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Factors related to gait and balance deficits in older adults

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Purpose: The aim of this study was to investigate the effects of physical, mental, and cognitive disabilities on gait and balance deficits among nursing home residents with different diseases in Jordan and also to find the risk of fall associated with or without these diseases.

Methods: A sample of 221 nursing home residents aged 18–100 years in Jordan was recruited for this study. All participants were assessed using the Arabic versions of the Tinetti assessment battery (TAB) for gait and balance, mini–mental state examination, and disability of arm, shoulder, and hand assessment test.

Results: A total of 221 nursing home residents were included in this study. Different chronic diseases were medically reported in this study. Psychiatric disorders (45.7%) were shown to be the most prevalent disease seen among the participants, followed by hypertension and diabetes mellitus affecting 33.5% and 23.5% of the participants, respectively. However, the least prevalent diseases were stroke (17.2%), joint inflammation (17.2%), and arthritis (9.0%). Based on TAB scores, the participants were classified into three groups: high risk of falls (≤18; n=116), moderate risk of falls (19–23; n=25), and low risk of falls (≥24; n=80). The correlation between physical activity and mental health problems with risks of falls was reported in all participants. The data showed that participants with over 50% upper extremity disability, stroke, heart disease, arthritis, joint diseases, diabetes, and hypertension recorded higher risks of falls as measured by TAB test compared to those with low and moderate TAB scores. Also, impairment in cognitive abilities and psychiatric disorders was shown to be associated with gait and balance problems, with a higher risk of falls in 47.5% and 46.1% of the residents, respectively.

Conclusion: This study revealed a significant impact of upper limb disability, stroke, heart disease, arthritis, joint diseases, diabetes, and hypertension as well as psychiatric disorders and cognitive disabilities on gait and balance deficits among home-resident older adults.

Keywords: risk factors, gait and balance deficits, upper limb disability, arthritis

Introduction

Gait and balance deficits occur frequently among nursing home residents. Fall-related injuries were shown to be responsible for around 1,800 deaths among older adults in most nursing home residents in the US. However, a reduction in the quality of life and permanent disability were dominant among older people who survive falls.[1] Also, other abnormal lifestyle factors such as social isolation, feeling of hopelessness, loss of function, and depression among nursing home residents were shown to be causal effects leading to fear of falls.[2,3] In most nursing home residents in the US, more money was spent on treating fall-related injuries among older adults.[4] So, gait and balance deficits were shown to be the most common causes of falls in older adults,[5–7] with falls usually leading to injury, disability, and poor quality of life.[8,9] Also, many studies reported that most of the changes occurring in gait and balance

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are related to other medical conditions such as diabetes and arthritis.[10,11] Previously it was reported that, the effect on gait and balance status among older people might be related to several parameters, including pain, loss of sensation, loss of reflexes, and diminished strength.[12] These parameters have been proposed, the importance of gait and balance defects on future falls among older adults,[13] especially in nursing home residents for many reasons such as generally frailer, more chronic conditions, take more medication, difficulty in walking, as well as more cognitive problems with difficulty in activities of daily living (ADLs).[5,14–16]

More research and clinical trials have reported the prevention of falls and its related risk factors among older adults. A number of risk assessment tools such as the Tinetti Assessment Battery (TAB) have been reported in literature.[17,18] The TAB tool was considered the most ideal measure to assess the risk of mobility dysfunction in various populations, including in older adults.[19]

In Jordan, older adults comprise approximately 6.3% of total population, most of them are residents of nursing homes.[20] The residents in these nursing homes are provided only general medical services, but there are no facilities for other important services such as mental and allied health as well as rehabilitation services, which are necessary to prevent the occurrence of gait and balance defects among nursing homes residents.[21–24]

Thus, to clarify the importance of the inclusion of rehabilitation services in nursing home residents, this study was performed to evaluate the effects of physical, mental, and cognitive disabilities on gait and balance deficits among nursing home residents with different diseases in Jordan and also to find the risk of fall associated with or without these diseases.

Materials and methods

Participants

A total of 290 residents aged 18–100 years of both sexes were randomly invited from eleven nursing homes at different localities in Jordan to participate in a cross-sectional survey study. Only, subjects able to communicate, understand basic oral instructions, and with no severe cognitive disabilities or significant dementia were selected for this study. A total of 69 residents (23.8%) were excluded from this study, as 33 of them (11.4%) had mental retardation or severe dementia, and 36 of the residents (12.4%) refused to complete this study. Finally, only 221 residents (76.2%) matched the inclusion criteria and agreed to complete this study. Around 30% of all participants were younger than 55 years old, which is relatively younger than the typical age of nursing home residents in western countries. Medical investigations were performed for all participants to evaluate the presence of different "risk" diseases, and the diagnosis was based upon the clinical evaluation sheets with both previous and current data (Table 1). All subjects were informed about the aim of the study, and written informed consent was obtained before data collection (Table 1). The study was approved by Institutional Research Board at King Abdullah University Hospital and the deanship of scientific research at Jordan University of Science and Technology.

Table 1 Sociodemographic, personal characteristics, and frequency distributions of medical conditions of the study sample (N=221)

Variable	N (%)
Age (years)	
<55	69 (31.2)
55–65	69 (31.2)
>65	83 (37.6)
Sex	
Male	121 (54.8)
Female	100 (45.2)
Educational level	
Unable to read/write	90 (40.7)
Primary education (grades 1–6)	46 (20.8)
Secondary education (grades 7–10)	37 (16.7)
High school and above (above grade 10)	48 (21.7)
Smoking	
No	143 (64.7)
Yes	78 (35.3)
Number of medical conditions and diseases	
0–1	87 (39.4)
2	64 (29.0)
≥3	70 (31.7)
Diabetes mellitus (yes)	52 (23.5)
Hypertension (yes)	74 (33.5)
Stroke (yes)	38 (17.2)
Arthritis (yes)	20 (9.0)
Joint disease osteoarthritis, gout, joint effusion (yes)	38 (17.2)
Psychiatric disorders (yes)	102 (46.1)

Assessment of gait and balance

Gait and balance of all participants were assessed using the prevalidated risk assessment tool TAB as previously reported.[25] Also, the test was translated into Arabic and adapted for use in the Arabic-speaking population.[26]

The test was performed in 10–15 minutes, and it measures the ability of subjects to perform specific tasks such as rise up from the chair, stand on one leg with eyes opened and then eyes closed, and walk ten steps. The data obtained were represented by three scores: gait score (12 points), balance score (18 points), and gait and balance total score (28 points). Each score was calculated according to a point ordinal scale with a range of 0 (the most impairment) to

2 (the least impairment). The participants were classified according to total TAB score into three classes: high fall risk (TAB; <19 points), medium fall risk (19–24 points), and low fall risk (25–28 points).[25,26]

Assessment of cognitive abilities

Cognitive performance for all subjects was assessed by the use of a prevalidated standardized Arabic version of the mental assessment tool mini–mental state examination (MMSE), which showed a similar validity and reliability scores when compared with MMSE English version as previously reported in literature.[27] The test comprises 30 assessing points and was performed in a short time (10 minutes). The subjects were classified into the following groups: not impaired (<25; with normal cognition) and impaired (≥25; with abnormal cognition).[28]

Assessment of upper extremity disability and symptoms

The participants of this study were measured for upper extremity disability and symptoms by the use of Arabic-translated and prevalidated disability of arm, shoulder, and hand assessment test (DASH). DASH test shows a consistent reliability coefficient (Cronbach's α=0.96), as mentioned in literature.[29] The DASH test comprises 30 self-reported items, which are scored from 0 (normal) to 100 (severe disability). According to DASH scores, the subjects with higher scores reported a significant upper extremity disability with reduced function.

Statistical analysis

Data were statistically analyzed using the Statistical Package for Social Sciences software version 11.0 (SPSS Inc., Chicago, IL, USA). Frequency distributions, mean values, and standard deviations were calculated. Chi-square test and Mann–Whitney *U*-test were used for comparison between groups. Multivariate logistic and linear regression analyses were performed to estimate the association between both independent and dependent variables. Odds ratios or regression coefficients (*B*) were estimated for all significant variables affecting gait and balance status as previously reported.[30,31] The data were deemed significant at $P \leq 0.05$.

Results

Sociodemographic and health characteristics

A total of 221 home residents of both sexes (males: 54.8%, females: 45.2%) with a mean age of 62.4±13.9 years were included in this study. Of them, only 21.7% showed a higher educational level; however, current smoking habit was reported in 35.3% of the total participants (Table 1).

Also, different chronic diseases were significantly reported from the medical survey of the participants; psychiatric disorders (45.7%) were the most important diseases reported among the participants, followed by hypertension and diabetes mellitus, at 33.5% and 23.5%, respectively (Table 1).

Physical and mental health scores among study sample

Table 2 shows Cronbach's α internal consistency for all measures in the Arabic version of the TAB test. All TAB measures showed an acceptable internal consistency with excellent reliability range (α=0.904–0.967). The results show that the TAB test in its Arabic version had a good reliability to measure gait and balance disorders or risks of fall among the nursing home residents. Based on the TAB measurements, the participants were classified into three groups: high risk of falls (n=116), moderate risk of falls (n=25), and low risk of falls (n=80) (Table 3).

Also, the effects of physical and mental health variables on gait and balance disorders were reported (Table 3). In participants with high risk of falls, approximately 87.5% of the participants showed >50% of upper limb disability as measured by the DASH, followed by stroke (87.1%), heart disease (83.3%), joint diseases (79.5%), diabetes (69.2%), and hypertension (63.5%). However, psychiatric and impairment in cognitive abilities were present in 37.2% and 50.5% of the participants, respectively, in comparison with other home residents with moderate and low risks of falls (Table 3).

High risk of gait and balance deficits group (≤18) compared with low-risk group

Factors associated with the gait and balance deficits and the ratio of probabilities of high risk to the probabilities of low risk are shown in Table 4. Diabetic participants had a 3.6 times higher risk of gait and balance deficits compared to nondiabetic participants. Also, participants with arthritis

Table 2 Cronbach's α coefficients for the Arabic version of TAB

Variable	α coefficient
Balance total score (items 1–9)	0.962
Gait total score (items 10–16)	0.904
Gait and balance total score (items 1–16)	0.967

Abbreviation: TAB, Tinetti Assessment Battery for gait and balance.

Table 3 The correlation between risk of gait and balance deficits with some medical diseases

Medical diseases	Risk of falls (gait and balance total score)			*P*-value (χ^2-test)
	High (≤18) (n=116), N (%)	Moderate (19–23) (n=25), N (%)	Low (≥24) (n=80), N (%)	
Diabetes mellitus				0.024
No (n=169)	80 (47.6)	21 (12.5)	67 (39.9)	
Yes (n=52)	36 (69.2)	4 (7.7)	12 (23.1)	
Hypertension				0.072
No (n=146)	69 (47.3)	18 (12.3)	59 (40.4)	
Yes (n=74)	47 (63.5)	7 (9.5)	20 (27.0)	
Heart failure				0.028
No (n=208)	106 (51.0)	23 (11.1)	79 (38.0)	
Yes (n=13)	11 (83.3)	2 (16.7)	0 (0.0)	
Stroke				0.000
No (n=182)	83 (45.6)	22 (12.1)	77 (42.3)	
Yes (n=39)	34 (87.1)	3 (7.9)	2 (5.3)	
Arthritis				0.010
No (n=200)	100 (50.0)	22 (11.0)	78 (39.0)	
Yes (n=21)	17 (81.0)	3 (15.0)	1 (5.0)	
Joint diseases				0.000
No (n=182)	86 (47.3)	19 (10.4)	77 (42.3)	
Yes (n=39)	31 (79.5)	6 (15.8)	2 (5.3)	
Psychiatric disorder				0.000
No (n=119)	79 (66.4)	15 (12.6)	25 (21.0)	
Yes (n=102)	38 (37.2)	10 (9.9)	54 (53.5)	
MMSE score				0.232
Impaired (<25) (n=105; 47.5%)	53 (50.5)	16 (15.2)	36 (34.3)	
Not impaired (≥25) (n=116; 52.5%)	62 (53.4)	11 (9.5)	43 (37.1)	
DASH score				0.000
<50% (n=141; 63.8%)	47 (33.3)	21 (14.9)	73 (51.8)	
≥50% (n=80; 36.2%)	70 (87.5)	4 (5.0)	6 (7.5)	

Notes: *P*-value >0.05, χ^2-test, *P*-value >0.05.
Abbreviations: MMSE, mini–mental state examination; DASH, disability of arm, shoulder, and hand assessment.

had a 17-time higher risk of gait and balance deficits compared to participants with no arthritis. Furthermore, participants with >50% disabilities in the upper limbs had a 24 times higher risk of gait and balance deficits compared to participants with <50% disabilities in the upper limbs.

Moderate risk of gait and balance deficits group (19–23) compared with low-risk group

Table 4 also illustrates factors associated with moderate risk of fall compared with low risk of fall. Participants complaining of arthritis had an eleven times high risk of gait and balance deficits compared with participants without arthritis.

Discussion

The main aim of this study was to investigate the effect of physical, mental, and cognitive disabilities on gait and balance deficits among nursing home residents in Jordan.

Many of the findings of this study were supported by the literature. However, some factors found in this study were in contrast to findings in the literature. This study revealed that participants' gait and balance deficits were

Table 4 ORs (95% CI) and *P*-values for factors effect on the probabilities of gait and balance deficits

Variables	High (≤18)/low (≥24)		Moderate (19–23)/low (≥24)	
	OR (95% CI for *B*)	*P*-value	OR (95% CI for *B*)	*P*-value
Diabetes mellitus	3.63 (1.54–8.54)	0.003	1.14 (0.33–3.97)	0.840
Arthritis	17.2 (2.05–144.6)	0.009	11.4 (1.1–116.5)	0.040
DASH (≥50%)/<50%)	23.95 (9.2–62.65)	0.000	2.5 (0.63–9.88)	0.191

Note: Entered variables to the model (multinomial logistic regression): diabetes, arthritis, and DASH.
Abbreviations: ORs, odds ratios; CI, confidence interval; DASH, disability of arm, shoulder, and hand assessment.

significantly higher in participants with diabetes mellitus. Similar results were found in previous studies.[32–35] For example, Maurer et al[31] studied the risk of fall in a prospective cohort study on 139 participants with diabetes mellitus. This study found that participants with diabetes mellitus had 78% risk of fall compared to 30% risk of fall in nondiabetic participants.[36] Similarly, Morrison et al[34] found that the risk of fall was greater in participants with multiple risk factors including diabetes mellitus.[37] Diabetes affects multiple systems in the body including nervous and circulatory systems, which lead to auditory neuropathies and decrease of blood circulation.[38] Gait and balance deficits increase the risk of fall in older adults.[39] Further research to investigate possible effects of diabetes on gait and balance is recommended.

In this study, gait and balance deficits were also found to be greater in participants with arthritis. Similar results were found by previous research.[40–42] For example, Stanmore et al[38] studied the incidence of fall in 559 community-dwelling adults with arthritis. Results revealed that the incidence of fall was greater in participants with arthritis. Vestibular reflexes, vision, and proprioception are important inputs for balance function. Arthritis affects proprioception in joints, which may then affect the overall balance and increase gait and balance deficits.[43]

Disabilities in upper limbs could also increase the risk of gait and balance deficits as found in this study. Previous research support this finding.[9,44,45] For example, Bumin et al[41] studied multiple factors that affect balance deficits and risk of fall in 33 older adult participants. Results indicated that upper limb disabilities, among other risk factors, increase the risk of balance deficits and risk of fall. Similarly, in another study, Chu et al[9] investigated predictors of falls in 1,517 ambulatory Chinese elderly participants. Results indicated that upper limb dysfunction was one predictor for balance deficits and risk of fall in the studied population. Upper limbs support the body during ambulation, especially when using ambulatory aids that help to maintain balance and consequently prevent falls. Upper limbs are important in reaching movements and grip strength, which are critical for preventing falls.[46]

Other factors in this study that were not found to be related to gait and balance deficits were found to be risk factors in previous studies. Factors such as psychiatric disorders[47] and cognitive impairments were found to be related to deficits in gait and balance as well as risk of fall.[48] The relatively younger age of the sample in this study in addition to the relatively small sample size could partially explain our results. Younger age groups might have less psychiatric or cognitive deficits. For example, dementia, cognition deficits, and Alzheimer's disease are more prevalent in adults >70 years old.[49]

Limitations

In this study, some limitations were recorded. First, the participants had a relatively wide age distribution (18–100 years), and approximately 31.2% of the participants were under the age of 55. This may be related to cultural, economic, and traditional issues and rules related to nursing homes in Jordon. Being relatively young (<55 years in this study) gives the initial impression that they should be healthy.

However, in this study, many of the younger age participants have chronic conditions such as diabetes or cognitive disorders. As mentioned, many of the younger adults in this study were admitted to the nursing home because of physical or mental disabilities due to lack of family and financial support. One implication from this study is that the definition of older adult in relation to gait and balance is not the same in all countries. In developing countries, people develop diseases at a younger age than in western countries.[50]

Second, this study discussed some factors related to gait and balance deficits of nursing home residents in Jordan; however, there are many other factors relating to this area not covered in this study. Third, the cutoff scores for the MMSE and TAB were determined depending on what have been used by majority of studies.[45,46] In nursing homes, supportive rehabilitation programs should be maintained to overcome and decrease the occurrence of gait and balance deficits and minimize the risks of falls among older adults, as reported previously.[22,23,47–50]

Conclusion

This study revealed a significant impact of upper limb disability, stroke, heart disease, arthritis, joint diseases, diabetes, and hypertension as well as psychiatric disorders and cognitive disabilities on gait and balance deficits among home-resident older adults in Jordon. Also, the data concluded that relatively younger adults (<55 years) with mental or physical health problems may have severe gait and balance deficits. Also, the data support that all nursing homes should have rehabilitation services to prevent gait- and balance-related defects.

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Disclosure

The authors report no conflicts of interest in this work.

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