Research Paper

The Influence of Fear of Falling on Cognitive-motor Interference in Walking in Older Adults

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ABSTRACT

Objectives: Fear of falling (FOF) is common among older people and may impact normal walking in this population. This study aimed to determine the effect of FOF on cognitive-motor interference in walking among older adults.

Methods: Ninety older adults with the ability to walk 20 meters and without cognitive disorder participated in this study. Three groups of high FOF, low FOF, and no FOF were identified using the fall efficacy scale-international (FES-I). The cognitive-motor interference was determined for the completion time of three functional movements, namely forward walking (FW), timed up and go (TUG), and obstacle crossing (OC), as well as the correct answer rate in verbal fluency (VF) and mental tracking (MT) tasks. The difference in outcomes between the groups was determined using multivariate analysis of variance (MANOVA). The Pearson correlation coefficients determined the association between FES-I and cognitive-motor interference in subjects with FOF.

Results: Dual-task cognitive performance measures, including MT+TUG, VF+OC, and MT+OC, significantly differed between the high FOF and no FOF groups (P<0.05). MT+TUG, VF+OC, and MT+OC also showed significant differences between the high FOF and low FOF groups (P<0.05). Other cognitive-motor interference measures were not significantly different between the groups. The FES-I showed a positive correlation with MT+TUG (r=0.76, P=0.001), VF+OC (r=0.72, P=0.001), and MT+OC (r=0.65, P=0.001) in individuals with FOF.

Discussion: The results indicate that FOF may impair cognitive performance during dual tasks in older adults. Future studies may be needed to investigate whether reduced FOF has the advantage of dual-task improvement in older people.

Keywords:
Fear, Accidental falls, Walking, Dual task, Older adults

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Highlights

- Fear of falling (FOF) may impair cognitive performance during dual-tasking in older adults.
- FOF did not impact mobility performance in dual-task conditions in the aged population.
- Current results can be helpful to implement interventions that enable older people to walk more safely.

Plain Language Summary

In older adults, high FOF may damage cognitive function during walking in dual-task conditions. It seems important that health services staff combine motor and cognitive therapy in clinical practice to help the older population walk more safely.

Introduction

The fear of falling (FOF) is a prevalent condition among older people, characterized by low perceived self-assurance or self-efficacy [1]. The frequency of FOF varies from 21% to 85% among the elderly population with past falls and from 35% to 46% among those without prior falls [2]. Due to activity restriction or avoidance, FOF can lead to physical and psychological impairments [3]. Limiting activities may result in muscular weakness, postural impairments, deconditioning, and potential future falls [3]. In addition, FOF has been related to decreased ability to perform activities of daily living (ADL), reduced quality of life (QoL), and increased mortality [3, 4].

Earlier studies have demonstrated a complex interplay between FOF, falls, and walking impairments in older adults [5-7]. FOF is related to increased gait variability, possibly increasing instability and fall risk [7]. Previous studies have shown that FOF results in an inability to allocate attention effectively to walking control while dual-task conditions in aged society [8, 9]. However, the impact of FOF on motor or cognitive function during dual-tasking is unclear in this population.

In real daily life, walking is not performed as an isolated activity. In most conditions, gait is combined with additional motor or cognitive tasks (dual-task conditions) [10]. Several studies revealed increased gait variability and reduced step length during dual-tasking in older people [11-13]. All these impairments have been considered indicators of increased fall risk [10]. In dual-task conditions, older adults may decrease performance in mobility, cognitive, or both tasks due to increased cognitive demands [14]. Schaefer and Schumacher reported that during perturbed standing and walking, older people prioritize mobility tasks over cognitive tasks [15]. Fallers also prioritize walking during dual-task conditions compared to non-fallers [15].

Notably, optimal execution of mobility and cognitive tasks is imperative for a safe and functional gait [14]. Since FOF interferes with attention to maintain balance control [8], people with FOF may have greater cognitive-motor interference than those without FOF. Hence, the objective of the present investigation was to ascertain the impact of FOF on the interference of dual tasks in walking with the aged community. The current results may help plan interventions for older people to walk more safely. It was hypothesized that older adults with functional impairment would exhibit greater cognitive-motor interference than those without it. Furthermore, it was anticipated that an increase in FOF levels would correlate with increased cognitive-motor interference.

Materials and Methods

Study participants

The present study was cross-sectional. Ninety community-dwelling older adults from Mashhad City, Iran, were recruited using a convenience sampling. Based on an initial power analysis (α error probability=0.05, power=0.8, and effect size=0.07), 86 participants were necessary for adequate statistical power. A researcher in the field screened all participants based on the eligibility criteria. The inclusion criteria included age 65-80, the ability to walk 20 m without walking aids, and mini-mental state examination scores >24 to reject any cognitive impairment [16]. The exclusion criteria included severe health problems (uncontrolled hypertension or uncontrolled diabetes), vision and hearing problems, neurologic or orthopedic diseases with documented influence on gait control, and an inability to give informed consent. Mashhad University of Medical Sciences approved the study protocol, and informed consent was provided from all participants.

The falls efficacy scale international (FES-I) was utilized to evaluate FOF. The FES-I instrument measures the level of FOF throughout 16 physical and social activities [17, 18]. The determination of the level of FOF for each activity is based on a 4-point scale (1: No FOF to 4: High FOF). The higher score demonstrates more FOF. The score range is between 16 and 64. This questionnaire is a valid and reliable instrument for evaluating the degree of FOF in older adults [17]. According to the level of concern about falls, all participants were divided into three groups: High FOF, low FOF, and no FOF (30 participants in each group). A score of 16 demonstrates no FOF [18]. A score of 23 was considered the threshold for allocating subjects into high and low FOF groups [18]. Subjects with scores below 23 were considered low FOF groups, and subjects above 23 were considered high FOF groups [18]. The number of falls during the last year was also determined for each participant in the present study. For this purpose, a fall was defined as falling unintentionally on the floor or ground, and falls due to a medical condition or an external force were excluded from the analysis [19].

Cognitive-motor interference in walking

In the dual-task testing, three distinct flexibility tasks with different degrees of hardship (elementary, moderate, complex) were executed, especially forward walking (FW), timed up and go (TUG), and obstacle crossing (OC) [20]. During the FW assessment, the subjects were instructed to walk on a 15-m walkway. In the TUG test, the participants were required to rise from a chair, walk for a distance of 3 m, and then return to their initial position. A stopwatch determined the completion time. In the OC test, 7 obstacles (length 70 cm, height 4 cm, width 6 cm) were embedded in the 15-m walkway. Obstacles were located 1.5 m apart from each other. Only the walking time in the middle 10 m of the 15-m walkway was determined for FW and OC. A shorter duration of the test exhibited superior functional performance.

Two cognitive tasks were assessed: Verbal fluency (VF) and mental tracking (MT). During the VF test, the subjects were instructed to mention specific words about a distinct category, such as vegetables. In the MT test, subjects count 4-additions consecutively from a number between 50 and 60. The valid response numbers were determined. During single-tasking, the subjects were instructed to begin with one of the motor tasks and then perform the same motor task plus one of the randomized cognitive tasks in a dual-task situation. Finally, subjects executed cognitive tasks independently. Dual-task evaluations demonstrated good reliability [20]. Each participant performed one practice trial before recording the data.

The rate of the correct answering to cognitive tasks was determined as described below (Equation 1):

1. *Correct answer rate (CAR)=(Number of correct answers/time)×100*

The percentage of dual-task interference (DTI%) was calculated as described below (Equations 2 and 3):

2. *DTI% in walking time: (Walking duration during dual tasking–walking duration during single-tasking)÷(walking duration during single-tasking)×100*

3. *DTI% in CAR: (CAR during single tasking–CAR during dual tasking) ÷ (CAR during single-tasking) ×100*

A higher value of these variables demonstrated higher dual-task interference (higher damage to the performance during dual-tasking rather than single-tasking) [21].

Statistical analysis

Participant characteristics were described using descriptive statistics. Data normality was determined based on the Shapiro-Wilk test. The distinction in baseline measurements between the groups was ascertained using either the Kruskal-Wallis test or a one-way analysis of variance (ANOVA). The analysis of variance with Bonferroni correction was employed to determine the disparities in dual-task interference measures among the groups. The homogeneity and normality of variance were also checked. Effect sizes were shown by η_p^2 values. A 95% confidence interval (CI) was considered the disparity in any parameter between the groups. The relationships between the dual-task interference measures and FES-I scores in participants with FOF were determined using the Pearson correlation coefficients. The statistical test was executed employing SPSS software, version 19 (available in Chicago, IL) for Windows platforms. The α level was set at 0.05.

Table 1. Characteristics of the participants

Background Variables	Mean±SD/No.			P
	No FOF (n=30)	Low FOF (n=30)	High FOF (n=30)	
Age (y)	70.16±3.25	71.2±4.44	72.03±4.24	0.23
Sex (female/male)	19/11	17/13	21/9	0.35
Weight (kg)	69.7±11.65	71.1±11.92	70.68±12.34	0.86
Height (cm)	165.03±10.66	166.8±7.61	163.1±9.19	0.3
The falls efficacy scale-international	16	20.03±1.95	31.26±5.08	-
Use an assistive device for ambulation (number)	8	7	11	0.32
Mini-mental state examination	29.7±4.1	28.52±5.3	27.9±4.78	0.68

Notes: The differences were determined using one-way ANOVA or the Kruskal-Wallis test.

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Results

Table 1 presents the general characteristics of all subjects. The differences in demographic characteristics between the three groups were not significant. The distribution of all measures was normal according to the Shapiro-Wilk test.

The Mean±SD outcome measures in the 3 groups are shown in Table 2. The assumptions, including the homogeneity and normality of variance, were not violated.

The results of multivariate tests revealed no significant distinctions between the three groups regarding the composed variables (P=0.001; F=11.8; η_p^2=0.724). The results of between-subject effects that consider the dependent variables separately identified statistically significant difference in DTI% in CAR (MT+TUG) (P=0.001; F=11.504; η_p^2=0.209), DTI% in CAR (VF+OC) (P=0.001; F=12.1; η_p^2=0.218), DTI% in CAR (MT+OC) (P=0.001; F=7.729; η_p^2=0.151), and fall numbers (P=0.001; F=36.674; η_p^2=0.457) between the three groups. The difference in other dependent variables was not statistically significant between the three groups (Table 2).

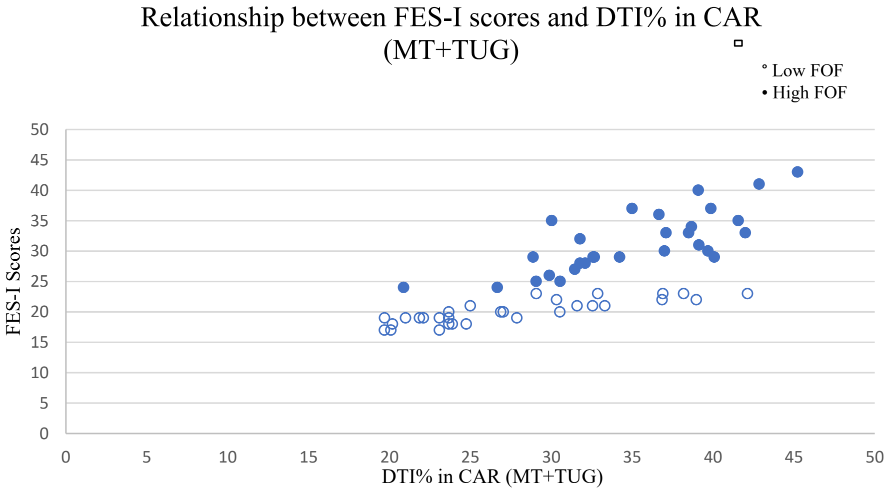

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Figure 1. A significant positive relationship was identified between FES-I scores and DTI% in CAR (MT+TUG) (P<0.001; r=0.76; n=60)

Abbreviations: FES-I: Falls efficacy scale-international; DTI: Dual task interference; CAR: Correct answer rate; MT: Mental tracking; TUG: Timed up & go).

Table 2. Comparison of outcomes between the 3 groups

Variables	Mean±SD			F	P	η_p^2
	No FOF	Low FOF	High FOF			
DTI% in walking time (FW+VF)	25.22±12.07	28.39±11.09	31.14±11.94	1.919	0.153	0.042
DTI% in walking time (FW+MT)	18.34±10.93	22.07±14.44	28.18±14.79	4.054	0.061	0.085
DTI% in walking time (TUG+VF)	25.74±16.75	32±16.67	36.29±20.28	2.609	0.079	0.057
DTI% in walking time (TUG+MT)	20.25±14.86	28.83±20.37	33.29±21.11	3.652	0.06	0.077
DTI% in walking time (OC+VF)	30.51±15.62	34.24±15.1	34.79±11.9	0.796	0.454	0.018
DTI% in walking time (OC+MT)	24.99±13.22	34.78±19.37	33.47±16.13	3.135	0.068	0.067
DTI% in CAR (VF+FW)	28.12±10.51	29.33±11.71	31.12±11.01	1.094	0.117	0.021
DTI% in CAR (MT+FW)	31.2±14.17	30.45±12.31	32.43±11.31	1.34	0.133	0.031
DTI% in CAR (VF+TUG)	29.48±9.26	31.39±12.1	30.51±10.21	0.763	0.469	0.017
DTI% in CAR (MT+TUG)	26.74±6.03	27.68±6.44	34.85±5.52	11.504	0.001*	0.209
DTI% in CAR (VF+OC)	27.62±5.81	28.92±6.45	35.58±5.25	12.1	0.001*	0.218
DTI% in CAR (MT+OC)	28.39±5.72	30.43±6.99	36.42±4.55	7.729	0.001*	0.151
Fall numbers	2.3±1.74	5.13±2.63	9.93±5.14	36.674	0.001*	0.457

*The difference is significant.

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Abbreviations: FOF: fear of falling; DTI: Dual-task interference; CAR: Correct answer rate; MT: Mental tracking; TUG: Timed up & go; OC: Obstacle crossing; VF: Verbal fluency; FW: Forward walking.

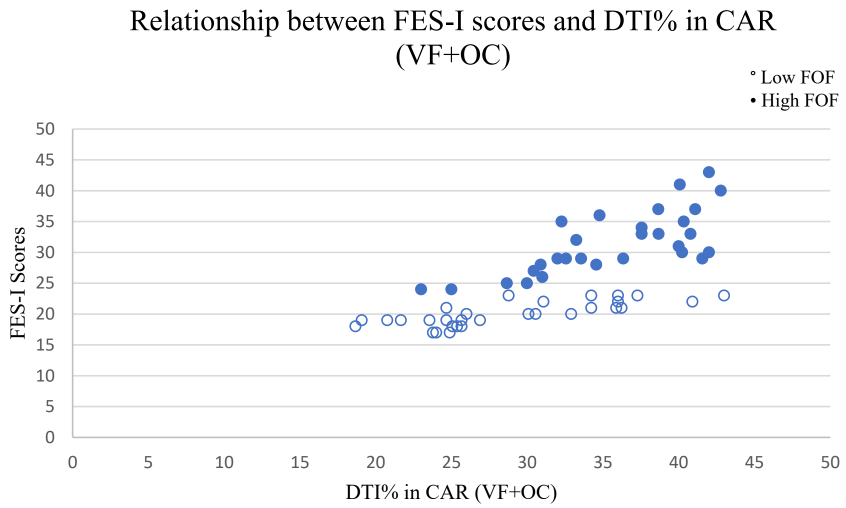

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Figure 2. A significant positive relationship was identified between FES-I scores and DTI% in CAR (VF+OC) (P<0.001; r=0.72; n=60)

Abbreviations: FES-I: Falls efficacy scale-international; DTI: Dual task interference; CAR: Correct answer rate; VF: Verbal fluency; OC: Obstacle crossing).

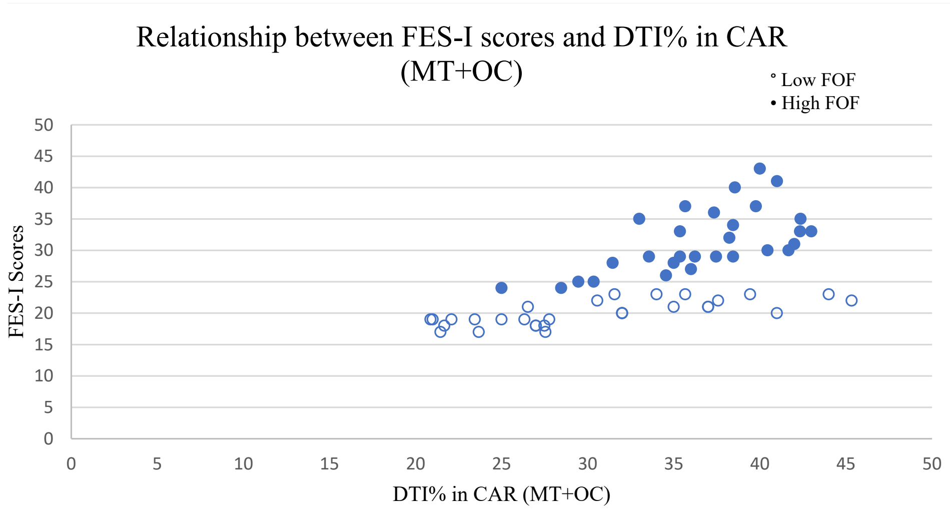

Figure 3. A significant positive relationship was identified between FES-I scores and DTI% in CAR (MT+OC) (P<0.001; r=0.65; (n=60)

Abbreviations: FES-I: Falls efficacy scale-international; DTI: Dual task interference; CAR: Correct answer rate; MT: Mental tracking; OC: Obstacle crossing.

The results of pair group comparisons identified the statistically significant difference in DTI% in CAR (MT+TUG) between high FOF and no FOF groups (95% CI, -19.432%, -12.249%, P=0.01), and high FOF and low FOF groups (95% CI, 9.226%, 20.364%, P=0.02). The statistically significant difference was also identified in DTI% in CAR (VF+OC) between high FOF and no FOF groups (95% CI, -18.436%, -0.624%; P=0.03), and high FOF and low FOF groups (95% CI, 9.03%, 26.843%; P=0.041). The difference in DTI% in CAR (MT+OC) was statistically different between high FOF and no FOF groups (95% CI, 6.951%, 13.871%; P=0.001), and high FOF and no FOF groups (95% CI, 3.069%, 19.988%; P=0.01). There was also a statistically significant difference in fall numbers between no FOF and low FOF groups (95% CI, -6.033%, -0.634%; P=0.01), high FOF and no FOF groups (95% CI, -9.833 %, -5.434%; P=0.001), and high FOF and low FOF groups (95% CI, -6%, -2.6%; P=0.001).

In participants with FOF, a significant positive relationship was seen between FES-I grades and DTI% in CAR (MT+TUG) measures (r=0.76, P<0.001) (Figure 1), FES-I scores and DTI% in CAR (VF+OC) measures (r=0.72, P<0.001) (Figure 2), and also between FES-I scores and DTI% in CAR (MT+OC) measures (r=0.65, P<0.001) (Figure 3). The correlation among FES-I scores and other dual-task interference measures was not significant.

Discussion

The principal goal of the current investigation was to figure out the cognitive-motor interference experienced by older people with different grades of FOF. This study also investigated the associations between cognitive-motor interference measures and FES-I in older persons with FOF. The current results demonstrated a significant difference in cognitive performance between the three groups during dual-task conditions (DTI% in CAR), including MT+TUG, VF+OC, and MT+OC. FES-I score was also positively related to DTI% in CAR (MT+TUG), DTI% in CAR (VF+OC), and DTI% in CAR (MT+OC) measures in participants with FOF.

According to current results, all mobility performances during dual-task conditions (DTI% in walking) were not different between the three groups. Walking is not an isolated daily activity; it is mostly part of a dual-task or multi-task performance [22]. The satisfactory attention to each simultaneous performance allows subjects to walk safely in various physical environments [23]. Based on a previous study, older people prioritize mobility performance over cognitive tasks during balance disturbances [13]. This finding has mainly been reported in walking and standing tasks [13]. Older people may adopt mobility task prioritization to improve their ability to balance maintenance and diminish the possibility of falling during dual-task execution [13]. Based on the current results, older people with FOF may still prioritize walking to maintain their physical performance.

Current results identified differences in some cognitive performances during dual-task conditions (DTI% in CAR) between the three groups. Cognitive performance during simple mobility tasks such as FW did not change; however, during more complicated mobility tasks, including TUG and OC, a significant difference in cognitive performance was identified between no FOF and high FOF groups and between low FOF and high FOF groups. Walking is not just an automated and cyclic process; it needs attention, which increases with age and task complexity [23]. Moreover, ignoring inappropriate information about the environment is also crucial for functional walking [9]. It has been proposed that concern about falling in older people may interfere with attention resources and reduce the ability to inhibit inappropriate inputs from surroundings [14]. During dual-task conditions, the amount of attention needs to be higher for mobility and cognitive tasks to manage both performances similarly [8]. Based on the current results, older people with high FOF and limited attentional resources may decrease their cognitive performance to maintain their capability to perform more challenging mobility tasks like TUG and OC. In the present study, VF performance during TUG was not different between the three groups; however, MT performance during TUG was different between no FOF and high FOF groups and between low FOF and high FOF groups. More challenging cognitive tasks, such as MT, are more likely to be impaired during dual-task conditions in the high FOF group.

Fall numbers during the last year were different between the three groups. Previous studies revealed that FOF may reduce the ability to adapt to the surrounding environment during walking, resulting in heightened instability and the risk of falling [6, 7]. Based on the current results, broadening the amount of FOF may increase the fall total in older people.

The correlational analysis demonstrated three significant relationships between cognitive-motor interference measures and FES-I scores in older adults with FOF. Although a causal relationship between these variables cannot be defined from the present study, these results may indicate the influence of FOF on cognitive-motor performance in the aged population. Therefore, it may be necessary to explore the consequence of a decreased FOF on dual-task performance in the elderly community. While this study indicates that there may be a relationship between FOF and cognitive-motor performance, the underlying mechanisms of this association are unclear. Neuroanatomical evidence indicated several pathways between the frontal cortex and subcortical areas, which may explain the influence of emotions on walking performance [24]. A previous study demonstrated more FOF and dysfunction of the frontal cortex and subcortical area in older people with increased gait variability compared to a control group of similar age and sex [24]. According to these results, cortical dysfunction due to FOF may influence walking performance.

There were limitations regarding the current study. First, all participants in this study had no cognitive disorder. The high prevalence of cognitive disorders in older adults might limit the generalization of the current results. Second, the information about falls was retrospectively collected in this study. Many people may not remember the exact number of falls during the last year, so a recall bias may affect fall assessment in the current study. Third, group assignment in this study was based on the FES-I score.

For this reason, the assessor could not be blinded to group assignments, which may increase the risk of bias. Fourth, several potential physical impairments due to aging, including loss of endurance, flexibility, weakness, balance, and neuromuscular impairments, may influence the ability of individuals to perform the tests in this study. Unfortunately, these potential confounders were not measured in the current study. Further investigations should explore the impact of these confounders on the association between FOF and cognitive-motor performance.

Despite these limitations, the FOF was evaluated using FES-I, a comprehensive questionnaire that provides information regarding the FOF level compared to a dichotomous FOF statement (yes or no) [17, 18]. The mini-mental state examination was a reliable and valid tool for evaluating cognitive impairment. It was also used for screening cognitive impairment [16]. Cognitive-motor tasks were also performed with different difficulty levels to supply robust comparisons.

According to the prevailing outcomes, it is beneficial for therapists to consider FOF as a tool for assessing walking performance in older adults. Cognitive behavioral therapy was distinguished as a practical approach to diminishing FOF in the older population [25]. As walking is frequently a component of a dual-task or multi-task activity, it is recommended that more studies invesate the impact of cognitive behavioral therapy on dual-task performance in elderly individuals with FOF.

Conclusion

The current results indicate that cognitive performance during dual tasks in walking may be impaired in older people with high FOF levels. Future clinical trials may be needed to investigate whether reduced FOF has the advantage of dual-task improvement in the elderly population.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by Mashhad University of Medical Sciences (Code: IR.MUMS.REC.1398.165).

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Authors' contributions

Conceptualization, investigation, writing, review, and editing: Mania Sheikh; Methodology, and writing the original draft: All authors; Funding acquisition, resources, and supervision: Hossein Asghar Hosseini.

Conflict of interest

The authors declared no conflict of interest.

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