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Comparison of Falls and its Determinants in the Elderly with and without Knee Osteoarthritis

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ABSTRACT

Background and Objective: The growth of aging reveals the importance of paying attention to the health needs of the elderly. According to some studies, falls and its consequences are more common in the individuals with knee osteoarthritis (KOA) than those without KOA, but due to lack of evidence, its related factors are still unknown. Thus, the aim of this study was to compare the falls and its determinants in the elderly with and without KOA.

Methods: In this case-control study, 700 older adults in two groups of elderly with and without KOA were compared in terms of falls and some variables including KOA, sex, age, body mass index, living status, quadriceps femoris muscle strength, hand muscles strength, balance, number of comorbidities, number of drugs used, walking duration, physical activity and frailty. KOA was diagnosed based on The American College of Rheumatology (ACR) criteria.

Findings: In this study, falls were 1.90 times higher in the elderly with KOA than elderly without KOA. Although all variables were significantly different in case and control groups, only female gender (p=0.035) and KOA (p=0.012) were significantly associated with falls.

Conclusion: These findings suggest that variables in combination may increase the risk of falls in the elderly with KOA, while each of them alone may not be associated with falls.

Keywords: *Falls, Knee Osteoarthritis, Aging.*

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Introduction

Aging is a concerning global challenge and health advances, increasing life expectancy, declining deaths and birth rates are the main reasons for its rapid growth (1). Aging is a sensitive stage of human development that is associated with extensive anatomical, biological and physiological changes. These changes lead to a progressive decline in the physical and mental health of the elderly (2-5). Decreased health can lead to an increase in accidents such as falls which as one of the most common and serious problems in old age, can lead to more injuries in the elderly (6,7). Approximately, one-third to one-half of the older adults fall each year, and half of this population experiences it frequently (8). The risk factors of falls may be modifiable or non-modifiable which are frequently categorized as being intrinsic (person specific) and extrinsic (environmental). The etiology of falls is multifactorial and can result from a complex interaction between risk factors (9).

Some studies have identified knee osteoarthritis (KOA) as a factor associated with falls. Based on the evidence, older adults with KOA have an increased risk for fall-related injuries, and fall more than twice compared with older adults without KOA (10-13). Despite the high prevalence of falls in the individuals with KOA, the underlying factors and mechanisms are not well known. KOA symptoms and conditions seem to be overlapping with risk factors of falls found in the older adults (9, 14). Although falls and KOA are very common in the elderly, they cannot be considered an inevitable and inseparable part of the aging process (15, 16).

It is essential to make precise assessments for individuals with KOA regarding the probability of falls and to plan multi-component interventions to prevent falls; because a general intervention alone could not prevent falls effectively without precise assessment of the individuals and multiple component interventions (17). The increase in the proportion of older adults is accompanied by an increase in the demand for health services (18). Despite extensive epidemiological research on the risk factors of falls, there is little information about falls and related factors in the elderly with KOA (9, 14). Identifying fall risk factors is the first step in designing effective prevention programs (19). Therefore, the aim of this study was to compare the falls and its determinants in the elderly with and without KOA.

Methods

This case-control study was a part of a cohort study known as the "Amirkola Health and Ageing Project" (AHAP) which was funded by the Vice Chancellery of Research and Technology, Babol University of Medical Sciences for the investigation of geriatric medical problems and was conducted in Amirkola, a city located in northern Iran and the southern coast of the Caspian Sea (20). In the present study, a group of 350 individuals with KOA as a case group, and a group of 350 individuals without KOA as a control group were randomly selected from among the total participated elderly population; and a total of 700 elderly were surveyed. Elderly who signed the informed consent were included in the study. Elderly with incomplete information, dementia and cognitive impairment (score below 24 in the Mini Mental State Examination questionnaire), history of lower limb and spine fractures were excluded from the study (21-24). This study was approved by the ethics committee of Babol University of Medical Sciences, Babol, Iran with the ethical code IR.MUBABOL.REC.1400.034. The required data were obtained by standard questionnaires, checklists, clinical and laboratory examinations. Information regarding age, sex, body mass index (BMI),

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living status (living alone/with others) was collected using a questionnaire. A history of falls was found by answering yes or no to the question "Did you fall last year?". If the answer was positive, a question was asked about the number of falls (20, 25). KOA was diagnosed by a rheumatologist based on the American College of Rheumatology criteria (26).

The maximum strength of the quadriceps femoris muscles (QFM) and hand muscles on both sides were measured by a dynamometer in kilograms and the mean value of three measurements was considered for analysis. To measure the QFM strength, the individuals were seated on a chair and the dynamometer on one end was fixed 5 cm above the lateral malleolus of the tibia and was fixed to the wall on the other end. Then they were asked to perform the concentric knee extension motion from a 90-degree knee flexion position. The reliability of QMS measurements was confirmed by test-retest reliability method in 20 consecutive patients in whom QMS measurement was repeated after 30 min rest (27-29).

In order to evaluate the balance, the Berg Balance Test with 14 items was used. Each item was scored from 0 to 4 (0= unable, 4= normal) and the total score ranged from 0 to 56. Individuals were divided into three categories based on total score: wheelchair bound (score 0-20), walking with assistance (score 21-40), and independent (score 41-56) (30).

The number of comorbidities was obtained by asking patients and their relatives, laboratory tests, checking prescriptions and medications. Comorbidities included heart disease (angina pectoris, myocardial infarction, congestive heart failure), high blood pressure, diabetes, urinary incontinence, osteoporosis, visual problems, hearing impairment, stroke, Parkinson's disease, depression, respiratory diseases (chronic obstructive pulmonary disease, asthma, chronic bronchitis, emphysema), cancer, epilepsy, thyroid problems (hypothyroidism and hyperthyroidism) (20, 25).

Physical activity was evaluated using the physical activity scale for the elderly (PASE) questionnaire. The scoring of this questionnaire was from 0 to 400; a higher score indicated a higher physical activity level (31). The validity and reliability of Persian version of PASE questionnaire have been assessed (32). Walking duration was measured by the "3 Meter walk" test, in which the elderly was asked to walk at a normal speed, on a flat 3-meter path with a determined starting and ending point. Then the duration was recorded in seconds using a chronometer (20).

Statistical analysis: The collected data were analyzed by SPSS20 software. T test was used to compare quantitative variables and Chi-square test for categorical variables in case and control groups. To determine the variables associated with falls, backward stepwise multivariate logistic regression model was applied. Adjusted odds ratios (OR) and confidence interval (CI) 95% were estimated. For all analyses, $p<0.05$ was considered statistically significant.

Results

In this study, 700 elderly aged 60 years and above were studied in two groups of the elderly with KOA (n=350) and without KOA (n=350) (Tables 1 and 2). 112 patients (32%) in the case group and 41 patients (11.7%) in the control group had a fall experience last year, and this difference was statistically significant ($p<0.0001$). Also, the frequency of falls in the case group was significantly higher than the control group ($p<0.0001$).

The results of multiple logistic regression model analysis in the total studied elderly population showed that in the first step only KOA (Odd Ratio= 1.90, 95% Confidence Interval (1.5-3.12), p=0.012) and female gender (Odd Ratio= 1.80, 95% Confidence Interval (1.04-3.20), p=0.035) had a significant association with falls, which after 12 stages, the same two variables remained significant (Table 3). Multiple logistic regression analysis in the case group showed that only QFM strength (p=0.007, 95% Confidence Interval

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(0.91-0.98), Odd Ratio= 0.94) had a significant association with falls. None of the studied variables showed a significant association with falls in the control group.

Individuals with KOA were significantly higher in women than men (p<0.0001). Furthermore, in the elderly with higher BMI, cases with KOA were significantly higher; in obese elderly, 69.4% of cases of KOA were observed, compared to 31.3% of cases in normal-weight elderly (p<0.001). In this study, 80.5% of the elderly with frailty had KOA, while the elderly without frailty constituted 17.4% of the cases with KOA, which was statistically significant (p<0.001). Also, according to the findings of this study, the cases with KOA in the elderly who lived alone was significantly higher than those who lived with others (p<0.0001) (Table 1).

In this study, the mean age in the elderly with KOA was 70.61±6.97 and in those without KOA was 69.09±6.96 (p=0.004). The mean BMI in the elderly with KOA was 29.93±5.03 and in the elderly without KOA was 26.85±4.22, and this difference was statistically significant (p<0.001). In the elderly with KOA, the strength of the QFM and hand muscles was significantly lower than the elderly without KOA (p<0.001); the mean strength of the quadriceps femoris and hand muscles in the elderly with KOA was 15.11±6.50 and 17.58±7.14 kg, respectively, and in the elderly without KOA was 24.54±9.92 and 26.90±8.67 kg. Moreover, the mean balance score in the elderly with KOA was 49.31±6.62, which was significantly lower than the elderly without KOA with mean of 53.89±3.40 (p<0.001). The mean number of comorbidities and the mean walking duration in the elderly with KOA were significantly higher than the elderly without KOA. Also, the mean physical activity in the elderly with KOA was significantly lower than those without KOA (p<0.000) (Table 2).

Table 1. Comparison of the studied qualitative variables in the case and control groups

Variables	Knee Osteoarthritis		p-value
	Yes Number(%)	No Number(%)	
Sex			
Female	244(73.5)	88(26.5)	<0.0001
Male	106(28.8)	262(71.2)	
Living Alone			
Alone	48(68.6)	22(31.4)	<0.001
With Others	302(47.9)	328(52.1)	
Body Mass Index (Kg/m^2)			
<25	55(31.3)	121(68.8)	
25-29.99	127(45)	155(55)	<0.0001
≥30	168(69.4)	74(30.6)	
Balance (score)			
Wheelchair Bound	2(100)	0(0)	
Walking With Assistance	35(92.1)	3(7.9)	<0.0001
Independent	313(47.4)	347(52.6)	
Frailty			
Frail	182(80.5)	44(19.5)	
Prefrail	140(44.7)	173(55.3)	<0.0001
Normal	28(17.4)	133(82.6)	

*Chi-Square Test

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Table 2. Comparison of quantitative variables studied in case and control groups

Variables	Knee Osteoarthritis		p-value
	Yes Mean±SD	No Mean±SD	
Age (year)	70.61±6.97	69.09±6.96	<0.0001
Body Mass Index (Kg/m^2)	29.93±5.03	26.85±4.22	<0.0001
Quadriceps Femoris Muscles Strength (Kg)	15.11±6.50	24.54±9.92	<0.0001
Hand Muscles Strength (Kg)	17.58±7.14	26.90±8.67	<0.0001
Balance (score)	49.31±6.62	53.89±3.40	<0.0001
Number of Comorbidities	4.89±2.32	2.87±1.86	<0.0001
Physical Activity (score)	84.40±46.08	114.87±63	<0.0001
Walking Duration (second)	12.24±6.97	8.31±4.17	<0.0001

*Independent t-test

Table 3. Multiple logistic regression analysis to determine the factors associated with falls in the total studied elderly population

Variables	Odd Ratio	Confidence Interval	p-value
Knee Osteoarthritis (Yes/No)	1.90	1.15-3.12	0.012
Sex Female/male	1.80	1.04-3.20	0.035
Age (year)	0.99	0.96-1.03	0.94
Body Mass Index (Kg/m^2)			
<25	1		
25-29.99	0.88	0.52-1.49	0.64
≥30	0.88	0.44-1.30	0.40
Living Status (Alone/with others)	1.27	0.70-2.28	0.42
Quadriceps Femoris Muscles Strength (Kg)	0.73	0.37-1.41	0.35
Hand Muscles Strength (Kg)	0.70	0.35-1.37	0.30
Balance (score)			
Independent	1		
Walking With Assistance	1.53	0.64-3.64	0.33
Wheelchair Bound	1.56	0.08-28.43	0.76
Number of Comorbidities	1.03	0.92-1.15	0.60
Walking Duration (second)	0.79	0.39-1.60	0.52
Physical Activity (score)	1.33	0.77-2.29	0.29
Frailty			
Normal	1		
Prefrail	0.88	0.48-1.63	0.70
Frail	0.93	0.45-1.92	0.84

*Backward stepwise method of multiple logistic regressions

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Discussion

In the present study, falls in the elderly with KOA were 1.90 times higher than the elderly without KOA. Among the studied variables, only two variables of KOA and female gender were significantly associated with falls in the total elderly population. According to the findings of this study, all the studied variables were significantly different between the case and control groups; the mean age, BMI, number of comorbidities and walking duration in the elderly with KOA were higher than the elderly without KOA. However, the mean QFM strength, hand muscle strength, balance score and physical activity were lower in the case group than the control group, and these differences were statistically significant. Also, the cases of KOA were significantly higher in the elderly who lived alone than those lived with others. The number of patients with KOA in the elderly with frailty was also higher than those did not have physical frailty and this difference was statistically significant.

In this study, the rates of fall in the total population of women were significantly higher than men, which is consistent with previous studies. In a systematic review article, Zhao et al. suggested that changes due to menopause, including changes in the speed of metabolic processes, weight, and body composition, can lead to falls in the older women. During menopause, with decreasing levels of female hormones, muscle and physical function in women decline more rapidly than men, leading to a higher prevalence of falls in women (33). Differences in the rates of falls between men and women may also indicate differences in health status, lifestyle, and behavioral factors between the sexes (34). However, female gender in case and control groups had no significant association with falls.

In our study, KOA was significantly associated with falls in the studied elderly. According to recent systematic reviews, KOA is considered as one of the risk factors for falls, but its mechanisms and underlying factors are not clear; related symptoms of KOA seem to be overlapping with risk factors of falls found in the older adults (9, 14).

In the present study, decreased QFM strength in the elderly with KOA was significantly associated with falls. Patients with knee OA typically show reduced force generating ability in the QFM which can be attributed to muscular atrophy as well as muscular inhibition. Because the QFM plays a significant role in shock absorption and attenuating loads across the knee joint, impaired neuromuscular mechanisms in weak QFM may lead to failure in dissipating potentially harmful loads and exacerbate pain and clinical symptoms during gait cycle. This may predispose to falls in elderly with KOA (35-38). QFM strength in the total elderly population we studied was not significantly associated with falls. Probably when studying the general population of the elderly, regardless of whether they have KOA or not, due to the generalization of the study, other factors besides the QFM strength become more important.

In this study, the decrease in hand muscles strength was not significantly associated with falls neither in the total studied elderly population nor in the case and control groups. The results of our study were consistent with the study by Esain et al. (39). Grip strength has been proposed as a biomarker of health status and physical activity level. Although grip strength is not directly required for the functional activities such as gait, more physical limitations such as standing from a chair, walking, climbing steps, and going out have been observed in the elderly with less grip strength (40). It seems the elderly with less grip strength may be less likely to fall by limiting physical activity.

In our study, increasing age was not significantly associated with falls. In some studies, it has been reported that increasing age is associated with higher rates of falls, however, age per se cannot increase the risk of falls, but it is age-related changes and syndromes that increase the risk of falls (41-43).

In this study, the increase in BMI was not significantly associated with falls. Sheehan et al. reported that higher BMI in the elderly was significantly associated with a reduced risk of falls. Overweight and obese older adults have been shown to change their gait pattern by slowing down walking velocity and increasing

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base of support. These alterations may inadvertently represent a protective effect against falls. Also, due to less physical activity in obese elderly, they are less likely to meet fall opportunities (44). In a study by Kim et al., obesity was significantly associated with outdoor falls but there was no significant association between obesity and indoor falls (45). However, Himes et al. reported that obesity was significantly associated with falls, and chronic conditions and health problems can explain it (46).

In this study, living alone was not significantly associated with falls. Studies have shown that elderly living alone often suffer from depression due to insufficient social support (47, 48). Depression is associated with decreased levels of physical activity and social interactions (49, 50). Decreased physical activity level in the elderly who live alone may make them less likely to fall (51, 52).

However, the findings of a study indicated that living alone was associated with an increased risk of falls. It has been suggested that having a spouse/partner is an important source of social support and chronic disease management that may also play a role in preventing falls (34).

In our study, balance was not significantly associated with falls, which was not consistent with previous studies. The differences between our study findings and previous studies may be due to methodological differences between studies. Not only various tests were used to assess the balance in the studies, but the standardization of procedures of all variables that influence the execution of the test was not performed; such as the command given to the individual, the height and depth of the chair, whether or not the use of the upper limbs was allowed, and if shoes were used or not. This standardization is necessary for comparisons between studies (53-55).

In the present study, the decrease in the physical activity level was not significantly associated with falls in the total studied elderly population as well as in the case and control groups. A systematic review indicated that older people with lower levels of physical activity were more likely to have recurrent falls. However, this study also noted that the use of different instruments in determining the physical activity level and the non-uniformity of its units in the studies, has prevented the estimation of the amount of physical activity needed to prevent recurrent falls (56). Therefore, due to the lack of a certain limit of physical activity as a risk factor for falls, the decrease in the level of physical activity observed in our study may not be at a level that can play a significant role in falls.

In the present study, the elderly with KOA walked significantly slower than the non-affected elderly. However, walking slowly was not significantly associated with falls. Oka et al. found that in the elderly with KOA, reduced lateral trunk sway while walking was significantly associated with fear of falls (57).

In this study, the mean number of comorbidities in the elderly with KOA was significantly higher than the elderly without KOA, but higher number of comorbidities was not significantly associated with falls. According to a study by McKevitt, an increase in the number of diseases is associated with a decrease in the physical activity level in individuals with OA (58). Individuals with OA commonly also have other comorbidities and take more medications. Therefore, they may be less likely to be in falling situations due to pain, fear of falling, depression, low self-confidence and reduced physical activity level (58-60).

In the present study, only female gender and KOA were significantly associated with falls, while all variables were significantly associated with KOA. Because KOA is a complex multifactorial disease, these findings probably demonstrate that the variables, combined with each other, increase the falls in the elderly with KOA; while each of them alone may have not significant association with falls. Based on the results of our study, prevention of KOA itself or treatment in the early stages to prevent the progression of the disease, in addition to controlling this complication, may also help reduce the risk of falls in the individuals with KOA.

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The etiology of falls is multifactorial and can result from a complex interaction between various risk factors such as physical, psychological and environmental factors (9, 61). In the present study, only some physical variables were studied; therefore, one of the possibilities that arises is that the role of psychological and environmental variables may have been more than physical variables (62-65). It is also undeniably important to pay attention to the role of environmental factors in falls, such as poor fitting footwear, slippery floor, unstable furniture, lack of stair railings, poor lighting (41, 66).

Other possibilities that can explain the difference between the results of our study and other studies are the methodological differences, including differences in the method of study, inclusion and exclusion criteria, KOA diagnostic criteria and instruments used to assess variables, method of analysis, and accuracy of data recording. Also, factors such as the study in different time periods and geographical locations, differences in the study populations, race, lifestyle and different definitions of falls and aging in different studies can affect the results.

Our study had some limitations. First, According to the study design, which was a case-control study, the cause and effect relationship between the variables was not clear. Second, in this study, the association between some physical variables and falls was investigated and psychological and environmental variables were not studied. Third, it may have been a recall bias in the falls and its frequency reported by the elderly. Also in our study, other rheumatic complications, such as hip osteoarthritis, were not included in the exclusion criteria. It is suggested that future studies consider these limitations.

In this study, falls were 1.90 times higher in the elderly with KOA than elderly without KOA. Although all variables were significantly different in case and control groups, only female gender and KOA were significantly associated with the falls. These findings suggest that variables in combination may increase the risk of falls in the elderly with KOA; while each of them alone may not be associated with fall.

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