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Review Paper

Functional Gait Assessment Tests in Elderly: A Systematic Review

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ABSTRACT

Background: Due to the mobility problems of the elderly, it is better to use low-cost and applicable methods in any place, which do not require expertise to measure gait. One of these ubiquitous methods is functional gait assessment (FGA).

Objectives: The purpose of this study was to collect and evaluate FGA in the elderly.

Materials & Methods: This study conducted a comprehensive study of FGA in the elderly by searching the databases of PubMed, MEDLINE, Web of Science, ScienceDirect, Cochrane Central Register of Controlled Clinical Trials, Google Scholar, Scopus, MAGIRAN, IRANDOC, Iran Medex, MedLib, and SID from 1996 to November 2020. After compiling the search results, we first studied the titles and then the abstracts. If an article matched the inclusion and exclusion criteria, its results were used in the review study; otherwise, it was excluded.

Results: Based on the research criteria and objectives, from 23 different tests, the results of 19 articles that studied FGA in the elderly were selected and reported.

Conclusion: Studies seem to attempt FGA in the elderly using different methods and for different purposes. For example, studies to assess gait velocity, normal gait, and gait, along with functional and cognitive tasks, have measured FGA in the elderly. Besides, the two main features of a valid test including sensitivity and specificity have been less studied. Therefore, more studies should focus on these test features in measuring FGA in the elderly.

Keywords: Gait, Sensitivity and specificity, Neuropsychological tests

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Highlights

- In this review study, 19 articles were found from 23 multiple tests that attempted to examine functional gait assessment (FGA) in the elderly.

- Studies show that they treat FGA in the elderly using different methods and for different purposes.

- Besides, the two main features of a valid test including sensitivity and specificity have been less studied; therefore, more studies should focus on these test features in measuring FGA in the elderly.

Introduction

Aging is part of the biological process experienced by humans. Along with the growth of the elderly population globally, Iran's population is also moving towards aging. It is estimated that by 2026, elderly Iranians will account for about 11% of the country's total population [1]. One of the major challenges facing elderly care systems is the problem of falling among the elderly. Studies show that one in three older adults over the age of 65 experiences falls at least once a year with serious consequences [2]. Therefore, all elderly care systems sought to reduce or delay the number and frequency of falls in the elderly to increase active social participation of the elderly.

Aging leads to several significant changes such as increased reaction time, decreased balance, decreased neuromuscular coordination, decreased muscle strength, decreased flexibility, decreased posture control, and, consequently, increased risk of falls [3]. Therefore, studies use different tools and methods to examine each of these factors and predict the rate of falls in the elderly [4]. Using the results of these measurements, a series of interventions and detailed programs are developed to reduce the rate of falls in the elderly [5]. Therefore, the tools and methods used to study and predict the rate of falls in the elderly, including the study of gait in the elderly [6], are extremely important.

Gait is considered a basic skill to which most daily human motor activities are dedicated [6]. To control stature and maintain rhythm and stability while gait, a sophisticated control system is needed that can adapt to internal and external changes [7]. This control system depends on the coordination of sensory systems that detect the body's position and movement, the visual environment, and the operating organs that produce postural and kinetic reactions [8]. In old age, this skill faces some problems including decreased gait speed, shorter stride length, increased double support time, decreased cadence, increased postural fluctuations, and greater variability of spatial-temporal parameters [9]. From this perspective, gait is considered an indicator to determine the degree to which the elderly can achieve independence in carrying out their daily activities [10]. Therefore, it is necessary to scrutinize this factor in the elderly because gait studies have been considered one of the main factors in predicting falls in the elderly [6].

The elderly population is growing. With age, the rate of falls in the elderly also increases, leading to several serious complications. Therefore, health systems must do their utmost to prevent falls among the elderly. One of the predictors of the risk of falls is the study of gait in the elderly, which requires appropriate methods. The reason is that the necessary interventions are made based on the results of this evaluation. Studies have used different methods to assess gait in the elderly. Gait in the elderly has been evaluated in two ways: the use of advanced equipment and functional tests [6]. The former increases the accuracy of measurements, while the latter is costly and cannot be applied anywhere. Due to the mobility problems of the elderly, it is better to use low-cost and applicable methods in any place, which do not require expertise to measure gait. One of these ubiquitous methods is functional gait assessment (FGA). Therefore, this study collects all FGAs used to evaluate the elderly for a general review of the tests and their functional characteristics. Therefore, the purpose of this review study is to evaluate FGA in the elderly.

Materials and Methods

Search strategies

This study conducted a comprehensive review of FGA in the elderly. For this purpose, searches were done in PubMed, Medline, Web of Science, ScienceDirect, Cochrane Central Register of Controlled Clinical Trials, Google Scholar, Scopus, Magiran, Irandoc, IranMedex, MedLib, and SID databases from 1996 to November 2020.

Keywords

A search was performed in databases using the following keywords: 1) Walk; Gait; Locomot; Ambulat; AND 2) Elder; Old; Older adult; Senescent; Senile; Aged; Gray; Geriatric; Age; Aging; AND 3) Functional tests; Physical examination; Functional performance tests; Lower extremity tests. The "AND" operator was used between the 3 keyword groups, while the "OR" operator was used within each keyword group. After collecting the search results, first, the titles were studied followed by the abstracts. If an article matched the inclusion and exclusion criteria, its results were used in the review study; otherwise, it was excluded. Based on the criteria and objectives of the research, 19 articles were selected after evaluation. All articles were provided in full text.

Exclusion and inclusion criteria

Inclusion criteria: In the first stage, the titles and abstracts of descriptive studies were screened with a focus on FGA in the elderly and their publication in Persian and English. Then, a research assistant independently reviewed the abstracts of the articles. The second step involved screening the entire text by a researcher concerning the release of the index (i.e. FGA in the elderly) and a specific target population (i.e. elderly). A senior researcher then checked the final list of selected papers to ensure that all papers aligned with the research objectives. A summary of the descriptive information was then collected by the research assistant and checked by the senior researcher. A sample table (Figure 1) was used to extract information about the target population, FGA in the elderly, and their results.

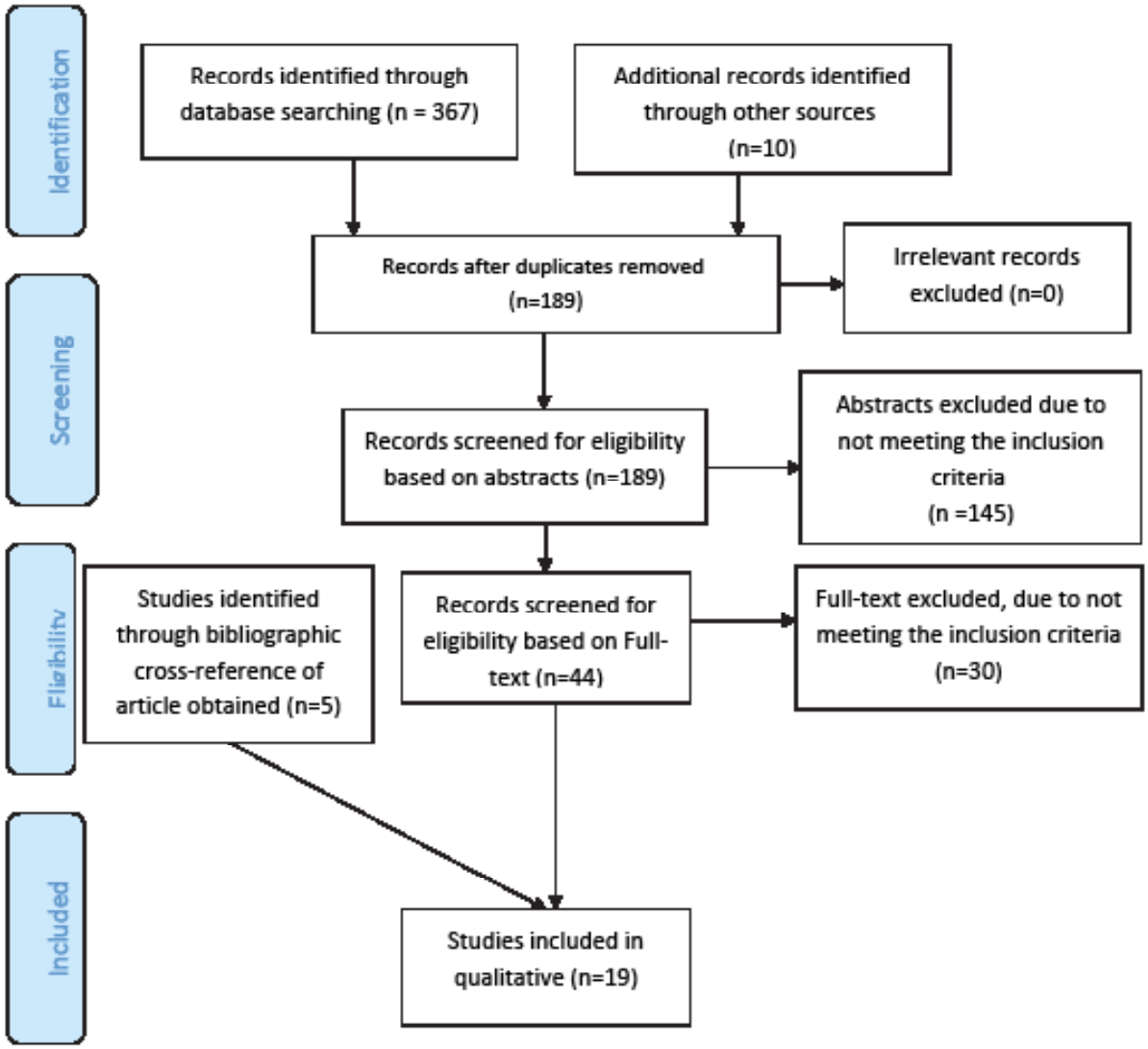

Figure 1. Shows the steps for selecting studies.

Exclusion criteria: The exclusion criteria included articles that did not address the elderly statistical population, articles that did not well define the stages of a test, and articles that used rigorous laboratory tools, which are not classified as functional tests.

Quality of evidence

The risk of bias was evaluated by both reviewers using Newcastle-Ottawa Quality Assessment Scale (NOS) [11]. Herzog et al.'s checklist for cross-sectional studies was employed [11]. Quality was assessed based on Herzog et al., as follows: Very Good Studies: 9-10 stars, Good Studies: 7-8 stars, Satisfactory Studies: 5-6 stars, Unsatisfactory Studies: 0-4 stars [11].

Data extraction

Data from studies were extracted independently by Researchers using some measures including the first reference and name of functional tests, validity, reliability, an explanation of how to evaluate and perform functional tests, and quality of evidence (Table 1).

Results

An electronic resource search yielded 367 titles. Furthermore, manually searching and reviewing the sources of articles gained 10 more titles. Following the removal of duplicate titles, 189 abstracts were identified for review. After reviewing the articles' titles and abstracts, 145 articles were excluded, and 44 articles were selected to read the full text. After reviewing the articles' full text, we selected and reported the results of 19 articles from 23 different tests, which studied FGA in the elderly (Table 1).

Based on the results of NOS, studies that were systematically reviewed had desirable qualities: 5 studies (22%) as very good (9-10 stars); 10 studies (44%) as good (7-8 stars), and 8 studies (34%) as satisfactory. Therefore, the studies that were systematically reviewed are of a very good to satisfactory quality. Results were shown in Table 1.

Discussion

This study aimed to evaluate FGA methods in the elderly. A review of the studies revealed that the studies used several methods to evaluate FGA in the elderly. In this review study, 19 articles were found from 23 multiple tests that attempted to examine FGA in the elderly. The features of these tests are discussed below.

An important factor examined in most FGAs in the elderly is gait assessment in the elderly speed [13, 21, 22, 26, 28]. Older people who take the test will score high in a short period, indicating that they are less prone to falls. Studies have examined the relationship between gait velocity and the risk of falling elderly [30, 31]. According to the results, the lower the gait speed in the elderly, the higher the risk of falls. Moreover, gait speed tests suitable for the elderly have been identified. Attempts have been made to answer the following questions: "Should tests be used in which the elderly are asked to walk at maximum speed or normal speed?" "Which of these factors best predicts the risk of falls in the elderly?" A study showed that both normal gait and gait factors with maximum speed could well predict the risk of falls in the elderly [32]. Therefore, in the case of gait in the elderly speed factor assessment tests, no distinction can be made between the tests that examined the maximum gait in the elderly rate and those that examined their normal gait rate. Both can predict the risk of falls in the elderly with approximately an equal probability.

Additionally, a 6-minute walking test [27] is designed to assess lower extremity muscle endurance in the elderly. In this test, the older the person who can walk, the more distance in 6 minutes and the higher the score, indicating a better physical condition of the elderly. Studies have evaluated the ability of the 6-minute walking test to predict the risk of falls in the elderly [33, 34]. The results showed that the 6-minute walking test could predict the risk of falls in the elderly with greater accuracy. It is also closely related to other physiological and psychological factors of the elderly. Therefore, it can be concluded that the 6-minute walking test is a practical test for assessing gait in the elderly. The results of this test can be used to evaluate the functional characteristics and risk of falls in the elderly.

Furthermore, among the FGA, several tests have examined gait by adding functional and cognitive tasks to the case [24-29]. Several tasks were imposed on the elderly during gait to approximate the normal daily life of the elderly and to examine the elderly gait. These studies have shown that several other posture control factors may be involved in gait in the elderly and increase the risk of falls in the elderly. Therefore, these studies attempted to examine gait in the elderly by giving multiple tasks. Several studies have also investigated the effect of these tasks on gait in the elderly [35-37]. They concluded that multiple posture control factors could affect gait in the elderly, and consequently, increase the risk of falls in the elderly [38]. Studies have shown that the risk of falls in the elderly increases by adding task posture control during gait [39].

Table 1. Results from studies addressing FGA in the elderly

Tests	Reliability	Validity	Specificity	Sensitivity	Descriptions	NOS Scales
Stated a modified TUG version expanded [12]	0.81	0.78	N/A	N/A	In this test, each subject rises without using their hands from a chair without a fixed arm resting on it. After a straight 10-meter walk, he returns and sits back in his chair. In this test, people were asked to take the desired route as quickly as possible (without running).	Good
Usual or habitual gait speed [13]	0.99-1.00	0.95	N/A	N/A	Normal gait velocity (UGS) (also known as normal gait velocity (HGS) or gait velocity measurement in a straight line) is a useful evaluation test, which provides us with important information about a person's overall functional capacity.	Good
Short physical performance battery [14]	0.87	0.74	N/A	N/A	This test is used to check gait, balance, strength, and endurance in the elderly. This test is divided into three subtests: 1) static balance assessment, 2) normal gait speed assessment, and 3) 5X Sit-To-Stand test.	Good
8 Foot-up-and-go [15]	0.9	0.81	86%	78%	It is a modified version of the Timed Up and Go test (TUG), as a combined measure of strength, speed, ability, and dynamic balance. This test is similar to the TUG test with some minor differences: the gait distance is reduced from 9.84 feet (3 meters) to 8 feet (2.44 meters).	Satisfactory
Figure of 8 walk test [16]	0.84-0.90	0.75	N/A	N/A	This test was modified by Hess et al. (2010) to describe the complex abilities and skills of walking in everyday life through straight, curved paths. This new test was the first evaluation tool to provide a curved path in both clockwise and counterclockwise directions, with a straight path between them.	Satisfactory
Trail walking test [17]	0.95	N/A	N/A	N/A	In this test, 15 flags are randomly installed in an area of 25 square meters in 15 different positions, marked with a circle with a diameter of 30 cm. Participants are then asked to move between the numbered flags in ascending or descending order, respectively.	Good
Modified gait efficacy scale [18]	0.93-0.95	N/A	N/A	N/A	This test is performed to evaluate mobility based on the principle of self-sufficiency in gait. An association has been identified between this test and several other motor function tests, including TUG, 6MWT, F9W, gait velocity, and barrier gait test.	Very good

Tests	Reliability	Validity	Specificity	Sensitivity	Descriptions	NOS Scales
Dynamic gait index [19]	0.95	N/A	N/A	N/A	In this test, the functional position includes a 50-foot (15.2-meter) walk. Gait when changing speed gait, gait with head rotation in vertical and horizontal directions, and gait with axial rotation when announcing, walking over obstacles, and going up or down stairs	Satisfactory
Timed up and go test [20]	0.97	N/A	N/A	N/A	In this test, each subject rises without using their hands from a chair without a fixed arm resting on it. After walking a straight 3 meters, he returns and sits on a chair again.	Good
10-Meter walk test [13]	0.95-0.99	0.60-0.87	N/A	N/A	In this test, the subject was asked to complete a 10-meter route at the maximum possible speed. Each subject performed this test twice. Then, his best record was calculated.	Very good
8-Foot walk time test [21]	N/A	N/A	N/A	N/A	In this test, the subject must rise from a chair without handles without using his or her hands, walk an 8-foot (2.44 m) path, and return to sit in the same chair again.	Good
Tinetti mobility test [1]	0.85	0.97-0.98	94%	N/A	In this test, subjects are asked to stand and try to gait in the room as soon as they hear the word go. Then, the desired components are evaluated and scored.	Very good
Functional gait assessment test [1]	N/A	N/A	N/A	N/A	FGA test: This test consists of 10 factors: 1) gait level, 2) change in gait velocity, 3) gait with the vertical rotation of the head, 4) gait with the horizontal rotation of the head, 5) gait and pelvic rotation, 6) gait from zinc obstacles, 7) gait with a low level of support, 8) gait with eyes closed, 9) moving backward, and 10) climbing stairs.	Very good
Speed gait cognitive [23]	0.91	0.84	N/A	N/A	The dual cognitive-gait task involves performing the gait speed test at a distance of 10 meters at normal speed, simultaneously counting down 30 randomly.	Good
Speed gait manual [24]	0.91	0.84	N/A	N/A	Dual motor-balance task, performing the gait speed test at a distance of 10 meters at normal speed, while holding a cup of water in people's superior hand. A stopwatch measures participants' gait speed.	Satisfactory
Complex gait test [17]	0.60	N/A	89%	N/A	In this test, the subject steps on a smooth and straight path of 6 meters in the fastest possible time. He then turns to the right and zigzags through four obstacles.	Satisfactory
Gait performance [17]	0.80	N/A	N/A	N/A	In this test, a person normally walks on a path with two obstacles at the beginning and end of a corridor at a distance of 5 meters from each other.	Satisfactory
2.4 Meter walk test [25]	0.95	N/A	N/A	N/A	In this test, the person is asked to "walk back and forth at his/her desired speed" for 2 minutes on a 60-foot walk.	Very good
Maximal walking speed [26]	0.93	N/A	N/A	N/A	Here, the maximum gait speed is measured when people cross the 10-meter floor. The total length of the designated footpath is 14 meters, making it possible to accelerate and reduce speeds by 2 meters. This test is performed twice, and the best record is set.	Good

Tests	Reliability	Validity	Specificity	Sensitivity	Descriptions	NOS Scales
10-Meter obstacle walk test [13]	0.76	0.89	N/A	N/A	To perform the 10-meter gait test on an obstacle course, the subject traverses (by gait and without running) a 10-meter route with six obstacles (2 meters apart) to a height of 20 cm.	Good
6-Minute walking test [27]	0.97	N/A	N/A	N/A	To perform the 6-minute gait test, the subjects travel (with gait) a distance of 25 meters back and forth in 6 minutes. Then, the total distance (in meters) traveled by the subjects in 6 minutes is calculated.	Satisfactory
Time 25-foot walk test [28]	0.86	N/A	N/A	N/A	Two tests are performed. The person begins to gait from a marked line on the ground. They are instructed to walk "as fast as possible but safely" at a distance of 25 feet away from the second line.	Good
Slow gait speed test [29]	N/A	N/A	N/A	N/A	The four marks are placed at a distance of 6 meters from each other on a flat surface with adhesive tape. The marking distance is as follows: (I) the first mark at the beginning, (II) the second mark at a distance of 1 meter, (III) the third mark at a distance of 4 meters from the second mark, and (IV) the fourth mark at a distance of 1 meter from the third mark.	Satisfactory

Abbreviations: FGA: functional gait test; TUG: time-up and go test; 6MWT: 6-meter walk test

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Therefore, it can be concluded that the purpose of designing these tests is to examine the effect of several different tasks during gait in the elderly. The results of this test can help accurately and correctly predict the physical condition and the risk of falls in the elderly.

Features of a valid functional test include validity, reliability, sensitivity, and high specificity. This review study examined FGA and found that validity and reliability were reported for most FGAs. However, few studies have addressed the sensitivity and specificity of FGA in the elderly. The sensitivity and specificity of tests were not reported for most FGAs. Sensitivity means that the number of people who fall is correctly identified, and specificity means that the number of people who do not fall is correctly identified. High sensitivity indicates that the test is suitable for screening.

On the other hand, high specificity indicates that the test is suitable for diagnosis. Therefore, studies should also specifically address the sensitivity and specificity of FGA in the elderly, as they help to more accurately analyze gait in the elderly functional tests. As a result, more accurate and appropriate interventions and programs can be developed following FGA measurements in the elderly.

This review study used a systematic search methodology but failed to quantify the articles. Although most articles taken from reputable international scientific-research journals are domestic and have an acceptable quality rating, care should be taken in generalizing their results. Moreover, although complete search strategies were used, only English and Persian articles were reviewed. There may be other related articles in other languages. Therefore, considering the mentioned limitations, future research should review the articles qualitatively.

Conclusion

Studies show that they treat FGA in the elderly using different methods and for different purposes. Studies to measure gait speed, normal gait, gait, and functional and cognitive tasks have helped measure functional gait in the elderly. Few studies have addressed the two main features of a valid test, sensitivity, and specificity. Studies should focus as much as possible on these test features in measuring FGA in the elderly.

Ethical Considerations

Compliance with ethical guidelines

Since this study is a review and does not require ethical approval, no university has been approved by the ethics committee. Also, the ethical principles in writing the article have been observed according to the instructions of the National Ethics Committee and the COPE regulations.

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Authors' contributions

Conceptualization: All authors; Methodology and Investigation: Esmail Balaiy, Hamed Zarei; Supervision, Writing--original draft, Writing--review & editing: Ali Asghar Norasteh, Hamed Zarei; Funding acquisition: Esmail Balaiy; Resources: All author.

Conflict of interest

The authors report no conflict of interest.

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