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Original Article

Diagnostic accuracy of Performance Oriented Mobility Assessment in community-dwelling older adults

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ABSTRACT

Background/Objective: The aim of this study was to investigate the fall diagnostic accuracy of performance oriented mobility assessment (POMA), a widely used clinical measure for balance, gait and risk of fall, in inactive/low physically active and sufficiently physically active older adults.

Methods: One hundred and forty three community-dwelling older adults aged 60 years and older were divided into two groups: inactive/low physically active; and sufficiently physically active. History of fall in the past year was recorded, and balance and gait were evaluated by POMA. Different cut-off points of POMA in the two groups were studied regarding specificity and sensitivity.

Results: The POMA scores showed significant differences between inactive/low physically active and sufficiently physically active older adults ($p < 0.001$). The best cut-off point in inactive/low physically active and sufficiently physically active older adults was 19 (sensitivity 86% and specificity 86%).

Conclusion: The POMA was a proper measure with sufficient sensitivity and specificity for diagnosing fall history in inactive/low physically active older adults.

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INTRODUCTION

Falling is an accident that causes unwanted laying on the ground or other low surfaces and this is not due to reasons such as loss of consciousness, paralysis, and sudden onset of a seizure.[1] Almost one third of older adults above 65 years old experience fall at least once a year, which increases with age.[2] In addition to physical damage and functional limitation, falling has social and economic consequences leading to increased use of health services.[3,4] Studies have indicated that preventive interventions could reduce fall incidence, and it has been emphasized that interventions targeting high-risk people could better prevent falling and have better cost-effectiveness.[5,6]

Due to the multifactorial nature of falling, it is optimal to develop an evaluation protocol which considers all main risk factors of falling. On the other hand, multidimensional evaluation protocols are time consuming and less applicable in clinical centres. Thus,

recognizing a perfect and simple tool with acceptable sensitivity and specificity is a constant concern among health professionals. With this goal, several fall-predicting models have been developed aimed at quick diagnosis of older adults for the risk of fall. Practical clinical tools are the main elements of these models due to advantages of simplicity, low cost and representing objective results of treatment.[7-10]

Falling risk factors are classified into an internal (individual) and external (environmental) categories, and a clinical tool evaluates a specific falling risk factor. Impaired balance and gait are among the main internal factors. Risk of falling among older adults with impaired balance and gait is about 2.9 greater than among older adults without these impairments.[11,12] Evaluation of balance and gait is the main part of fall risk screening tools such as the Berg Balance Scale, Time-up-and-go test, Dynamic Gait Index and Tinetti Performance Oriented Mobility Assessment (POMA).[13-16]

The POMA is composed of several daily functional manoeuvres. It is developed to assess the gait and balance in older adults.[16] Various studies have investigated POMA prediction power for evaluating falling in different settings and at different cut-off points. Generally, it is reported that POMA does not have high sensitivity for diagnosing older adults with fall history, but has high specificity for diagnosing older adults without fall history. [17-19]

Physical activity is defined as "any bodily movement produced by skeletal muscles that results in energy expenditure".[20] Although the effectiveness of physical activity as a therapeutic approach for preventing fall has been shown in previous studies,[21-24] but contradictory evidence has been provided.[25-27] Association between physical activity and fall in older adults may be a U-shaped so that fall risk increases both among older adults with high physical activity (likely due to enhanced exposure to environmental risks) and older adults with low physical activity (likely due to poorer muscle strength, coordination, and balance). To develop prevention programs, clinicians should be aware of the most appropriate tool for evaluating risk factors in the specific community groups including older adults with different level of physical activity.[28]

Diagnostic accuracy of POMA in the older population of inactive/low physically active and sufficiently physically activity categories has not yet been studied. Thus, the current study aimed to investigate diagnostic accuracy of the POMA for fall risk in community-dwelling inactive/low physically active and sufficiently physically active older adults.

METHODS

Participants

In this cross-sectional study, 143 community-dwelling older adults from Tehran city who were 60 years and older[19] with mean (SD) age of 72.37 (6.83) and body mass index (BMI) of 26.15 (2.29) who were living at home, were selected by convenience sampling method. All participants had the ability to get up from a chair and walk 10 meters with or without a walking assistive device. They did not have cognitive impairment (i.e. score higher than 21 in Persian version of Mini-Mental State Examination).[29] Older adults with neurologic and orthopaedic pathological condition (such as Parkinson's disease, knee replacement and macular degeneration), which have a direct effect on balance and gait, as well as those who were obese (BMI ≥30), and people with a diagnosis of visual disorders, were excluded.

Procedure

A demographic questionnaire was used to record age, gender, history of fall in the previous year, education level, marital status, living arrangement, vertigo, arthritis, smoking, cardiopulmonary disease, list of medications per day, height, weight and walking assistive device. Participants were divided into inactive/low physically active and sufficiently physically active groups based on the single-item physical activity Measure. Participants were asked to answer this question: "In the past week, how many days have you done a total of 30 min or more physical activity, which was enough to raise your breathing rate. This may include sport, exercise, brisk walking, cycling for recreation or to get to and from places, but it does not include housework or physical activity that may be part of your job." This measure has indicated strong repeatability (r=0.86) and moderate validity (r=0.53) for measuring physical activity level.[30] A participant was classified as inactive/low physically active (<150 min of physical activity per week) and sufficiently physically active (≥150 min of physical activity per week) on the single-item physical activity question.[31] The POMA was used to assess falling, balance and gait. Study protocol was approved by the Ethics Committee of Iran University of Medical Sciences. All participants signed their written consent form. All assessments were carried out by an occupational therapist with sufficient training and experience to perform the tests.

Outcome measure

The POMA is a clinical tool for evaluating balance and gait which can be simply implemented using a standard chair and a chronometer with some level of experience so that it is commonly used in different settings. POMA includes two subscales of balance and gait. Balance subscale has a maximum score of 16 and includes the following items: 1-sitting balance; 2-arise; 3-attempt to arise; 4-immediate standing balance (first 5 s); 5-standing balance; 6-nudged (subject at a position with feet as close together as possible, examiner pushes lightly on subject's sternum with palm of hand three times); 7-the same as item 6 but with eyes closed; 8-turning 360 degrees; 9-sitting down. Gait subscale has maximum score of 12 and includes the following items: 1-initiation of gait (immediately or after saying to "go"); 2-step length and height; 3-step symmetry; 4-step continuity; 5-path deviation; 6-trunk stability; 7-walking stance (heels apart/heels almost touching while walking). Some items are scored as binary (0=cannot perform, 1=can perform),

while the others are scored as 0, 1, and 2 (0=abnormal, 1=adaptive and 2=normal). If needed, rest between items was given to the participants. In order to familiarize participants with the procedure, they were allowed to have one pilot attempt. POMA had total score between 0 and 28, with low scores indicating increased risk of falling.[16] This tool has been translated into various languages including Persian. Its Persian version used in this study has high reliability and validity.[32]

Statistical analysis

Statistical package for social science (version 13) and Med Cal Statistical (version 13.0.6) software were used in the current study. The Kolmogorov–Smirnov test was done to examine the normal distribution of the data. Age, BMI and POMA score were normally distributed. Independent Sample t-test was used for comparing the groups when there was normal distribution. Chi-square test was used for comparing frequency of qualitative variables in two groups.

The diagnostic accuracy of POMA was investigated by constructing a contingency 2 × 2 table which used for calculating sensitivity (S), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (PLR), and negative likelihood ratio (NLR). Definition and calculation formulas of these diagnostic accuracy measures are presented in Table 1.

RESULTS

Descriptive data

According to the Single-item physical activity measure, participants were divided into inactive/low physically active group (80 subjects [56%] by mean [SD] age of 74.07 [6.89]), and sufficiently physically active group (63 subjects [44%] by mean [SD] age of 70.21 [6.17]). The age showed significant difference between the two groups (p=0.001). Mean (SD) of BMI was 26.48 (2.12) in inactive/low physically active group and 25.72 (2.44) in sufficiently physically active group, which showed significant difference between the two groups (p <0.05). Table 2 shows the descriptive data of qualitative variables. Thirty-six (45%) subjects of inactive/low physically active older adults and 23 (37%) subjects of sufficiently physically active older adults reported at least one fall during the past year which showed no significant difference (p=0.31) between the two groups (Table 2). The POMA score was significantly different between the two groups (p <0.001) (Table 3).

Diagnostic accuracy

In inactive/low physically active s group, the best cut-off point was 19 (S=86.11%, SP=86.36%, AUC=91%, CI95%=0.82-0.96) but the sensitivity of this cut-off point was low for detecting risk of fall in the sufficiently physically active group (S=39.13%). With a score equal to or less than 19, the most of inactive/low physically active older adults (75.70%) showed a history of fall in the past year and were correctly classified in the group at risk of falling (PPV) (Table 4). In general, it can be suggested that the sensitivity enhanced by increasing the cut-off point in the sufficiently physically active group. However, a ceiling effect was observed by increasing the cut-off points in this group (i.e. greater than 25) which indicated that POMA may not be an appropriate clinical tool for detecting risk of fall in sufficiently physically active older adults (Table 3).

DISCUSSION

Different tests have been suggested for evaluating balance, functional mobility and risk of falling in older adults. However, little is known about sensitivity and specificity of these tests for determining balance changes and identifying vulnerability to falling in specific groups. The POMA is one of the main measures for evaluating balance and gait and predicting risk of fall in older adults.[33]

Raiche et al. (2000) reported high sensitivity (70%) and moderate specificity (52%) of POMA for screening older adults with risk of fall.[34] Knobe et al. (2016) found poor

Table 1. Abbreviations, formulas and definition of measures for diagnostic accuracy

Measure	Abbreviations	Formula	Define
Sensitivity	S	TP/(TP+FN)	Measures the ability of the test to detect the occurrence of the disease, in this case the fall, including individuals who have suffered, i.e., how sensitive the test is.
Specificity	Sp	TN/(TN+FP)	The ability of the test to exclude individuals who do not have the disease, in this case the fall, i.e., how specific the test is.
Positive predictive value	PPV	TP/(TP+FP)	The probability there will be a self-reported fall if the POMA was negative at a certain cut-off point.
Negative predictive value	NPV	TN/(FN+ TN)	The probability that there will not be a self-reported fall if the test was negative at a certain cut-off point.
Positive likelihood ratio	PLR	Sensitivity/(1-Specificity)	The ratio of probability that a POMA cut-off point will be positive if there is a self-reported fall, and the probability of cut-off of POMA will be positive if there is no self-reported fall.
Negative likelihood ratio	NLR	(1-Sensitivity)/Specificity	The ratio of probability that a POMA cut-off point will be negative if there is a self-reported fall and the probability that a POMA cut-off point will be negative if there is no self-reported fall.

TP= true positive; TN= true negative; FP= false positive; FN= false negative.

sensitivity (45%) and moderate specificity (69%) of this measure for evaluating risk of fall in older adults.[35] High sensitivity (70-80%) of POMA has been reported by Sterk et al. (2010) for assessing risk of fall in older adults with dementia diagnosis.[36]

In the current study, the results of sensitivity and specificity were interpreted as follows: Scores less than 60%, equal to or greater than 60% to less than 70%, equal to or greater than 70% to equal to or less than 80%, equal to or greater than 81% to less than 90%, and equal to or greater than 90% were considered as low, moderately low, moderate, moderately high, and high, respectively.[37]

Our findings showed that the best cut-off point for POMA in active/low physically active older adults was 19 (with moderately high sensitivity=86% and moderately high specificity=86%) to recognize older adults with and without fall history. Previous studies have reported different cut-off point of POMA (i.e. in the range of 15-26) for screening fall in older adults.[16-19,34-36,38-40] Different study designs, sample sizes or fall definition may result in this difference.

In contrast to the current study, most of the previous studies have reported a weak diagnostic accuracy of POMA in older adults. However, our results are consistent with the Tooper et al. (1993) and Thomas et al. (2000) studies which showed high sensitivity and moderately high specificity (S=93%, Sp=89%) and moderately high sensitivity and moderate specificity (S=83%, Sp=75%) of POMA in older adults, respectively. A possible explanation for this might be considering the pathologic disorders, old age and low level of physical activity in these two studies and the current study. It has been reported that POMA has an appropriate sensitivity and specificity in older adults with specific conditions but it has not an appropriate diagnostic accuracy in individuals without these specific conditions.[39,40]

The results of the current study showed that sensitivity enhanced by increasing the cut-off point in the sufficiently physically active group but it caused two problems. First, the specificity decreased,[41] second the ceiling effect was observed so that the POMA scores in 35 percent of older adults were in the upper limit (90% and higher). This finding is in agreement with those of Farber et al. (2006) and Pardaseny

Table 2. General characteristics of sufficiently and inactive/low physically active older adults

Variable	Inactive/Low Physically Active Older Adults	Inactive/Low Physically Active Older Adults	Chi	d_f	p
	Frequency (%)	Frequency (%)			
Gender			2.53	1	0.11
Male	27 (42.86%)	45 (56.25%)			
Female	36 (57.14%)	35 (43.75%)			
Education level			1.81	2	0.41
Under diploma	32 (50.79%)	42 (52.5%)			
Diploma	21 (33.33%)	31 (38.75%)			
Collage	10 (15.87%)	7 (8.75%)			
Family status			0.77	2	0.38
Single	2 (3.17%)	1 (1.25%)			
Married	40 (63.50%)	45 (56.25%)			
Widow/divorce	21 (33.33%)	34 (42.50%)			
Living arrangement			2.43	1	0.12
Alone	11 (17.46%)	7 (8.75%)			
With spouse/relative	52 (82.34)	73 (91.25%)			
Having Job (engagement)			8.03	1	0.005
Yes	31 (49.21%)	21 (26.25%)			
No	32 (50.79%)	59 (73.75%)			
Use assistive device			12.55	1	<0.001
Yes	14 (22.22%)	41 (51.25%)			
No	49 (77.78%)	39 (48.75%)			
High risk factors (Positive)					
Vertigo	24 (38.10%)	30 (37.50%)	0.05	1	0.94
Cardiopulmonary	23 (36.51%)	36 (45.00%)	1.05	1	0.31
Arthritis	23 (36.51%)	46 (57.50%)	6.22	1	0.01
Smoking	8 (12.70%)	19 (23.75%)	2.81	1	0.09
Poly pharmacy ≥ 4	26 (41.27%)	48 (60.00%)	4.95	1	0.03
History falls over last year			1.05	1	0.31
0	40 (63.49%)	44 (55.00%)			
≥1	23 (36.51%)	36 (45.00%)			

Table 3. Score of POMA in sufficiently and inactive/low physically active physically active older adults with regards to history of fall

Score of POMA	Sufficiently Physically Active Older Adults		Inactive/Low Physically Active Older Adults	
	With History of Fall	Without History of Fall	With History of Fall	Without History of Fall
11	0	0	1	0
12	0	0	2	0
13	1	0	1	0
14	1	0	3	0
15	1	0	4	0
16	0	0	7	0
17	2	0	3	1
18	1	0	5	3
19	3	0	9	2
20	3	1	1	2
21	3	2	1	2
22	2	3	0	6
23	2	5	0	5
24	1	2	1	3
25	1	7	1	6
26	2	2	0	2
27	0	7	0	4
28	0	11	1	8
Total	23	40	40	44
Mean (SD)	23.49 (±3.80)		20.75 (±4.72)	

SD=standard deviation.

et al. (2011) who reported that POMA showed a ceiling effect in community-dwelling older adults. Therefore, there is need to modify POMA for screening fall risk in the sufficiently physically active older adults.[42,43]

The results of this study showed a cut-off point of 19 with PPV=75.70, NPV=92.70, PLR=6.31 and NLR=0.16 in the inactive/ low physically active group. A PPV of 76% showed that 76% of participants with a positive test (i.e. POMA Score ≤19) were classified as fallers (the gold standard) and 24% of the participants were misclassified as fallers based on the POMA, an error rate that we considered to be weak in inactive/low physically active older adults. A NPV of 93% showed that 93% of participants with a negative test (i.e. POMA Score >19) were classified as non-fallers (the gold standard). Our misclassification rate for non-fallers was less than fallers (i.e., we can be more confident about identifying non-fallers compared to fallers based POMA test scores).The risk of falling in older adults with POMA score of 19 or below was more than six times higher than older adults with POMA score above 19. This result indicates that POMA is a sensitive measure for predicting fall in the inactive/low physically active older adults but not in the sufficiently physically active older adults.

In the current study, participants with low physical activity were older than participants with sufficient physical activity. As balance and functional mobility in older adults decrease with age, POMA score reduces with age too. Therefore, age may affect the results of the diagnostic accuracy/predictive value for measuring risk of falling in the current study and it should be further investigated in the future studies. This result is similar to findings of Baloh et al. (2008) which were done in longitudinal type. They mentioned that POMA scores reduced by increasing age, so that 0.5 score reduction was observed in POMA with one year increase in the age.[44] Also, KO et al. (2009) reported that increasing age caused reduction in the POMA score.[45]

Incidence of using assistive devices in inactive/low physically active older adults was significantly higher than sufficiently physically active older adults in our study. Moreover, POMA scores in inactive/low physically active older adults were significantly lower than sufficiently physically active older adults. These results are consistent with findings of Mitchel and Newton (2006), who reported a score less than 12 in the POMA balance subscale and higher probability of falling in people who used mobility-assistive devices.[46]

Limitation

This study has a few limitations. Verification of falling in the form of self-report may cause bias in the results, especially when reminding period is long. However, self-report for falling record has been used in many studies.[10,47,48] The time interval between fall occurrence and evaluation in the current study, based on question about fall history in the past year, may influence the results. Thus, it is suggested that balance and gait performance, physical activity level and incidence of fall in community-dwelling older adults be investigated in a prospective study, which may be better able to show diagnostic accuracy of POMA in community-dwelling older adults. This study was conducted only on older adults living in the community which limits the generalizability of the results. Therefore, it is suggested that a study with a larger sample size be conducted in older participants from all settings.

Implication to rehabilitation in older adults

Considering that medical and rehabilitation professionals routinely used the POMA to screen falls risk in community-

Table 4. Sensitivity, specificity, positive likelihood ratio, negative likelihood ratio, positive predictive value and negative predictive value for POMA cut-off point among sufficiently and inactive/low physically active older adults

Cut-off Point	Sufficiently Physically Active Older Adults						Inactive/Low Physically Active Older-Adults					
	S	Sp	PLR	PLR	PPV	NPV	S	Sp	PLR	NLR	PPV	NPV
15	13.04%	100%	-	0.87	100%	70.00%	30.56%	100%	-	0.69	100%	79.80%
16	17.39%	100%	-	0.83	100%	71.10%	50.00%	100%	-	0.50	100%	81.20%
17	21.74%	100%	-	0.78	100%	72.20%	58.33%	97.3%	25.67	0.43	92.70%	82.60%
18	26.09%	100%	-	0.74	100%	73.30%	72.22%	90.91%	7.94	0.31	86.00%	86.90%
19	39.13%	100%	-	0.61	100%	76.90%	86.11%	86.36%	6.31	0.16	75.70%	92.70%
20	52.17%	97.50%	20.87	0.49	91.10%	80.50%	88.89%	81.82%	4.19	0.14	70.70%	93.70%
21	65.22%	92.50%	8.70	0.38	81.1%	84.40%	91.67%	77.27%	4.03	0.11	66.50%	95.00%
22	73.91%	85.00%	4.93	0.31	70.80%	86.90%	91.67%	63.64%	2.52	0.13	55.40%	93.90%
23	82.61%	72.50%	3.00	0.24	59.70%	89.40%	91.67%	52.27%	1.92	0.16	48.60%	92.70%
24	86.96%	67.50%	2.68	0.19	56.90%	91.30%	94.44%	45.45%	1.73	0.12	46.00%	94.30%
25	91.30%	50.00%	1.83	0.17	47.40%	92.10%	97.22%	31.82%	1.43	0.09	41.30%	95.90%
26	100%	45.00%	1.82	0.00	47.20%	100%	97.22%	27.27%	1.34	0.09	39.70%	95.20

S=sensitivity; Sp=specificity; PLR=positive likelihood ratio; NLR=negative likelihood ratio; PPV=positive predictive value; NPV=negative predictive value.

dwelling older adults, our study indicated that this tool is a suitable measure for inactive/low physically active older adults but not for sufficiently physically active older adults. Therefore, for screening fall risk of older adults by POMA, clinicians should consider the level of physical activity.

CONCLUSION

The results of the current study indicated that POMA is a suitable and sensitive measure for predicting risk of fall in the inactive/low physically active older adults. However, POMA has not suitable diagnostic accuracy for fall in sufficiently physically active older adults and different performance-oriented tests, possibly more challenging, may reveal balance deficits that could cause falls in sufficiently physically active older adults. The development of new tests for this population should be considered in future studies.

CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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