Abstract

Background Fear of falling (FoF) is prevalent among older adults, particularly women, and is a known factor increasing fall risk during movement. FoF may naturally arise after the first fall incident as well as long before the first fall occurs. This study examined how FoF intensity affects static balance and transitional locomotor tasks in 81 healthy women aged 60 and older.

Methods Participants were divided into LOW, MODERATE, and HIGH FoF groups based on their Falls Efficacy Scale-International (FES-I) scores. Static balance was measured by center of pressure velocity (vCOP), while transitional tasks were assessed through transit time (TT), double support period (DSP), and stability times (S1—the time needed to destabilize the body before taking a step and S2- the time required to stabilize the position after taking a step) under unimpeded transition on a flat surface, obstacle clearance, step-up, and step-down conditions.

Results The findings showed no significant differences in static balance (vCOP) across FoF groups. However, the HIGH FoF group took longer to complete transitional tasks, with significantly increased TT, DSP, and S1 compared to the MODERATE group, particularly during obstacle clearance and step-up/down movements. This suggests that individuals with higher FoF take a more cautious approach, prioritizing stability over speed. No significant differences in S2 were found, indicating that FoF does not affect balance recovery after a step.

Conclusion The study concludes that while FoF does not impair static balance, it significantly impacts movement initiation and execution in transitional tasks. Prolonged preparation time (S1) in the HIGH FoF group highlights the role of fear in delaying movement. These findings are important for designing interventions to reduce FoF and prevent falls in older adults.

Keywords Fear of falling, Postural threat, Postural control, Step initiation, Aging

Background

Fear of falling (FoF) is a psychological condition characterized by heightened anxiety about the possibility of falling during daily activities, particularly among older adults [1]. FoF is not merely a fear in the colloquial sense but a complex psychological construct with anxiety as its core component [2]. Although fear is a psychological phenomenon, its consequences are evident in motor behavior [3]. FoF influences activity avoidance and balance performance. It impairs postural control modify visual search strategies while walking,, causing a greater focus on immediate environmental cues instead of anticipating future movement [4, 5]. Individuals experiencing fear of falling exhibit poorer reactive stepping performance [6]. FoF may arise from the psychological trauma experienced after a fall, a phenomenon also known as

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post-fall syndrome [7]. However, post-fall syndrome can also occur in older individuals who have never experienced a fall. Regardless of its origin, FoF increases the risk of losing balance and experiencing initial or recurrent falls [8].

Although fear of falling is a psychological phenomenon, its manifestation is visible in postural behavior, allowing it to be assessed using various questionnaires. These range from a simple question like "Are you afraid of falling?" to scales such as the Activities of Daily Living (ADL) and the Geriatric Mobility Function (GMF), and ending with. the Falls Efficacy Scale-International (FES-I) [9–11]. RecentlyFES-I has gained widespread recognition due to its validation in both short and long formats [12, 13]. Additionally, it has been translated into many languages. Unlike other scales, the FES-I assesses not only the presence of FoF but also the intensity of fear related to falling, categorizing it as low, moderate, or high based on survey responses.

There are many studies assessing the impact of FoF, measured using the FES-I, on static balance, relatively few focus on dynamic balance, such as step initiation. This is puzzling, as the questions in the FES-I questionnaire pertain to dynamic movements, with none addressing static balance.m. Respondents indicate the level of fear related to specific movements [12]. It would be more accurate to link the declaration of fear in a given activity with the motor assessment of that activity.

It becomes crucial to distinguish between the impact of previous fall experience and the state of feeling FoF. It's unclear whether changes in postural behavior stem from a fall or anxiety itself, as FoF is often analyzed alongside fall history. By evaluating these two factors together, it is well known that they influence postural strategies for maintaining balance, with anxiety linked to increased body sway and reduced leaning range [14–16]. Interestingly, Taglietti et al. [17] found no correlation between anxiety and static balance. However, in their studies do not provide information about fall history. On the other hand, the lack of correlation between FoF and static balance could be understandable, since falls typically occur during dynamic activities such as transferring or transitioning between positions [14]. Therefore, in the present study, in addition to static balance, we examined dynamic balance, which, in light of the literature, appears to be more justified.

Balance disturbances are commonly assessed using clinical tests like the Timed Up and Go (TUG) test, Berg Balance Scale (BBS), or Tinetti Test [15]. These tests evaluate the potential presence or absence of an increased risk loss of balance. To determine which aspects of movement are impaired or how changes in postural control mechanisms contribute to balance deterioration, advanced diagnostic techniques, such as posturography, provide a more detailed and objective analysis by quantifying subtle impairments in balance and movement that clinical tests may overlook. This precision makes them invaluable in addressing gaps in understanding how postural control deteriorates, particularly in populations at high risk of falls, such as older adults [3]. FoF also affects gait parameters, including gait speed, step length, double support period, and the initiation and termination of gait [16]. However, the use of the FES-I questionnaire to assess FoF in posturographic studies of dynamic balance is extremely rare.

Today, activities included in FoF questionnaires can be partially quantified. On one hand, they provide information about the anxiety experienced during specific activities; on the other hand, they allow for the assessment of whether declarative responses correlate with actual changes in movement control. Loss of balance occurs predominantly during step initiation or over short walking distances [18]. Previous researches have shown, that for older adults stepping over an obstacle is challenging [19]. Additionally, negotiating stairs is the most difficult task for older adults, as it can be particularly demanding and may even result in loosing balance [20]. Therefore, in this study, we decided to use transitional locomotor tasks to assess both static, and, especially, dynamic balance under daily-life conditions included in the FES-I, such as obstacle clearance and ascending and descending stairs. The procedure has been used to assess dynamic balance in various age groups (from children to older adults) and in different medical conditions [21–23], but it has been used for the first time to assess the impact of FoF on dynamic balance. Furthermore, these studies assessed not only the impact of FoF on dynamic balance but also the current level of anxiety based on the FES-I questionnaire.

Accordingly, the purpose of this study is to examine not only the effect but also the intensity of FoF on transitional locomotor tasks. We hypothesize that postural sway, measured by the mean velocity of the center of foot pressure (CoP), will increase before and after taking a step in relation to the level of FoF. Additionally, we expect that individuals with high FoF will exhibit longer transitional locomotor task times, including extended transit time, double support period, preparation time for movement, and time required to regain balance.

Methods

Eighty-one female volunteers participated in the study. Inclusion criteria were a minimum age of 60 years, social independence, and no history of fall (Table 1). Exclusion criteria included severe neurological or cognitive impairments and lower limb injuries. All participants provided

Table 1 Physical characteristics of participants

	LC (*n* = 23)	MC (*n* = 37)	HC (*n* = 21)
Age [years]	66 ± 4.5	65 ± 3	67 ± 5
Weight [kg]	68 ± 11	75 ± 14	77 ± 13
Height [cm]	161 ± 5.8	158 ± 17	151 ± 8.5

LC group with low concern of FoF, *MC* group with moderate concern of FoF, *HC* group with high concern of FoF

written informed consent. Ethical approval was granted by the local ethics committee (approval number: 1/2021), and the study was conducted in accordance with the Declaration of Helsinki.

Participants were categorized into three groups—LOW, MODERATE, and HIGH concerns—based on their scores on the short Falls Efficacy Scale-International (short FES-I) [24]. It measures of "fear of falling" or, more properly, "concerns about falling". includes 7 questions about a daily activities: (1) getting dressed or undressed, (2) taking a bath or shower, (3) getting in or out of a chair, (4) going up or down stairs (5) reaching for something above your head or on the ground, (6) walking up or down a slope, (7) going out to a social event (e.g. religious service, family gathering or club meeting). There are four possible answers: not at all concerned (one point), somewhat concerned (two points), fairly concerned (three points) and very concerned (four points). The highest score (very concerned about falling) is therefore 28 and the minimum (no concern about falling) is 7. The cut-off points of low FoF concern are 7–8, for moderate 9–13, and for high 14–28 [25].

Static balance and transitional locomotor tasks were assessed using two force plates (AMTI Accugait, Watertown, MA, USA), which measured ground reaction forces (Fx, Fy, Fz) and moments (Mx, My, Mz) at a sampling frequency of 100 Hz. The force plates, each measuring 50 cm × 50 cm with a height of 4.5 cm, were arranged linearly with a 4 cm gap between them to accommodate the obstacle used in the tasks. Raw data were processed offline using MATLAB software (MathWorks, Natick, MA). A low-pass Butterworth filter with a cutoff frequency of 7 Hz was applied to the data to remove noise.

The procedure of transitional task applied in this study have already been published in our previous studies [23, 26]. Research procedure involves three phases: FIRST – quiet standing (QS) phase, initiating with a 20-s double leg stance on the platform A; SECOND – forward stepping phase where participants, after an acoustic signal, take a step from one platform (A) to the other (B) while shifting their body weight; THIRD – QS phase, on a platform B until measurement completion. Assessment of transitional locomotor task was performed under four distinct conditions: unimpeded transition on a flat surface, obstacle clearance, step-up, and step-down (Fig. 1). An obstacle, measuring 16 cm in height and 4 cm in thickness, corresponding the average height of a curb. During the step-up and step-down one conditions platform was positioned on a 17-cm base, directly at the edge of the other platform. The placing of platforms were adopted based on the typical height of a one stair step. The transitional locomotor task was repeated three times in each condition and lasted 45 s. The trial order was randomized. Before each trial, the participants had time to practice stepping on the force platforms. The participants were instructed to start with the dominant leg. If errors were made by the participants (e.g., touching the obstacle or losing balance) or if the task was not completed, the trial was did again. The rest period between conditions lasted two minutes. The participants started all trials with their dominant leg and performed the step as quick as possible.

The following variables were analysed:

1 st and 3rd phases: mean velocity of COP – v COP (cm/s) in an anterior–posterior (AP) and a medio-lateral (ML) plane.

2nd phase: transit time – TT (s): the duration of the 2nd phase – time from exit from the stability state until gaining post-transit stability; stability time 1 – S1 (s): the time from exiting steady standing (beginning of the 2nd phase) to the time when the leading foot was resting on the other platform (preparatory stability time); stability time 2 – S2 (s): time from raising the foot off the first platform until gaining stability on the other platform (regained stability time); double support period – DSP (s): when each foot is in contact with one of the platforms.

Data normality was assessed using the Shapiro–Wilk test, and homogeneity of variances was evaluated with Levene's test. Since the data did not meet the assumptions for parametric tests, nonparametric methods were employed. The Kruskal–Wallis test was used to compare variables (mean v-COP (cm/s) from the 1 st and ^{3}rd phases and TT, S1, S2, DSP (s) from the 2nd phase) across the three FoF groups. Additionally, Dunn's post hoc test was performed for pairwise comparisons between each independent group. Effect sizes (η2) were also calculated to facilitate interpretation of the clinical meaningfulness of the data, based on following formula: $\eta^2 = \frac{H-k+1}{N-k}$, where H – Kruskal–Wallis H test statistic; k – number of groups; N – sample size. Effect sizes were interpreted as small (0.01), medium (0.06), and large (0.14) effects, respectively [27]. All statistical analyses were conducted using STATISTICA version 13.1 (Stat-Soft, Inc., USA). Research materials are available at: (https://osf.io/g4akz/?view_only=cf400c6e437645d5895a6d95bb7c1b5b).

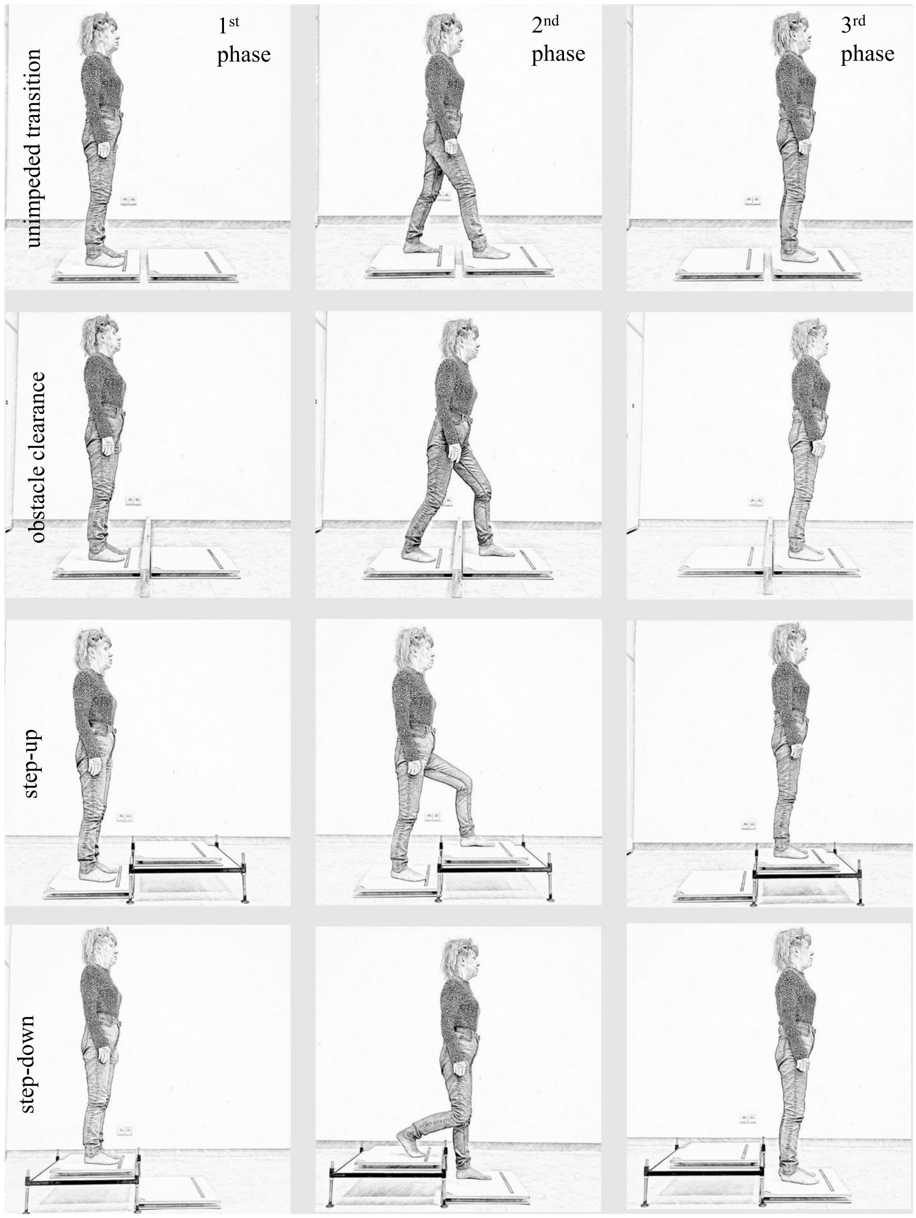

Fig. 1 Four conditions of the transitional locomotor tasks

Results

Postural Sway in 1 st and 3rd QS phase of t the transitional locomotor task

There were no significant changes in postural sway characteristics related to the difficulty of the transitional locomotor task across different levels of FoF. The mean velocity of the COP (vCOP) in both the anterior–posterior (AP) and medio-lateral (ML) planes did not differ significantly among the LOW, MODERATE, and HIGH concern groups in 1 st and 3rd phase of the Transitional Locomotor Task ($p > 0.05$).

Transitional Phase – 2nd phase

Transit Time (TT)

The Kruskal–Wallis test revealed significant differences in transit time (TT) between the MODERATE and HIGH concern groups (Table 2). Participants in the HIGH concern group exhibited longer TT during obstacle clearance, step-up, and step-down conditions compared to those in the MODERATE concern group ($p < 0.05$). No significant differences in TT were found between the LOW and MODERATE groups or between the LOW and HIGH concern groups (Fig. 2).

Table 2 Intergroup comparison between three groups LC, MC, and HC

variable	phase	condition	group LC	group MC	group HC	H & *p* value	η2	Intergroup comparison		
			Mdn (min–max)	Mdn (min–max)	Mdn (min–max)			LC vs. MC	MC vs. HC	LC vs. HC
TT [s]	S	unperturbed crossing	3.65 (2.53–4.79)	3.67 (2.37–4.91)	4.14 (3.16–7.60)	H = 8.18 *p* =.017	0.079	-	*p* =.002	*p* =.048
	E	obstacle crossing	4.03 (2.95–5.42)	3.92 (2.95–5.30)	4.76 (3.10–7.50)	H = 13.01 *p* =. 001	0.141	-	*p* =.002	*p* =.011
	C	step-up	3.95 (2.95- 4.69)	3.78 (2.95–5.30)	4.32 (3.29–9.58)	H = 11.76 *p* =. 003	0.125	-	*p* =.003	*p* =.045
	O	step-down	4.03 (2.46–5.14)	3.56 (2.79–5.14)	4.28 (2.99–7.98)	H = 12.69 *p* =. 002	0.137	-	*p* =.002	-
S1 [s]	N	unperturbed crossing	1.13 (0.87–1.73)	1.15 (0.85–1.53)	1.34 (0.98–2.34)	H = 9.44 *p* =. 009	0.095	-	*p* =.01	*p* =.03
	D	obstacle crossing	1.27 (0.85–1.71)	1.26 (0.97–1.86)	1.55 (1.20–3.08)	H = 14.78 *p* =. 001	0.164	-	*p* =.001	*p* =.003
		step-up	1.17 (0.84–1.43)	1.18 (0.91–1.75)	1.39 (1.01–2.74)	H = 13.36 *p* =. 001	0.146		*p* =.005	*P* =.002
		step-down	1.30 (0..84–1.69)	1.26 (0.98–2.00)	1.80 (0.95–2.94)	H = 20.75*p* =. 000	0.240	-	*p* =.001	*p* =.001
S2 [s]		unperturbed crossing	2.46 (1.41–3.68)	2.19 (1.10–3.26)	2.47 (1.51–4.45)	H = 3.15 *p* =. 206	0.015	-	-	-
		obstacle crossing	2.25 (1.69–3.45)	2.38 (1.43–3.55)	2.96 (1.55–4.30)	H = 6.85 *p* =. 032	0.062	-	-	-
		step-up	2.46 (1.50–3.48)	2.11 (1.51–3.02)	2.36 (1.74–4.37)	H = 4.93 *p* =. 085	0.038	-	-	-
		step-down	2.36 (1.49–3.49)	2.14 (1.32–2.88)	2.37 (1.37–4.30)	H = 6.53 *p* =. 038	0.058	-	-	-
DST [s]		unperturbed crossing	0.30 (0.15–0.56)	0.31 (0.17–0.54)	0.35 (0.15–0.87)	H = 5.42 *p* =. 066	0.044	-	-	-
		obstacle crossing	0.27 (0.19–0.79)	0.27 (0.16–0.52)	0.37 (0.19–1.04)	H = 12.96 *p* =.001	0.141	-	*p* =.001	*p* =.020
		step-up	0.37 (0.19–0.79)	0.37 (0.20–0.70)	0.53 (0.29–2.48)	H = 18.36 *p* =.0001	0.210	-	*p* =.001	*p* =.002
		step-down	0.24 (0.10–0.48)	0.23 (0.13–0.97)	0.33 (0.11–2.74)	H = 7.74 *p* =.0208	0.074	-	*p* =.026	-

Abbreviations: TT transit time, *S1* stability time 1, *S2* stability time 2, *DST* double support time, *group LC* LOW CONCERN, *group MC* MODERATE CONCERN, *group HC* HIGH CONCERN

'- ' – no significant differences between groups ($p > 0.05$)

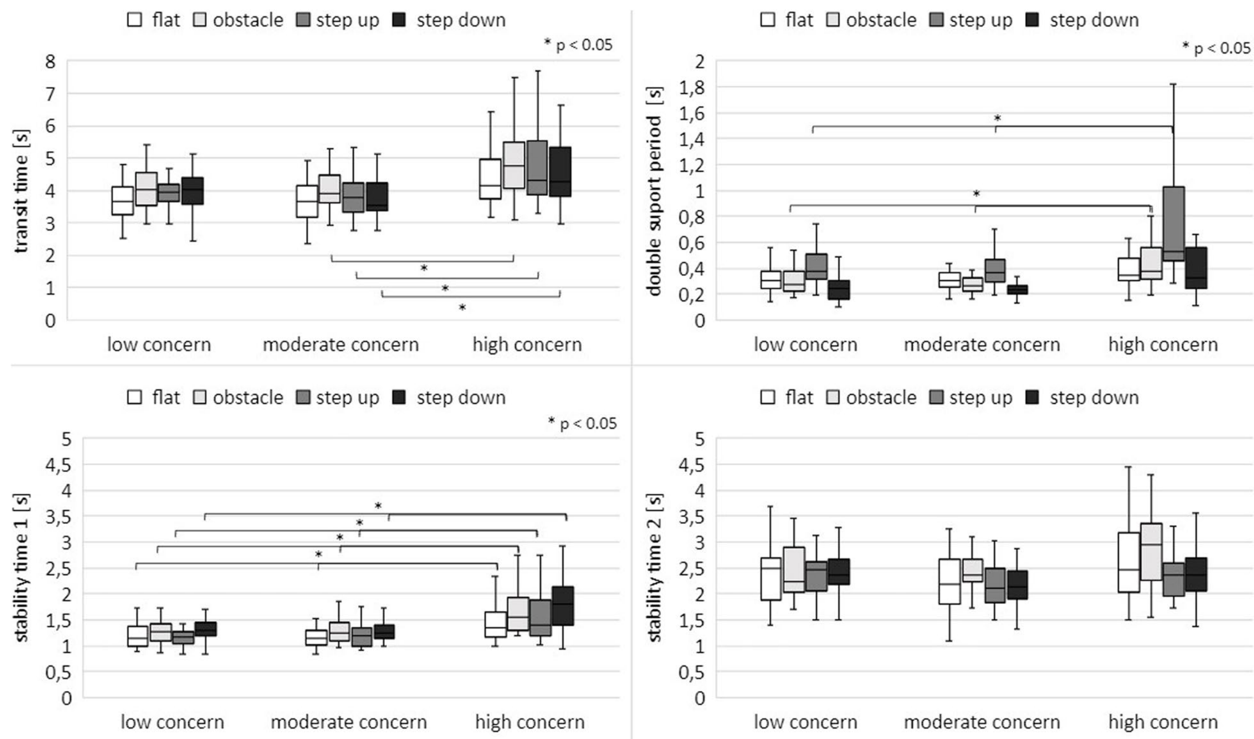

Fig. 2 Median values for the transit time, stability time 1, stability time 2, double-support period (minimum, maximum marked as error bars) in fourth trials (2nd phase) performed by LOW, MODERATE and HIGH concern participants. Horizontal bars indicate statistically significant differences between groups

Double Support Period (DSP)

Significant differences in the double support period (DSP) were observed between the LOW and HIGH concern groups, as well as between the MODERATE and HIGH concern groups ($p < 0.05$) (Table 2). The HIGH concern group demonstrated longer DSP during obstacle clearance and step-up conditions compared to both the MODERATE and LOW concern groups. DSP did not significantly differ between the LOW and MODERATE concern groups (Fig. 2).

Stability Time 1 (S1)

The S1 showed significant differences between the LOW and HIGH concern groups and between the MODERATE and HIGH concern groups ($p < 0.05$) (Table 2). Participants in the HIGH concern group had longer S1 across all conditions—including unimpeded crossing, obstacle clearance, step-up, and step-down—compared to both the LOW and MODERATE concern groups. No significant differences in S1 were detected between the LOW and MODERATE concern groups (Fig. 2).

Stability Time 2 (S2)

No significant differences in S2 were found among the groups with different levels of fear of falling ($p > 0.05$) (Fig. 2).

Discussion

Psychological theories propose that anxiety stemming from fear of falling (FoF) can lead to an attentional bias toward threatening stimuli, thereby compromising working memory efficiency and balance performance [3]. As FoF becomes increasingly prevalent in aging societies, it contributes significantly to the risk of falls, which are predominantly incident during movement. Consequently, it is essential for assessment tools and research protocols to reflect real-life risk conditions. This study aimed to examine the impact of FoF intensity on static balance and transitional locomotor tasks.

FoF is more common in women and its prevalence increases with age [28]. Therefore, our study focused on a cohort of healthy older women. The findings revealed that postural sway characteristics were unaffected by FoF levels during static balance tasks, both before and after the transitional locomotor task. The mean vCOP in the anterior–posterior (AP) and medio-lateral (ML) planes did not differ significantly among the LOW, MODERATE, and HIGH concern groups. These results align with those of Taglietti et al., [17], who also found no correlation between FES-I scores and postural sway. The authors also used a QS test in their study to assess static balance, analyzing COP variables. However, in addition, participants performed a QS test with their eyes closed as the second condition of the test. In contrast, clinical populations such as individuals with Parkinson's disease (PD), multiple sclerosis (MS), or diabetes often exhibit altered COP metrics in relation to FoF. However, in our study, by excluding participants with recent falls and maintaining a homogeneous sample in terms of age, gender, and medical history, we could attribute the lack of impact on static balance directly to FoF levels.

Given that falls most frequently occur during movement, especially over short distances [18], it was logical to employ a more functional motor task like the transitional locomotor task. This task has been effectively utilized in assessing balance across various populations, from children to the elderly [21, 22, 29]. Our findings indicate a tendency for TT to increase with greater FoF. Specifically, the HIGH concern group exhibited significantly longer TT during obstacle clearance, step-up, and step-down conditions compared to the MODERATE concern group—by 26%, 30%, and 25%, respectively—despite instructions to move as quickly as possible. This suggests that participants with higher FoF prioritize balance maintenance over rapid movement initiation. This behavior is consistent with Tisserand et al. [30], who observed that older adults with disturbed balance tend to enhance stability at the expense of speed. In their studies, the participants did not perform a full step but moved the lower limb forward as quickly as possible. The participants responded to light stimuli by reacting with either the right or left lower limb accordingly.

Additionally, as TT increased, the double support period (DSP) also lengthened, particularly during obstacle clearance and step-up conditions, correlating with higher FoF levels. This indicates a shift towards a greater proportion of time spent with both feet on the ground, reducing single support time. Hommen et al. [31] reported similar findings, noting that frail individuals with FoF took shorter first steps compared to non-frail older adults. This was possible to determine because the participants covered a distance of 4 m. They suggested that reduced step length and increased DSP are indicative of altered postural strategies aimed at fall prevention. Furthermore, Åberg et al. [10] found that FoF affects not only step length but also step width, with wider strides not necessarily enhancing stability but potentially serving as predictors of future falls due to increased medio-lateral velocity of the center of mass (CoM). In their studies, they assessed not only kinetic variables but also kinematic variables using markers and a video camera system, which allowed for the analysis of both COP and COM.

When facing a postural threat, the central nervous system (CNS) adjusts agonist and antagonist muscle synergies during the anticipatory phase, favoring muscle reciprocal activation over co-activation [32]. In these studies, the most sensitive variable to the level of FoF turned out to be S1. The S1 variable represents the time required to prepare for taking a step, which includes both the anticipatory postural adjustment (APA) and the stepping phase. Before the stepping leg moves during step initiation, the APA occurs, shifting the COM toward the supporting side to allow the leg to be lifted. Subsequently, the time from exiting steady standing increased by about 21% during unimpeded transition, 33% during obstacle clearance, 34% during step-up, and almost 41% during step-down conditions between low and high concern groups. It can be assumed that each successive measurement condition was characterized by a greater degree of difficulty. Accordingly, the smallest difference between the groups could be observed in the unimpeded transition, compared to others condition. Uemura et al. [16] also noted similar trend. There were no differences between 'fear' and 'no fear' groups in APA during gait initiation. Only when a cognitive task was introduced into the motor task, a longer APA phase can be observed among 'fear' group. In the gait initiation test participants performed at least five steps on a 2-m walkway. In dual – task condition participants were required to count backward aloud while awaiting the visual cue.

When placing individuals in a state of postural threat, it was observed that prolonged APA during step initiation often correlates with a shorter first step [33]. A shorter stride reduces balance safety and increases the risk of falling. According to Ellmers et al. [33], larger APAs negatively impacted the mechanism but were required to produce step initiation. The authors introduced an actual condition that could provoke a FoF. The task of the participants was to cover a distance of about 3 m and four centimeters, as well as 1.1 m above the floor, without a harness. Based on the fear declarations and the Movement Specific Reinvestment Scale, participants were divided into a fearful and a non-fearful group. Fearful participants sought to ensure that the APA was sufficient to position their COM above the support leg prior to initiating the first step, though it resulted in a smaller step. On one hand, a concerning sign in older adults is the prolonged phase of APA, while on the other, its absence is equally worrisome. In the elderly, APAs play a key role in preserving lateral stability [34]. The authors suggested, that elderly without APAs were more prone to falling toward the swing leg side and showed greater lateral velocities compared to those with APAs.

A key finding of this study is that FoF did not affect the time required to regain balance after stepping (S2). There were no significant differences in S2 among the LOW, MODERATE, and HIGH concern groups across all conditions. Similarly, Marone et al. [9] reported no impact of FoF on recovery step length between fear and no fear groups. Their research procedure was different from ours. Participants did not overcome the obstacle, as in our study, but rather, they tripped over it. Trips were induced by using a hidden pneumatically driven obstacle when manually triggered. This suggests that while FoF may delay movement initiation, it does not impair the mechanisms for regaining balance post-step in healthy elderly individuals. However, in populations with neurodegenerative diseases, FoF has been shown to affect compensatory postural adjustments and reaction times [35, 36].

This study has several limitations. The sample was homogeneous, consisting exclusively of healthy older females, which restricts the generalizability of the findings to broader populations, including males and individuals with varying health statuses. Future research should include diverse populations, including those with a history of falls, to better understand the interplay between FoF and balance across different groups.

Conclusions

This study provides valuable insights into the relationship between FoF and balance performance in older females. The intensity of FoF does not influence static balance; however, higher levels of FoF adversely affect performance during transitional locomotor tasks. Specifically, individuals with higher FoF adopt a more cautious approach, prioritizing balance maintenance over movement speed. The preparation phase for stepping (S1) was particularly sensitive to FoF levels, indicating that fear may delay movement initiation. Importantly, FoF did not significantly impact the time required to regain balance after stepping (S2), suggesting that while fear affects movement initiation, it does not impair balance recovery mechanisms in healthy elderly individuals. Understanding how FoF, as a psychological condition, influences movement and postural strategies is essential for developing interventions that address not only physical but also mental health aspects of fall prevention.

Abbreviations

APA	Anticipatory postural adjustment
COP	Center of foot pressure
DST	Double-support time
FoF	Fear of falling
S1	Stability time 1
S2	Stability time 2
TT	Transit time
v- COP	COP velocity

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Not applicable.

Authors' contributions

KJS, and GJ contributed to the conception and the design of the study. JM, and AK, carried out the data acquisition. JM, and AK performed the analysis, JM, and AK drafted the article. KJS has critically revised the article.

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Data availability

All data and code are available online on the Open Science Framework at https://osf.io/g4akz/?view_only=cf400c6e437645d5895a6d95bb7c1b5b.

Declarations

Ethics approval and consent to participate

The subjects provided a written informed consent for voluntary participation in the study. The research was approved by the University Bioethics Committee for Scientific Research at The Jerzy Kukuczka Academy of Physical Education (approval number: 1/2021).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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