Gerontology & Geriatrics: Research

Open Access

Austin Publishing Group

Special Article - Fall Prevention

Influence of Fear of Falling and Multiple Falls Risks on Gait Performance under Single and Dual-Task Conditions

Wollesen B*, Köhler B and Mattes K
Department of Human Movement Science, University of Hamburg, Germany

***Corresponding author:** Wollesen B, Department of Human Movement Science, University of Hamburg, Turmweg 2, 20148 Hamburg, Germany

Received: August 08, 2016; **Accepted:** September 28, 2016; **Published:** September 30, 2016

Abstract

Fear of Falling (FOF), Balance Declines (BD) and Multiple Falls Risks (MFR) influence gait performance in older adults. This study evaluates if and how these factors affect gait variables under Single-Task (ST) and Dual-Task (DT) conditions. A total of 223 participants of females (n=160) and males (n=63) were examined in (a) ST cognitive performance: visual-verbal Stroop test, (b) ST: walking, and (c) DT: walking + Stroop test. The FES-I, self-reported fall risks and SPPB were used to analyze influence factors on gait on a Zebris treadmill (FDM-T) with F-tests (SPSS 22).

ST and DT walking analyzing MFR led to different Peak Forces (PF) of the forefoot ($F=4.92$; $p= .028$). BD influenced the gait-line (left: $F=3.81$; $p=0.05$; right: $F=5.44$; $p=0.012$) and accompanying PF from ST to DT. Additionally, they increased step width ($F=6.25$; $p=0.013$), decreased step length and PF for the forefoot. FOF increased step width ($F=5.27$; $p=0.023$), reduced step length (left: $F=21.80$; $p< .001$; right: $F=22.23$; $p< .001$) reduced gait-line (left: $F=14.18$; $p<0.001$; right: $F=15.83$; $p<0.001$) and decreased PF in the midfoot and heel. Differences from ST to DT were found for step width and step length.

Overall, FOF and balance declines led to reduced walking quality under ST and DT conditions. However, one has to assume that the DT effect might be independent from the evaluated factors since there was no interaction effect.

The data indicates that FOF might have the most impact on gait performance whereas self-reported fall risks do not. It has to be discussed whether self-reported functional declines is accurate in determining an individual's falls risk. Future studies should further investigate on the use of the SPPB and the FES-I as tools to identify reduced stability in ST and DT walking.

Keywords: Fear of falling; Multiple fall risks; Gait kinematics; Dual task walking

Abbreviations

ANOVA: Analysis Of Variance; DT: Dual-Task; DTC: Dual Task Costs; FES-I: Falls Efficacy Scale-International; FDM-T: Force Distribution Measurement System from Zebris; PF: Peak Forces; ST: Single-Task; SPPB: Short Physical Performance Battery

Introduction

Due to demographic changes, the question of how to stay healthy, mobile and independent into old age, is becoming more and more important not only for the individual, but also for the wider community.

The ability to walk safely is one of the key aspects of mobility and independence in old age, because it allows social participation and prevents falls [1-4]. Therefore, it is of great interest to identify factors that influence gait patterns and that may be modified with appropriate training programs [5,6].

Several studies have already shown that postural control, which means the ability to control the center of pressure over the base of support, is of great importance for gait stability [7,8]. Postural control consists of two main functions: first, there is *balance coordination* which refers to the interactions of the motor cognitive system to maintain postural control. Second, there is balance recovery which refers to the ability to (re)gain postural stability following external disturbances [9,10].

Beside the postural control, other biomechanical or kinematical aspects have shown to be important in maintaining gait stability. For example, active rolling movements of the foot and ankle joint as well as stabilization of the pelvis from heel strike to mid-stance are necessary to maintain balance while moving forward [7]. Therefore, the peak reaction forces, gait-line, step length and step width have proved to be important characteristics of gait stability. Furthermore, a review by Hamacher et al. [11], has shown that the variability of stride, swing and stance time is an indicator of gait stability and can be used to discriminate between fallers and non-fallers [11].

Other aspects influencing gait are the surrounding conditions. Mostly, gait is not performed as a single-task, but more often is part of a dual- or multitask performance in which walking is combined with other cognitive or motor tasks [12]. These dual-task conditions lead to so called dual task costs (DTCs), which means that the performance in one or both tasks decreases in comparison to a single-task-condition due to higher cognitive demands. And these DTCs are

Citation: Wollesen B, Köhler B and Mattes K. Influence of Fear of Falling and Multiple Falls Risks on Gait Performance under Single and Dual-Task Conditions. Gerontol Geriatr Res. 2016; 2(4): 1021.

even higher in old age [13-15].

While some of the changes of walking kinematics in dual-task situations might be a positive strategy in order to maintain a stable gait pattern (e.g. reduced gait speed), others are more negative and may increase the risk of falling [10]. In several studies, a higher gait variability (e.g. variability of step length and velocity), a lower step length and reduced rolling movements with additional shift of plantar pressure were observed in dual-task situations for older adults and are seen as indicators of a higher falls risk [13,15,16].

Beside these biomechanical and dual-task aspects, several pre-existing illnesses or fall risks may influence gait patterns [2,17], have shown that seniors with pre-disability have a slower gait velocity and shorter stride length in different walking conditions [17]. A cross-sectional study by Montero-Odasso et al. [18] has also proven that several quantitative gait parameters beyond velocity (e.g. stride time variability) are associated with the functional status of elderly people assessed via frailty-indexes [18-21].

Another important intrinsic aspect influencing gait is the anxiety or fear of falling of the elderly. Several studies have already shown, that fear of falling is related to activity restrictions, often followed by a decrease in physical capacity and an increase in the risk for future falls [22,23]. Observing gait performance, people with a fear of falling show a slower gait speed compared to those with no such fear [24,25].

As in the dual-task related gait changes, some studies indicate that the anxiety-related gait changes (e.g. the slower gait velocity) may be beneficial in order to reduce the risk of falling and do not necessarily represent a decreased balance capacity. For example, Brown and colleagues showed that people with fear of falling used a more conservative gait pattern in order to avoid obstacles on a walkway [24]. However, the slower gait velocity may also be an indicator of a fearful gait pattern, which may lead to a decline in walking and other activities of daily living [26].

In conclusion, it seems clear that there are many factors that influence gait or are somehow related to gait. To the best of our knowledge, there is no study that has examined the influence of fear of falling, reduced balance performance and multiple falls risks as a result of physical declines on single and dual-task gait variables like gait-line and peak pressure, which are important factors of gait stability. Moreover, previous studies did not distinguish between the influence of fear of falling and multiple fall risks on the performance on ST and DT walking conditions.

The aim of this study therefore is to evaluate if and how fear of falling, reduced balance performance and multiple fall risks influence gait kinematics and gait stability under single-Task (ST) and Dual-Task (DT) conditions. We hypothesize that the higher the fear of falling and the more fall risks are existent, the higher the decline on gait performance from single to DT condition.

Methods

Participants

Two hundred twenty-three participants between 65 and 79 years of age (Table 1) participated in the study. They were recruited via advertisements in popular newspapers. The inclusion criteria were: independent-living, age above 65 years, and sufficient mobility to join the experimental sessions. Exclusion criteria were: acute or chronic diseases with a documented influence on balance control (e.g. Parkinson's disease; diabetes) or cognition; use of gait assistance (e.g. walking frames, rolling walkers). All participants were German native speakers.

Table 1: Sample (*N* = 223).

Gender	Age [years]	Body height [cm]	Body mass [kg]	Comfortable Walking speed [km/h]	SPPB
male (n = 63)	73.0 ± 5.6	177.8 ± 6.7	84.6 ± 10.2	3.2 ± 0.7	10.7 ± 1.5
female (n = 160)	72.1 ± 5.3	164.2 ± 6.6	68.0 ± 11.2	2.8 ± 0.9	10.8 ± 1.5

Test design and procedure

The test procedure included a comparison of three different test conditions: (a) ST cognitive performance: visual-verbal Stroop test while sitting; (b) ST motor performance: walking and (c). DT walking: walking in combination with the Stroop test).

Tests and measurements

Questionnaires

Two standardized questionnaires were used to examine the fear of falling and the fall risks.

16 Item Falls Efficacy Scale-International (German version): The Falls Efficacy Scale-International (FES-I) is an instrument used to measure fear of falling. It is based on the operational definition of this fear as "low perceived self-efficacy at avoiding falls during essential, non-hazardous activities of daily living [27-29].

Fall Risks Self-Assessment Questionnaire: This questionnaire includes 20 questions concerning the common major fall risks (e.g. balance loss, reduced muscle power, mobility and incontinence). Participants answer the question with yes or no. It was conducted by Elliot et al.

with a test-retest-reliability of r= .91.

Balance SPPB

The short physical performance battery [30], was used to assess lower extremity abilities.

Walking performance under single and dual task conditions

All gait performance measurements were examined barefoot.

Gait task: Gait parameters, such as step length, step width, and gait-line (length of the rolling movements of the foot), as well as the vertical maximum impact (maximum forces of heel, midfoot and forefoot) were measured as main outcome parameters. Force data were collected for both feet at 100Hz. For gait performance, the measurements included a 30 second (s) walking test at a self-selected speed on an h/p/cosmos treadmill (Zebris; Isny, Germany: FDM-T). Participants practiced treadmill walking for at least five minutes before the test session in order to get familiarized with the task. The participants walked at a self-selected comfortable walking speed. This comfortable walking speed was fixed and used to perform the two 30s testing trials.

Cognitive task: A visual-verbal Stroop test was performed.

Table 2: Descriptive statistics of gait variables under ST and DT conditions with multiple fall risks (Elliot-Questionnaire).

Gait variables		Single-Task		Dual-Task		Comparison of ST and DT			Comparison of multiple falls risks			Fall risk x task condition (ST vs DT)		
		Fall risks ≤4	Fall risks ≥5	Fall risks ≤4	Fall risks ≥5	**F**	**p**	$_p\eta^2$	**F**	**P**	$_p\eta^2$	**F**	**p**	$_p\eta^2$
step width [cm]		12.7 ± 3.2	11.8 ± 3.5	12 ± 3.4	11.6 ± 3.8	3.645	.059	.030	.854	.357	.007	1.051	.307	.009
step length [cm]	left	42.3 ± 11	41.9 ± 13.2	42.9 ± 12.2	41.7 ± 13	.299	.585	.003	.097	.755	.001	.775	.380	.007
	right	42.1 ± 11	42.4 ± 13.4	42.9 ± 12.2	41.8 ± 13	.016	.898	.000	.032	.858	.000	1.783	.184	.015
gait-line [mm]	left	192.2 ± 46.6	197.4 ± 44.9	201.8 ± 37.2	197.9 ± 43.7	2.922	.090	.025	.006	.939	.000	2.346	.128	.020
	right	191.6 ± 47.6	197.5 ± 45.9	200.9 ± 39.5	199.4 ± 43.1	3.478	.065	.029	.068	.795	.001	1.522	.220	.013
peak force forefoot [N]	left	28.2 ± 8.8	27.1 ± 8.5	27.1 ± 8.8	26.3 ± 7.8	2.262	.135	.019	.380	.539	.003	.048	.826	.000
	right	29.3 ± 9.4	27.6 ± 9	27.4 ± 9.4	26.5 ± 7.9	4.923	.028	.041	.640	.425	.005	.400	.528	.003
peak force midfoot [N]	left	16.6 ± 4.7	17.2 ± 5.2	17.5 ± 5.4	17.2 ± 4.8	.922	.339	.008	.032	.857	.000	.740	.391	.006
	right	16.4 ± 5.1	16.4 ± 4.4	16.8 ± 4	17.1 ± 4.5	1.611	.207	.014	.045	.833	.000	.147	.702	.001
peak force heel[N]	left	19.5 ± 7.7	19.5 ± 8.5	20.3 ± 8.1	20.9 ± 8.6	3.114	.080	.026	.037	.847	.000	.275	.601	.002
	right	21.8 ± 7.2	20.2 ± 8.3	21.2 ± 8	20.6 ± 8.2	.113	.737	.001	.514	.475	.004	1.590	.210	.014

Table 3: Descriptive statistics of gait variables under ST and DT conditions with balance decline (SPPB).

Gait variables		Single-Task		Dual-Task		Comparison of ST and DT			Comparison of balance decline			Balance factor x task condition (ST vs DT)		
		SPPB=12	SPPB<12	SPPB=12	SPPB<12	**F**	**p**	$_p\eta^2$	**F**	**P**	$_p\eta^2$	**F**	**p**	$_p\eta^2$
step width [cm]		11.5 ± 3.4	12.9 ± 3.7	11.2 ± 3.5	12.5 ± 4	2.555	.112	.014	6.254	.013	0.35	.056	.814	.000
step length [cm]	left	44.4 ± 11.4	39.6 ± 13	43.9 ± 11.2	40.9 ± 14	.787	.376	.005	4.320	.039	.024	3.840	.052	.022
	right	44.8 ± 11.5	39.5 ± 13.3	45 ± 11.3	40.8 ± 14.0	4.921	0.28	0.28	5.862	.016	.033	3.088	.081	.017
gait-line [mm]	left	198.4 ± 46.4	194.3 ± 52.7	199.8 ± 40.2	202.4 ± 55.3	3.811	.053	.021	.010	.919	.000	.1917	.168	.011
	right	199 ± 44.8	194.7 ± 54.6	202.7 ± 38	203.5 ± 52.3	5.442	.021	.030	.060	.806	.000	.870	.352	.005
peak force forefoot [N]	left	28.4 ± 8.8	25.6 ± 7.7	27.8 ± 8.6	24 ± 7.2	6.462	.012	.036	8.102	.005	.044	1.621	.205	.009
	right	28.9 ± 9.1	26.5 ± 8.9	27.7 ± 8.2	24.9 ± 8.6	10.221	.002	.055	4.185	.042	.023	.184	.668	.001
peak force midfoot [N]	left	16.7 ± 4.8	16.5 ± 5.3	17.1 ± 4.6	16.8 ± 5.3	1.194	.276	.007	.114	.736	.001	.078	.780	.000
	right	16.2 ± 4.8	16 ± 4.7	16.9 ± 4.2	16.7 ± 4.7	5.144	.025	.029	.127	.722	.001	.002	.962	.000
peak force heel[N]	left	20.3 ± 7.5	18.1 ± 7.8	21.1 ± 8	19.2 ± 7.9	4.914	.028	.027	3.364	.068	.019	.083	.773	.000
	right	21.2 ± 7.4	18.9 ± 7.7	21 ± 8.2	19.1 ± 7.7	.009	.924	.000	3.263	.073	.018	.647	.422	.004

Participants were presented sixteen events of incongruent and congruent color words each within a 30s trial per condition (familiarization, ST, standing, walking).

Data Analysis

All statistics were evaluated using SPSS 22 (IBM statistics Armonk, NY). In order to analyze differences between the task conditions (single-task vs. dual-task) analysis of variance (one-way ANOVA) were computed. To analyze the influence of fear of falling and fall risks on walking performance under ST and DT conditions, we performed ANOVAs with ST and DT performance as repeated measurement factor for each variable we assessed to describe walking performance (i.e. sway length, sway velocity, step width, step length; gait-line; peak forces of forefoot, midfoot and heel x FES-I or number of fall risks). In addition, the ANOVA analysis was controlled for age. Significance level was set as $\alpha = 0.05$; normal distribution was tested using the Kolmogorov-Smirnov test. Effect sizes are given as partial eta squares (ηp^2). Bonferroni correction was applied to post-hoc comparisons.

Ethical Considerations

The study was part of an intervention study approved by the ethics committee of the Hamburg Chamber of Physicians (registration number PV4376). All participants were informed about the study goals and signed informed consent according to the Declaration of Helsinki.

Results

Walking performance in comparison with multiple falls risks

Walking performance under ST and DT conditions (Table 2) in comparison to the self-reported fall risks only showed a significant difference for the peak force of the forefoot.

Walking performance in comparison with balance decline

Balance declines showed an influence on the gait-line and accompanying peak forces (cf. Table 3) from single to DT conditions. While the gait-line increases from single to DT conditions, there was a shift in between the peak forces with reduced peak forces of the heel

Table 4: Descriptive statistics of gait variables under ST and DT conditions with fear of falling (FES-I).

Gait variables		Single-Task		Dual-Task		Factor 1			Fear of falling vs no fear of falling			Fear factor x task condition (ST vs DT)		
		FES-I =16	FES-I>16	FES-I=16	FES-I>16	**F**	**p**	$_p\eta^2$	**F**	**P**	$_p\eta^2$	**F**	**p**	$_p\eta^2$
step width [cm]		11 ± 3.4	12.5 ± 3.7	10.3 ± 3.3	12.2 ± 3.9	4.053	.046	.023	5.267	.023	.030	1.019	.314	.023
step length [cm]	left	51.1 ± 8.5	40 ± 12.4	52.2 ± 7.5	40.6 ± 12.9	1.753	.187	.010	21.801	.000	.114	.151	.698	.001
	right	51.7 ± 8.9	40 ± 12.6	52.9 ± 8,1	40.9 ± 12.9	5.406	.021	.031	22.230	.000	.116	.136	.713	.001
gait-line [mm]	left	228.1 ± 33.1	190.6 ± 50.6	230.6 ± 30.3	196.7 ± 50,1	1.621	.205	.009	14.180	.000	.077	.298	.586	.002
	right	230.9 ± 32.8	190.6 ± 51.1	231.5 ± 33.2	198.7 ± 47,5	1.409	.237	.008	15.828	.000	.085	1.052	.306	.006
peak force forefoot [N]	left	27.5 ± 8.4	26.5 ± 8.3	26.6 ± 7.2	25.4 ± 8.1	2.765	.098	.013	.491	.485	.003	.019	.892	.000
	right	28.8 ± 9.2	27.2 ± 9	28 ± 9.1	25.8 ± 8.5	3.446	.065	.020	1.189	.277	.007	.238	.626	.001
peak force midfoot [N]	left	17.5 ± 5.1	16.5 ± 5.1	17.2 ± 4.1	17 ± 5.2	.037	.848	.000	.406	.525	.002	.706	.402	.004
	right	18.1 ± 5	15.7 ± 4.5	18.1 ± 4.2	16.7 ± 4.5	.989	.322	.006	5.098	.025	.029	1.252	.265	.007
peak force heel[N]	left	21.9 ± 8.4	18.6 ± 7.4	22.3 ± 8.1	19.5 ± 8	1.478	.226	.009	4.013	.047	0.23	.230	.632	.001
	right	23.8 ± 7.6	19.3 ± 7.3	23.6 ± 7.8	19.3 ± 7.8	.110	.741	.001	8.081	.005	.045	.039	.843	.000

and the forefoot and increased peak forces of the midfoot. Moreover, participants with balance decline had an increased step width and decreased step length as well as decreased peak forces for the forefoot (Table 3).

Walking performance in comparison with fear of falling under ST and DT conditions

Fear of falling led to increased step width, reduced step length, reduced gait-line, as well as reduced peak forces in the midfoot and heel. Moreover, differences of ST and DT performance were found in step width and step length (Table 4).

When the data on walking performance was analyzed with age as a covariate, there was a main age effect on step length of the left and right foot ($p < .05$). Moreover the peak forces showed in between subject effects ($p < .01$). Participants with less than twelve points in the SPPB were an average of two years older than the people with a SPPB score of twelve. This difference was not observed for the FES-I.

Discussion

The study aim was to analyze if and how fear of falling, reduced balance performance and multiple fall risks influence gait kinematics and gait stability under single (ST) and dual-task (DT) conditions. Moreover we were interested in identifying gait variables that are most modifiable in order to develop future training programs for gait stability and fall prevention.

The results confirmed previous research findings on functional decline on balance and walking performance. However, regarding the three different conditions, the self-reported fall risks did not show relevant effects. This might be explained with the idea that an individual's feeling of balance decline, reduced muscle power or reduced fitness level is subjective and relative and not necessarily based on a real reduction in fitness levels.

In contrast, the balance declines showed decrements in the walking parameters for the elderly with lower scores on the SPPB. These decrements are reduced step width, decreased step length and decreased peak forces of the forefoot. One might argue that these changes in walking performance are compensatory strategies to maintain walking stability. On the other hand, Perera et al. found that differences of .27 to .55 on the SPPB are clinically relevant and might be a predictor for increased fall risks. In addition, Vasunilashorn et al. [31], revealed that a score less than 10 points of the SPPB is a predictor of reduced walking ability.

Comparable results were found for the FES-I. Older subjects with a high score of fear of falling showed the most changes in the analyzed walking parameters. Our findings are in line with Maki, who reported that reduced stride length and poorer clinical gait scores were also associated with fear of falling and Delbare et al. [32], who also observed shorter steps, decreased cadence and reduced walking speed. In addition, the increased stride width was associated with falling and fear of falling (Maki, 1997).

Moreover, we found changes in walking parameters from single to dual-task conditions as expected. Walking stability was affected by the dual-task condition. The gait-line declines with a shift of peak forces from the forefoot to the midfoot. These results are in line with previous findings of our research group [10]. Further, this study reveals that balance decline (observed with a screening test like the SPPB) and fear of falling showed more impact on ST and DT walking than self-reported fall risks, even if the older persons reported more than five physical decrements (e.g. reduced muscle strength, and fitness level, balance declines, vertigo) which might be predictors of an increased fall risk [33,34]. Therefore, we conclude that a self-report of functional decline does not have an impact on the objective data collected in gait analysis. In contrast, the FES-I and the SPPB are suitable to identify differences in walking stability. The older people with balance decline in the SPPB coupled with fear of falling showed a reduced walking stability even under ST conditions.

Interestingly, there were no differences in the decreases of walking stability from ST to DT walking performance. All older adults, regardless of the scores in the SPPB and the FES-I [35], showed decrements in gait performance which can be described as dual-task costs (DTC). Despite better scoring on either the SPPB or less fear of falling, this was not linked to walking stability during DT performance. This might lead to the conclusion, that according to Holman et al. the destabilizing effect of dual-task walking increases the falls risk. This finding is amplified in people with balance declines and fear of falling compared to seniors with better scores in the SPPB and FES-I.

Overall, our original hypothesis that more fall risks and a higher fear of falling would lead to the most decrements on gait performance from single to dual-task conditions has to be rejected. The fear of falling was more prominent than expected, whereas multiple self-reported fall risks were not. Moreover, decrements in DT gait performance cannot be explained by fear of falling, balance declines or multiple fall risks. More research is needed to identify the underlying mechanisms of DTC during gait of older adults. The cognitive performance should also be assessed.

This is one limitation of this study. We did not examine cognitive DTC or control for the influence of fear of falling on cognitive DT performance. Following Yogev-Seligmann at al. [36], older adults are able to prioritize gait over cognition if they have good hazard estimation. This might result in a reduced cognitive performance under DT conditions. Moreover, Schäfer & Schumacher [37] confirmed that fallers in comparison to non-fallers are not able to prioritize gait performance. Therefore, future studies should focus on this aspect as well.

Additionally, the results of this study confirm the requirement of special interventions to target the fear of falling. Fear or concerns of falling are associated with a reduction of daily movements that can result in sedentary behavior and immobility. This again raises the risk of falling due to further functional decline. Moreover, the self-reported fall risks might amplify fear of falling in individuals. Therefore, these elderly people should participate in falls prevention programs before their fear of falling leads to a reduction in their activity levels. One solution might be fall prevention training that teaches strategies for balance control in DT or even multi-task settings. The older people can learn to manage challenging balance situations or destabilizing walking conditions with strategies to prioritize the motor task (e.g. focus on foot rolling movements when they are confronted with obstacles or how to control the center of movement over the base of support when they are afraid of falling). This might help to overcome fear of falling even in challenging balance situations like DT walking.

Conclusion

The additional benefit of this study results out of the fact, that the SPPB and the FES-I are suitable in identifying a reduced walking stability, whereas self-reported fall risks are not. The reduced scores of the FES-I had the most impact on the observed walking parameters. Fall prevention or gait performance studies should incorporate strategies to reduce fear of falling and establish whether walking performance or walking stability is improved as a result. Moreover, the influence of fear of falling on DT cognitive performance should be analyzed.

In addition, it might be interesting to identify the gait variables that are most modifiable in order to develop future training programs for gait stability and falls prevention.

References

1. Amadori K, Püllen R, Steiner T. Gangstörungen im Alter. [Gait disorders in the elderly] Der Nervenarzt. 2014; 85: 310-317.
2. Müngersdorf M, Reichmann H. Gangstörungen [Gaitdisorders]. Der Internist. 1999; 40: 83-93.
3. Stolze H, Vieregge P, Deuschl G. Gangstörungen in der Neurologie. [Gait disorders in Neurology] Der Nervenarzt. 2008; 79: 485-499.
4. Scholtz J. Modulation des menschlichen Ganges bei gesunden Kontrollen und Morbus Parkinson [dissertation]. Ludwig-Maximilians-UniversitätMünchen. 2013.
5. Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JCT. Effective Exercise for the Prevention of Falls: A Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. 2008; 56: 2234-2243.
6. Skelton DA, Todd CJ. Thoughts on effective falls prevention intervention on a population basis.Journal of Public Health. 2005; 13: 196-202.
7. Perry J. Ganganalyse: Norm und Pathologie des Gehens. 1th edn.München: Urban & Fisher. 2003.
8. Shumway-Cook A, Woollacott MH. Motor control: translating research into clinical practice. 3th edn. Philadelphia: Lippincott Williams & Wilkins. 2007.
9. Fraizer EV, Mitra S. Methodological and interpretive issues in posture-cognition dual-tasking in upright stance.Gait & Posture. 2008; 27: 271-279.
10. Wollesen B, Voelcker-Rehage C, Willer J, Zech A, Mattes K. Feasibility study of dual-task-managing training to improve gait performance of older adults. Aging Clinical and Experimental Research. 2015; 27: 447-455.
11. Hamacher D, Singh NB, Van Dieen JH, Heller MO, Taylor WR Kinematic measures for assessing gait stability in elderly individuals: a systematic review. Journal of the Royal Society Interface. 2011; 8: 1682-1698.
12. Faulkner KA, Redfern MS, Cauley JA, Landsittel DP, Studenski SA, Rosano C, et al. Multitasking: Association between poorer performance and a history of recurrent falls. Journal of the American Geriatrics Society. 2007; 55: 570-576.
13. Al-Yahya E, Dawes H, Smith L, Dennis A, Howells K, Cockburn J. Cognitive motor interference while walking: A systematic review and meta-analysis. Neuroscience and Biobehavioral Reviews. 2011; 35: 715-728.
14. Beurskens R, Bock. Age-related deficits of dual-task walking: a review. Neural Plasticity. 2012.
15. Woollacott M, Shumway-Cook A. Attention and the control of posture and gait: A review of an emerging area of research. Gait and Posture. 2002; 16: 1-14.
16. Springer S, Giladi N, Peretz C, Yogev G, Simon ES, Hausdorff JM. Dual-tasking effects on gait variability: The role of aging, falls, and executive function. Movement Disorders. 2006; 21: 950-957.
17. Verghese J, Xue X. Predisability and gait patterns in older adults.Gait and Posture. 2011; 33: 98-101.
18. Montero-Odasso M, Muir SW, Hall M, Doherty TJ, Kloseck M, Beauchet O. et al. Gait Variability Is Associated With Frailty in Community-dwelling Older Adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2011; 66: 568-576.
19. Kalff R, Ewald C, Waschke A, Gobisch L, Hopf C. Degenerative lumbar spinal stenosis in older people: current treatment options. Deutsches Ärzteblatt International. 2013; 110: 613-623.
20. Jahn K, Zwergal A, Schniepp R. Gait disturbances in old age: classification, diagnosis, and treatment from a neurological perspective. Deutsches Ärzteblatt International. 2010; 107: 306-315.
21. Fiser WM, Hays NP, Rogers SC, Kajkenova O, Williams AE, Evans CM et al. Energetics of walking in elderly people: factors related to gait speed. The Journals of Gerontology.Series A, Biological Sciences and Medical Sciences. 2010; 65: 1332-1337.
22. Yardley L, Smith H. A prospective study of the relationship between feared consequences of falling and avoidance of activity in community-living older people.The Gerontologist. 2002; 42: 17-23.
23. Zijlstra GAR, Van Haastregt JCM, Van Rossum E, Van Eijk JTM, Yardley L,

Kempen GIJM. Interventions to Reduce Fear of Falling in Community-Living Older People: A Systematic Review. Journal of the American Geriatrics Society. 2007; 55: 603-615.

24. Reelick MF, van Iersel MB, Kessels RPC, OldeRikkert MGM. The influence of fear of falling on gait and balance in older people. Age and Ageing. 2009; 38: 435-440.

25. Busch T de A, Duarte YA, PiresNunes D, Lebrão ML, Satya Naslavsky M, dos Santos Rodrigues A, et al. Factors associated with lower gait speed among the elderly living in a developing country: a cross-sectional population-based study. BMC Geriatrics. 2015; 15: 35.

26. Anders J, Dapp U, Laub S, Wolfgang Von Renteln-Kruse AH. Einfluss von Sturzgefährdung und Sturzangst auf die Mobilität selbstständig lebender, älterer Menschen am Übergang zur Gebrechlichkeit Screeningergebnisse zur kommunalen Sturzprävention [Influence of fall riskandfear of falling on themobility of independentlyliving, olderpeople at thetransitiontothefrailty of screeningresultstothelocal falls prevention]. Z GerontolGeriat. 2007; 4: 255-267.

27. Tinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. Journal of gerontology. 1990; 45: 239-243.

28. Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). Age and ageing. 2005; 34: 614-619.

29. Delbaere K, Close JC, Mikolaizak AS, Sachdev PS, Brodaty H, Lord SR. The falls efficacy scale international (FES-I). A comprehensive longitudinal validation study. Age and ageing. 2010; 39: 210-216.

30. Guralnik JM, Simonsick EM, Ferrucci L , Glynn RJ, Berkman LF, Blazer DG et al. A short physical performance battery assessing lower extremity function: Association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994; 49: 85-94.

31. Vasunilashorn S, Coppin AK, Patel KV, Lauretani F, Ferrucci L, Bandinelli S, et al. Use of the Short Physical Performance Battery Score to predict loss of ability to walk 400 meters: analysis from the InCHIANTI study. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2009.

32. Delbaere K, Sturnieks DL, Crombez G, Lord SR. Concern about falls elicits changes in gait parameters in conditions of postural threat in older people. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences. 2009: 1-6.

33. Perera S, Mody SH, Woodman RC, Studenski SA. Meaningful change and responsiveness in common Fperformance measures in older adults. Journal of the American Geriatrics Society. 2006; 54: 743-749.

34. Rubenstein LZ. Falls in older people: epidemiology, risk factors and strategies for prevention. Age and ageing. 2006; 35: 37-41.

35. Kempen GI, Yardley L, Van Haastregt JC, Zijlstra GR, Beyer N, Hauer K, et al. The Short FES-I: a shortened version of the falls efficacy scale-international to assess fear of falling. Age and ageing. 2008; 37: 45-50.

36. Yogev-Seligmann G, Hausdorff JM, Giladi N. Do we always prioritize balance when walking? Towards an integrated model of task prioritization. MovDisord. 2012; 27: 765-770.

37. Schäfer S, Schumacher V. The interplay between cognitive and motor functioning in healthy older adults: findings from dualtask studies and suggestions for intervention. Gerontology. 2011; 57: 239-246.

Gerontol Geriatr Res - Volume 2 Issue 4 - 2016
Submit your Manuscript | www.austinpublishinggroup.com

Citation: Wollesen B, Köhler B and Mattes K. Influence of Fear of Falling and Multiple Falls Risks on Gait Performance under Single and Dual-Task Conditions. Gerontol Geriatr Res. 2016; 2(4): 1021.