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ORIGINAL ARTICLE

Physical functioning and fall-related efficacy among community-dwelling elderly people

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ABSTRACT

Objective: The aim of this study was to assess the association between physical functioning and fall-related efficacy among community-dwelling elderly people.

Method: Participants ($n = 176$) were 60 years old and older. Data were collected using physical functioning tests: hand grip strength, Timed Up and Go (TUG), Short Physical Performance Battery (SPPB), Falls Efficacy Scale – International (FES-I) and History of Falling Checklist (HoFC). Statistical analyses were used to determine group differences with respect to age, gender and fall history, as well as the correlation between the total scores of the FES-I and hand grip strength, TUG and SPPB.

Results. Values of physical functioning measures were significantly higher in non-fallers than in fallers ($p < 0.05$). The FES-I total scores were positively correlated with TUG ($r_s = 0.615$) and negatively correlated with hand grip strength ($r_s = -0.522$) and SPPB scores ($r_s = -0.727$). There were significant differences in the FES-I scores according to TUG and SPPB cut-off values ($p < 0.001$).

Conclusion: Higher physical functioning values were associated with a lower incidence of falling and a lower level of fear of falling. Maintaining and improving physical functioning should be considered as an important factor that may influence fall-related efficacy and risk of falling among elderly people.

KEYWORDS

Falling, functional performance, hand grip strength, Short Physical Performance Battery

HISTORY

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Introduction

Falls in elderly people are common and often contribute to the higher rate of morbidity and mortality in elderly people above 65 years old (1–3). Worldwide, 35–40% of people aged 65 and over fall each year (4,5). Falls and their related injuries form a major health problem (4) and result in a considerable cause of activity restriction, reduced quality of life (6–10), disability and loss of independence among elderly people (5,11,12). In addition, health-care costs associated with falls among elderly people are significantly increasing all over the world (4). According to the World Health Organization (WHO) report on fall prevention, if preventive measures are not taken in the immediate future, the number of injuries caused by falls in elderly people is projected to be 100% higher by 2030 (4,13). Consequently, as the number of elderly people increases worldwide, fall prevention and fall-related factors need to be addressed (4).

The consequences of a fall in an elderly person may lead to more serious health problems owing to their greater susceptibility to injuries and to the fear of falling again (14). Fear of falling is identified as a common fear among community-dwelling older people (15). The concept of fear of falling is operationalized by different theoretical constructs: balance-related self-efficacy and falls self-efficacy (16). Self-efficacy measures are grounded in social cognitive theory (17), which defines self-efficacy as the individual's perceptions of his or her capabilities within a particular domain of activities. *Falls self-efficacy* has been defined as "perceived self-confidence at avoiding falls during essential, non-hazardous activities" (18). *Balance-related self-efficacy* addresses a person's confidence in maintaining balance and has been defined as "individual's degree of belief in one's ability to avoid a loss of balance during activities of daily living" (19). The relationship between fear of falling and falls among community-dwelling elderly people is conceptualized by a novel multicomponent model of fear of falling (20) as: "fear of falling originates from an individual's appraisal of his or her own abilities to maintain balance in combination with other

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contributors''. The model proposes that falls efficacy is a mediator in the relationship between fear of falling and falls (20).

Level of physical functioning seems to be associated with fall incidence and fall-related efficacy (5,8), and the incidence of falls may significantly increase in elderly people with a lower physical functioning (5,9,21). Fear of falling has been associated with reduced leaning balance (10) and impaired gait (22) in community-dwelling elderly people. Evidence suggests that balance and gait problems are major predictors of falling among elderly people (23–25). Muscular weakness of the lower extremities, such as impaired sit-to-stand performance, can effectively predict injurious falls (5,26). The sit-to-stand test has been described as a good discriminant test between fallers and non-fallers (27). Furthermore, reduced hand grip strength and lower level of mobility have been recorded among elderly people who had fallen one or more times compared to those who had not fallen (28,29). Delbaere et al. found that the best physical predictor of frequent falling among elderly people was a low score on the physical performance, followed by decreased maximal hand grip strength (21).

In some developing countries, fall prevention has not been given sufficient attention (4). In the West Bank (Palestine), where elderly people constitute one of the most vulnerable groups, with high rates of poverty and chronic diseases, the number of elderly people is continuously increasing (30). Prevention and related risk factors of falling need to be addressed. Thus, the aim of this study was to assess the association between physical functioning and fall-related efficacy in community-dwelling elderly people who are 60 years old and older.

Material and methods

Study design

This is a cross-sectional study of physical functioning and fall-related efficacy in community-dwelling elderly people.

Participants

Community-dwelling elderly people were invited to participate in this study. Inclusion criteria consisted of women and men aged 60 years or older, living in the West Bank (Palestine), and who were independent in indoor ambulation with or without walking aids. Exclusion criteria included severe diseases that made investigations impossible or communication deficits (e.g. the prospective participant could not answer questions about their age, their children, current place, time, season and year). In total, we recruited a volunteer sample of 176 participants (115 women and 61 men; mean ± SD age 68.15 ± 6.74 years) from the community and from the public centres for the elderly. The majority of the participants (92%) were fully independent in the basic activities of daily living, and 8% were partially independent according to the Katz index (31).

All participants were informed about the aim of the study and signed an informed consent. The study received ethical approval from the research ethics committee of Al-Quds University/Palestine (ref. no. 1/REC/13), which complies with the Declaration of Helsinki.

Instruments

Background characteristics questionnaire

Demographic clinical descriptive data on age, gender, living status, educational level, job status, smoking habits, medication, diagnosed disease (cardiovascular, musculoskeletal, hypertension and others), sensory functions (visual, hearing and speech) were registered. Participants were asked whether they had received medical treatment or had been hospitalized during the previous year. Anthropometric measurements (weight, height and umbilical circumference) were also recorded.

Measures of physical functioning

Hand grip strength. The participant was tested in the sitting position, shoulder adducted and neutrally rotated with the elbow flexed at 90°. The forearm was placed in a neutral position and the wrist was placed between 0° and 30° dorsiflexion and between 0° and 15° ulnar deviations. The participant was asked to squeeze the handle of the Jamar® Hydraulic Hand Dynamometer apparatus as hard as possible for 5 s and then relax (32). The best value out of three for each hand was registered in kilograms. Hand grip has been described as a valid measure and good marker of physical performance among elderly people (21,33,34) and has very high test–retest reliability (35).

Timed Up and Go (TUG). In the TUG, the person being tested starts in a sitting position on a regular chair. The person stands up without using their arms, walks 3 m, turns around, walks back to the chair and sits down again. The time taken to complete the activity was registered in seconds (36). A cut-off value of 14 s was used (37). The reliability and validity of the TUG test have been established for quantifying functional mobility with older community-dwelling adults (37,38).

Short Physical Performance Battery (SPPB). The SPPB (39) consists of three components of lower body

function tests (balance, gait speed and five times sit-to-stand test). The balance tests include side-by-side stand, semi-tandem stand and tandem stand. Gait speed was tested using a 4 m gait speed: the participant was asked to walk at a self-selected speed for 4 m. This test was repeated twice at the participant's usual pace, and the shorter time of the two tests was recorded in seconds. The third component of SPPB is the five times chair stand test. The participant was instructed to stand up straight as quickly as possible five times without stopping in between, while keeping the arms folded across the chest. The time taken to accomplish the test was registered in seconds. Each SPPB component test (balance, gait and chair stand) was scored from 0 to 4, with a score of 0 indicating not attempted or could not do the test and a score of 4 indicating the highest category of performance. The total score of SPPB ranges from 0 (low performance) to 12 (high performance) (39). Participants with a total score of 10 or less have a higher risk of mobility disability (40). The SPPB has been described as a valid and reliable measure of muscle strength and physical performance in community-dwelling older people and it has been tested for validity and reliability in diverse populations (41,42).

Fall-related measures

History of Falling Checklist (HoFC). The HoFC includes questions such as "Are you afraid of falling?" The questions have four answering alternatives: no, not at all afraid; yes, a little afraid; yes, afraid; or yes, very afraid. In addition, the HoFC asks the following questions: "Did you fall on the floor during the last six months? If yes, how many times have you fallen? "Did you get an injury from falling? Did you have to go to a medical care centre to treat your injury? Did you get a fracture? (7). A fall is defined as "unintentionally coming to rest on the ground or floor" (43). A faller is defined as a participant who has sustained one or more falls during the previous 6 months.

Arabic version of the Falls Efficacy Scale – International [FES-I (Ar)]. The FES-I consists of 16 items that assess concern about falling while performing both easy and more demanding physical and social activities (6,7). The scale was translated and validated into Arabic based on the Prevention of Falls Network Europe (ProFaNE) 10-step translation protocol (6). Fall-related efficacy is rated on a four-point scale for each activity (1 = not at all concerned; 2 = somewhat concerned; 3 = fairly concerned; and 4 = very concerned). The total score ranges from 16 (no concern about falling) to 64 (severe concern about falling) (6). The FES-I has been described as a reliable and valid measure of fear of falling among elderly people in a cross-cultural context (7,44,45).

Statistical analysis

Descriptive statistics were used to characterize the sample. Values of physical functioning and FES-I (Ar) were calculated as mean ± SD and median (min.–max.). Between-group comparisons were performed based on SPPB and TUG cut-off values. An independent sample *t* test was performed on continuous variables; for ordinal variables, the Mann–Whitney *U* test and Kruskal–Wallis test were used to determine differences between the groups according to age (the cut-off value of 68 years was used based on the mean age of the participants), gender, education, use of walking aids, fear of falling and history of falls. Spearman's rank correlation coefficient was used to examine the correlation between the total scores on FES-I (Ar) and TUG, hand grip strength and total SPPB score. Statistical significance was set at $p < 0.05$. Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 20 (SPSS, Chicago, IL, USA).

Results

The mean age of the participants ($n = 176$) was 68.15 ± 6.74 years with a range of 60–91 years. The majority of the participants (86.4%) had a diagnosed disease, including hypertension (48.9%), musculoskeletal diseases (54.0%) and cardiovascular diseases (22.2%). During the previous 6 months, 38% of the participants had sustained one or more falls, and 72% of the fallers recorded being injured as a result of falling (Table I).

All values of physical functioning measures, including hand grip strength, TUG and SPPB, were significantly

Table I. Study population by age category, gender, clinical characteristics and fall history.

Variable	All ($n = 176$)	Women ($n = 115$)	Men ($n = 61$)
Age (mean 68.15 ± 6.74)			
<68 years	97 (55)	66 (57)	31 (51)
≥68 years	79 (45)	49 (43)	30 (49)
Diagnosed disease			
Yes	152 (86)	101(88)	51 (84)
No	24 (14)	14 (12)	10 (16
Cardiovascular	39 (22)	22 (19)	17 (28)
Hypertension	86 (49)	57 (49)	29 (47)
Diabetes	54 (31)	36 (31)	18 (29)
Musculoskeletal	95 (54)	70 (61)	25 (41)
Osteoporosis	30 (17)	28 (24)	2 (3)
Taking medications	145 (82)	95 (83)	50 (82)
Fallen in the last 6 months	67 (38)	48 (72)	19 (28)
Fallers < 68 years	28 (42)	21 (44)	7 (37)
Fallers ≥ 68 years	39 (58)	27 (56)	12 (63)
Been injured as a result of falling	49 (72)	35 (73)	14 (70)

Data are shown as *n* (%).

Table II. Values of physical functioning measures among genders according to age ($n = 176$).

Variable	Women <68 years ($n = 66$)	Women ≥68 years ($n = 49$)	p	Men <68 years ($n = 31$)	Men ≥68 years ($n = 30$)	p
Hand grip (kg)						
Right hand	21.8 ± 5.67	17.0 ± 4.56	<0.001	35.9 ± 10.60	29.6 ± 7.58	0.010
Left hand	20.2 ± 5.11	15.8 ± 4.97	<0.001	34.4 ± 7.64	28.0 ± 7.05	0.003
TUG (s)	10.0 ± 3.20	14.9 ± 8.67	<0.001	10.2 ± 5.17	12.5 ± 7.38	0.16
Total SPPB score	9.7 ± 2.19	7.5 ± 3.05	<0.001	10.4 ± 2.76	8.4 ± 2.82	0.006

Data are shown as mean ± SD.
TUG, Timed Up and Go; SPPB, Short Physical Performance Battery.

Table III. Values of physical functioning among fallers and non-fallers ($n = 176$).

Variable	Fallers ($n = 67$)	Non-fallers ($n = 109$)	p
Right hand grip (kg)	21.7 ± 8.81	25.8 ± 9.77	0.004
Left hand grip (kg)	19.7 ± 8.99	23.4 ± 8.89	0.009
TUG (s)	13.8 ± 8.09	10.6 ± 5.00	0.003
Total SPPB score	8.2 ± 3.26	9.5 ± 2.46	0.002

Data are shown as mean ± SD.
TUG, Timed Up and Go; SPPB, Short Physical Performance Battery.

Table IV. Values of the Falls Efficacy Scale – International (FES-I) scores according to categorical variables ($n = 176$).

Variables	n (%)	FES-I score Mean ± SD	Median (range)	p
Age				
<68 years	97 (55)	32.6 ± 7.20	33 (16–51)	<0.001
≥68 years	79 (45)	37.6 ± 6.59	37 (21–58)	
Gender				
Female	115 (69)	36.6 ± 6.59	36 (23–58)	<0.001
Male	61 (31)	31.5 ± 7.60	32 (16–50)	
Education				
No education	31 (18)	38.8 ± 7.27	39 (26–58)	<0.001
Primary	42 (24)	37.0 ± 6.99	36 (25–52)	
Secondary	60 (34)	33.5 ± 6.42	34 (19–49)	
College	43 (24)	31.9 ± 7.35	33 (16–48)	
Use of walking aids				
No aids	151 (86)	33.6 ± 6.71	34 (16–52)	<0.001
Cane	25 (14)	42.6 ± 6.45	42 (31–58)	
Afraid of falling				
Not at all	18 (10)	24.3 ± 4.57	25 (16–32)	<0.001
A little afraid	58 (33)	30.6 ± 4.42	31 (18–43)	
Afraid	68 (39)	36.9 ± 3.83	37 (27–46)	
Very afraid	32 (18)	44.2 ± 5.35	44 (34–58)	
Falls history				
Yes	67 (38)	37.8 ± 6.92	37 (18–58)	<0.001
No	109 (62)	33.0 ± 7.06	33 (16–52)	

Table V. Comparisons of the Falls Efficacy Scale – International (FES-I) scores according to physical functioning variables ($n = 176$).

Variable	n (%)	FES-I score Mean ± SD	Median (range)	p
TUG (s)				
≥14	36 (21)	42.3 ± 5.64	42 (34–58)	<0.001
<14	140 (79)	33.0 ± 6.51	33 (16–52)	
SPPB score				
≤10	113 (64)	37.9 ± 6.72	38 (18–58)	<0.001
>10	63 (36)	29.5 ± 5.11	30 (16–39)	

TUG, Timed Up and Go; SPPB, Short Physical Performance Battery.

different according to age and gender (Table II). There were also significant differences for the three components of SPPB according to age and gender ($p < 0.05$). Values of physical functioning measures among fallers and non-fallers were significantly different (Table III). Participants who had fallen one or more times during the previous 6 months had lower hand grip strength, took a longer time to complete the TUG and recorded a lower SPPB score.

The total mean scores of FES-I (Ar) were significantly higher in women, in participants 68 years of age or older, in participants who recorded using walking aids and in participants who had a history of falls ($p < 0.001$) (Table IV). There were significant differences in the FES-I (Ar) scores according to TUG and SPPB cut-off values, where participants who took longer than 14 s to complete the TUG and participants who scored less than 10 on SPPB total score recorded significantly higher scores in the FES-I (Ar) ($p < 0.001$) (Table V). The FES-I (Ar) total scores were positively correlated with TUG ($r_s = 0.615$, $p < 0.001$) and negatively correlated with SPPB total score ($r_s = -0.720$, $p < 0.001$) (Table VI).

Discussion

The results indicated that during the previous 6 months 38% of the participants had sustained one or more falls, and 72% of the fallers recorded being injured as a result of falling. These findings show that the magnitude of falls among elderly Palestinians is relatively high. This corresponds with the magnitude of falls worldwide, with approximately 28–35% of people 65 years old and over falling each year, increasing to 32–42% for people over 70 years of age worldwide (4). Higher incidence of falls is associated with higher age (1,3) and women tend to fall more frequently than men (46). These findings are consistent with our findings: the majority of the fallers were 68 years of age or older, and were women.

Our findings revealed that both men and women less than 68 years old recorded better scores on all physical

Table VI. Correlation between the Falls Efficacy Scale – International (FES-I) scores and physical functioning variables ($n = 176$).

Variable	r_s	95% CI	
		Lower	Upper
Right hand grip (kg)	−0.522	−0.698	−0.454
Left hand grip (kg)	−0.494	−0.677	−0.428
TUG (s)	0.615	0.437	0.685
Total score SPPB	−0.727	−0.793	−0.574
Balance score	−0.598	−0.703	−0.460
Gait speed score	−0.646	−0.759	−0.531
Sit-to-stand score	−0.641	−0.730	−0.494

TUG, Timed Up and Go; SPPB, Short Physical Performance Battery; CI, confidence interval.

functioning measures. This finding indicates that with increasing age components of physical functions are influenced by changes occurring in the skeletal muscles, and the decline in strength may lead to functional decline in elderly people (47). Several studies have shown that the level of physical functioning is associated with the incidence of falls in elderly people (22–24) and that lower levels of physical functioning are recorded among fallers (28,29). In the present study, discriminant analysis indicated that measures of physical functioning differentiated between fallers and non-fallers: fallers recorded lower levels of physical functioning compared to non-fallers. In addition, evidence suggests that better physical functioning is associated with higher levels of physical activity and better health-related quality of life in elderly people (48–52).

Fear of falling and self-efficacy affect the incidence of falls in elderly people (53). In the present study, the total mean scores of the FES-I (Ar) were significantly higher in females and in participants over 68 years of age, indicating that fall efficacy was influenced by demographic factors such as gender and advancing age (6,7). In addition, the total mean score of the FES-I (Ar) was higher among the participants who reported one fall or more in the previous 6 months. Thus, these results might be attributed to the fact that the history of falls influences fall-related efficacy among elderly people (6). A longitudinal validation study of FES-I results indicated that FES-I scores increased over time, with a trend towards higher FES-I scores when a person sustained multiple falls (54).

The FES-I (Ar) total scores were positively correlated with TUG, indicating that limited functional mobility among community-dwelling elderly people was associated with higher scores on the FES-I (Ar). Similar findings were recorded in comparable studies (7,45). TUG was used in this study to measure physical functioning and to identify older people who are at risk for falling (37,38). The positive correlation between the FES-I (Ar) total and TUG, in addition to the significant difference in the scores of FES-I (Ar) between the two groups according to the TUG cut-off (37) value, indicates that subjects with higher recorded FES-I scores may have a higher risk of falling.

As people age, their sensorimotor functions decline, leading to perturbed balance, decreased ability to maintain postural stability and increased vulnerability to falling (25). Balance and gait speed are important measures in comprehensive geriatric assessment (55). The tests of SPPB are balance, gait speed and sit-to-stand performance, and these items are independently associated with falls in elderly people (5,23–25). The reference values of SPPB can give a rapid and valid assessment of the functional state of elderly people (41). In this study, the FES-I (Ar) total scores were negatively correlated with SPPB total score, indicating that subjects who recorded lower scores on SPPB tests had lower functional abilities that may have contributed to a higher risk of falling.

Limitation and strength

This study included more women than men, a possible limitation of the study. This gender imbalance could be attributed to the fact that women have a higher average life expectancy; they outlive men by 4–10 years (56). In addition, women tend to have more contact with the health system, as they are more consistent in requiring medical examinations (56), trends also reflected in the gender distribution in this study.

The applied physical functioning tests in the present study were feasible to administer in home settings, which can be considered as a strength of the study; the tests were appropriate for evaluating the physical performance of the elderly participants with respect to their fall-related efficacy. Therefore, we think that tests of hand grip strength, TUG and SPPB are practical and efficient measures in the field of physiotherapy for testing and studying physical functioning among elderly people.

Conclusion

Levels of physical functioning influence fall-related efficacy among elderly people. Higher physical functioning values were associated with a lower incidence of falling and a lower level of fear of falling. Components of physical functioning are important factors to be assessed and treated in elderly people at risk of falling. Maintenance of physical functioning components should be considered as an important factor that may influence the risk of falling in elderly people.

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Declaration of interest

The authors report no conflicts of interest.

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