# GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 12 (345) Декабрь 2023

ТБИЛИСИ - NEW YORK


ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

**GEORGIAN MEDICAL NEWS**

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

**GMN: Georgian Medical News** is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

**GMN: Медицинские новости Грузии -** ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

**GMN: Georgian Medical News –** საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

**WEBSITE**

www.geomednews.com

## К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

**При нарушении указанных правил статьи не рассматриваются**.

## REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.**

## ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

*GEORGIAN MEDICAL NEWS*
*No 12 (345) 2023*

*Содержание:*

*GEORGIAN MEDICAL NEWS*
*No 12 (345) 2023*

# THE EFFECT OF A 6-WEEK BALANCE EXERCISE PROGRAM ON BALANCE PARAMETERS IN FRAILTY SYNDROME: A RANDOMIZED CONTROLLED, DOUBLE-BLIND, PROSPECTIVE STUDY

**Sevil Karagül[1], Sibel Kibar[2], Saime Ay[3], Deniz Evcik[4], Süreyya Ergin[5].**

[1]*Istanbul Gedik University, Faculty of Health Sciences, Physical therapy and rehabilitation, Istanbul, Turkey.*

[2]*Atılım University, Vocational School of Health, Department of Physiotherapy and Rehabilitation, Ankara, Turkey.*

[3]*Ufuk University, School of Medicine, Department of Physical Medicine and Rehabilitation, Ankara, Turkey.*

[4]*Ankara Güven Hospital, Department of Physical Medicine and Rehabilitation, Ankara, Turkey.*

[5]*Retired Faculty Member Ankara University, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Ankara, Turkey.*

## Abstract.

**Objective:** This study assessed the effectiveness of a six-week balance exercise program on balance parameters and fall frequency in geriatric patients with frailty syndrome.

**Methodology:** This randomized prospective study evaluated a total of 216 patients after referral to a physical medicine and rehabilitation outpatient clinic. Participants were divided into group 1 (flexibility exercises) and group 2 (balance exercises, including kinesthetic ability trainer [KAT] balance exercises, and flexibility exercises). Both groups performed exercises five days per week for six weeks. Balance assessments included the Berg Balance Scale and time-up-and-go test to evaluate dynamic and functional balance, while the one-leg stand test and KAT 4000 static balance test were done to evaluate static balance.

**Results:** Frailty was observed in 37 patients (17.12%). Patients without frailty syndrome initially performed significantly better ($p < 0.001$). Group 2 demonstrated statistically significant improvements after six weeks ($p < 0.05$).

**Conclusion:** Long-term exercise programs improve balance parameters and exercise performance in older adults with frailty.

**Key words.** Frail elderly, postural balance, exercise, falls.

**Abbreviations.** ACSM: American College of Sports Medicine; BBS: Berg Balance Scale; BDI: Beck Depression Inventory; KAT: Kinesthetic Ability Trainer; SLS: The single-leg stance; TUG: The timed up go.

## Introduction.

Frailty syndrome, affecting 7-23% of individuals over 65, is a chronic condition characterized by increased vulnerability to stressors [1]. These include falls, balance problems, fractures, disabilities, comorbid conditions, higher healthcare costs, and even premature death [2]. Common markers of frailty include age-related reductions in body mass, strength, endurance, balance, walking performance, and activity levels. The clinical presence of multiple components confirms frailty status [3].

Frailty disproportionately affects women and becomes more prevalent with age [2,4]. Key symptoms include weight loss, fatigue, low activity levels, weakness, and slow walking speed [2]. Recent studies have explored the varying frequency of frailty across diverse populations and situations, with a focus on identifying modifiable risk factors for prevention or delay.

Four main intervention types target improved health and resilience in vulnerable individuals: exercise, diet regulation, multifaceted intervention, and personalized geriatric care models. Given the multifactorial nature of frailty's causes, various combinations of interventions have been tested, including exercise, behavioral therapy, nutrition, and cognitive training. Many exercise programs focus on flexibility, balance, resistance, and endurance training [2,9].

Frailty syndrome first gained recognition and validation in epidemiological studies: the Cardiovascular Health Study established it as a syndrome, while the Canadian Study of Health and Aging developed a risk index for its identification. These studies aimed to characterize the frailty's features and natural history, identify associated outcomes and underlying physiological mechanisms, and assess the biological plausibility of frailty as a distinct syndrome [2,5]. Five core components emerged as crucial for defining frailty: weight loss, reduced muscle strength or weakness, slow walking speed, exhaustion, and low activity levels [2]. While extensive research has explored frailty, the specific dynamics of fall frequency and balance in this population remain under investigated.

Balance relies heavily on the postural control system, encompassing functions of the motor, sensory, and nervous system [6]. As we age, our sway increases, even in basic postural tasks, leading older adults to exhibit greater sway than younger individuals [7]. Impaired balance directly translates to a higher risk of falls, making them more prevalent in older adults.

Sarcopenia, the loss of muscle mass, stands as the key pathophysiological mechanism underlying frailty, driven by biological aging. Additional disease states, such as malnutrition, immobility, anemia, obesity, cancer, and cardiovascular disease, can further accelerate the morbidity and mortality, associated with frailty syndrome [8].

There have been studies, examining the definitions of frailty syndrome and cardiac capacity in older adults [9,10]. These showed that balance exercises positively affected the balancing ability of older adults. However, there have been no previous studies, that monitored the effectiveness of balance exercises in frail patients. There is no consensus, regarding the optimal duration of balance exercises. In addition, it is important to raise awareness of balance problems and the risk of falling among older adults with frailty syndrome. Therefore, this study aimed to evaluate the effects of a six-week balance exercise program on the balance parameters and fall frequency in geriatric patients with frailty syndrome. It was hypothesized that the improvement in the balance parameters of patients with frailty syndrome would improve less than those of the control group after six weeks of balance exercises.

## Materials and Methods.

The study included 216 elderly individuals (age ≥65), who applied to the physical therapy and rehabilitation outpatient clinic between January to December 2016. All volunteers were evaluated for the presence of frailty syndrome based on the Fried criteria [11]. Volunteers, who were at least 65 years old, were included in the study. Patients with deficiencies in vitamin B12, 25-hydroxy-vitamin D, and folate; those with diabetes mellitus, neurological diseases, eye and internal ear pathologies, previous knee or hip surgeries, chronic arthritis, or rheumatoid diseases; as well as those, admitted for physical therapy and/or an exercise program for their pain within the previous year, were excluded. Patients with advanced cardiovascular and lung pathologies and those with uncontrolled hypertension or hypotension were also excluded since such conditions affected balance measurements and exercise performance.

The participants were randomly assigned to the two groups, based on their patient record numbers, by a colleague, who was not directly involved in the recruitment or evaluation process.

Group 1 and Group 2 went through balance exercises, dynamic and static balance training with a Sports Kinesthetic Ability Trainer (KAT) 4000 device (SportKAT LLC., Fallbrook, CA., USA), and flexibility exercises.

Two individuals, who were blinded to the groups, performed the evaluations at baseline and the end of the six-week exercise program. Patients, who had been using antidepressants or anti-epileptic drugs for more than three months in both groups, were allowed to continue taking their medications, but no new drugs other than paracetamol were permitted during the study. This research was conducted in accordance with the Declaration of Helsinki, and it was approved by the Research Committee. All patients and the University School of Medicine provided written informed consent. The registration number for this study is 31032015-4.

**Balance exercises:** Group 1 and Group 2 went through the low-level balance exercises, recommended by the American College of Sports Medicine (ACSM). These exercises are not strenuous and may be performed alone [12]. The ACSM recommendations included the following activities: postures that gradually reduce the base of support (two-legged stand, semi-tandem stand, tandem stand, or one-legged stand), dynamic movements that disturb the center of gravity (tandem walk or circle turns), exercises that stress the postural muscle groups (heel or toe stands), and exercises that reduce sensory input (standing with one's eyes closed) [12]. Training was provided by an experienced physiotherapist for six weeks (20 min per session and five days a week).

**KAT balance training:** Group 1 and Group 2 also had five minutes of static and five minutes of dynamic balance training with the KAT device thrice weekly during the program.

**Flexibility exercises:** Active static flexion exercises were prescribed to the eight large muscle groups. There were three 60-second stretching repetitions for the neck, back, lower back, biceps, triceps, gluteal, iliopsoas, quadriceps femoris, hamstring, and gastrosoleus muscle groups [13]. Ten minutes of walking in place was also recommended as a warm-up for stretching exercises. Group 1 and Group 2 performed flexibility exercises under the physiotherapist's supervision during the program. The order and manner of performing the exercises were visually explained to the participants using illustrated exercise forms.

Patient attendance was monitored by the physiotherapist, and all patients received a weekly telephone call to ensure that they achieved the required attendance of 80% (at least four days a week).

The patients' sociodemographic data (i.e., age, sex, body mass index, education level, working status, and antidepressant or antiepileptic drug usage) were recorded.

To establish a fall history, the patients were interviewed regarding the number of times they had fallen in the preceding year. Falling was defined as unintentionally coming to rest on the ground, floor, or other lower levels with or without an injury [14].

The Berg Balance Scale (BBS) was used to assess functional balance, a widely used parameter in rehabilitation [15]. It consisted of 14 items, particularly static balance measurements (e.g., standing unsupported, single leg stance [SLS]), dynamic balance, and functional assessment during commonly performed daily activities, including reaching forward, standing up from a sitting position, and retrieving objects from the floor [16]. A five-point scoring scale with a maximum score of 56 points was used. The validity and reliability of the Turkish version of the BBS were proven by Şahin et al. [17].

The timed up-go (TUG) test is a practical equipment-free assessment tool for mobility [18]. To start, the participant sits on a chair, stands up with the "Start" command, walks to a marked place 3 meters ahead, returns, and sits down on the chair again. The elapsed time is then recorded. Scores of more than 20 s indicate the need for a walking aid and training, while scores of 30 s or more indicate a tendency to fall [19,20].

Dynamic and static balance were evaluated using a KAT device. The device has a movable platform and a tilt sensor, connected to a computer. For both static and dynamic balance tests, the patients were asked to stand barefoot on the platform. A computer screen was positioned directly in front of the participants to provide concurrent biofeedback on their position. Each test lasted 30 s and was repeated thrice. The highest score was accepted as the final score. Higher scores indicated poor balance [21].

The Hendrich II Fall Risk model was used to evaluate the fall risk. It included risk factors, such as confusion (4 points), depression (2 points), changes at discharge (1 point), vertigo (1 point), male sex (1 point), use of antiepileptics (2 points) and benzodiazepines (1 point), and the standing up and walking test (8 points). The maximum score was 20, and a total score of 5 or greater signified a higher risk for falls [22]. The validity and reliability of the Turkish version of the scale were previously verified [23].

The SLS test assesses balance and static standing ability. It is an inexpensive, time-consuming, and easy test, that can be performed without special equipment. The patient was asked to safely stand on one foot while raising the other. Values below 10 s indicated a balance disorder, while values below 5 s indicated a risk of falling [24].

The quality of life was measured by the Turkish version of The Nottingham Health Profile [25]. It was designed to give

a brief indication of perceived physical, social, and emotional health problems. The newest version consisted of 38 items, answerable by "Yes" or "No". The total scores of each patient were calculated [26].

The Beck Depression Inventory (BDI) was used to assess the depression level [27]. The BDI evaluated 21 symptoms of depression. Among these items, there were 15 items on emotion, four on behavioral changes, and six on somatic symptoms. Each symptom was rated on a four-point intensity scale, and the total score ranged between 0 to 63. Higher scores indicated more severe depression. The validity and reliability of the Turkish version were verified by Hisli et al. [28].

The PASW Statistics version 18.0 for Windows software program (SPSS, Inc., Chicago, IL, USA) was used for all statistical analyses in this study. The mean values and frequencies of the parameters were assessed using descriptive statistics, and the normality of the variables was analyzed via the Kolmogorov-Smirnov test. An independent samples t-test (for parametric variables) and the Mann-Whitney U test (for nonparametric variables) were used for group comparisons, and the differences were assessed before and after treatment. A p value of $<0.05$ was considered to be statistically significant. The number of people to be included in the study to achieve a power of 90% with type 1 error of 5% and type 2 error of 10% was determined by calculating the sample size, using the G* power program.

## Results.

A total of 57 patients completed the six-week exercise program. Seven patients in the balance exercise group and four in the control group dropped out of the study. Among those who dropped out, three quit for personal reasons. Another three did not exercise for up to 20% of the exercise period, while another three were lost to follow-up. The remaining two individuals complained of leg and back pains during exercise and thus no longer wanted to participate. The allocation and randomization process are shown in Figure 1. There were no significant differences between Groups 1 and 2 with respect to the sociodemographic characteristics during the baseline measurements ($p>0.05$). The results are shown in Table 1.

Upon comparing the baseline clinical variables of the two groups, a significant statistical difference, in favor of Group 2, was observed in the BBS scores ($p=0.02$). The results are shown in Table 2. In Group 2, statistically significant improvements were observed in all parameters in the sixth week ($p<0.05$). However, no improvements were observed in Group 1 ($p>0.05$) in the sixth week. Meanwhile, significant differences were observed in all balance parameters of Group 2. The results are shown in Table 3.

## Discussion.

In the present study, the frailty syndrome group had lower BBS, TUG, standing on one leg test and KAT 4000 static balance

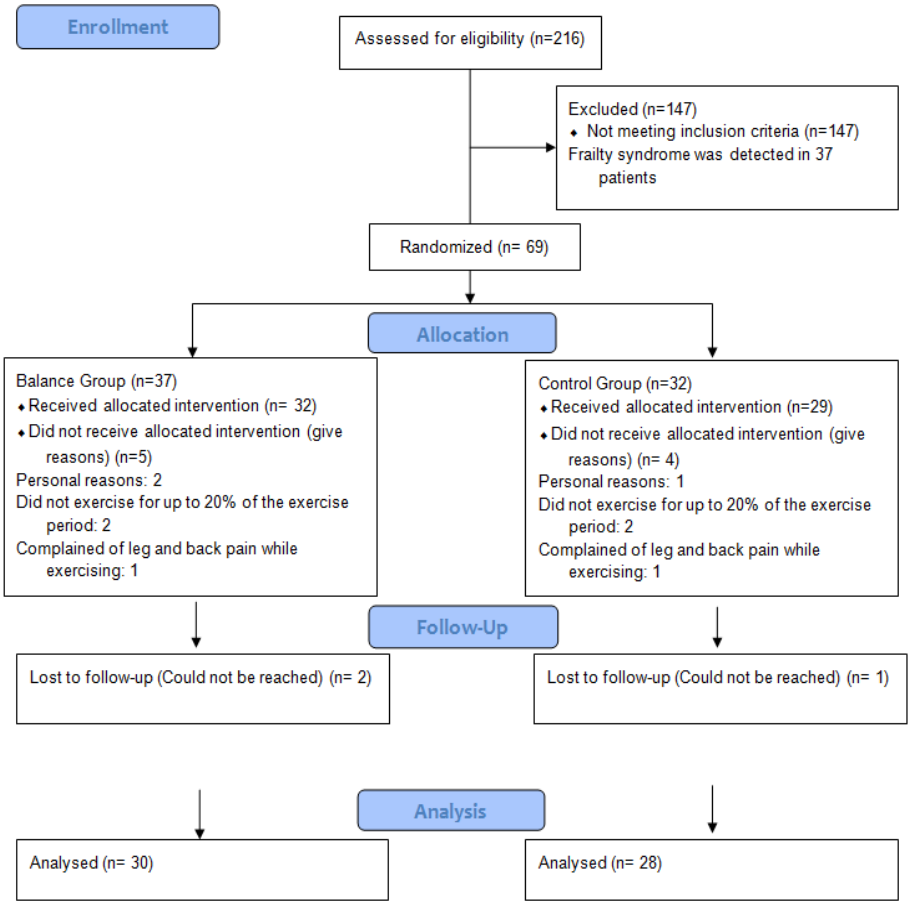


***Figure 1.*** *Allocation and randomization process.*

***Table 1.*** *Comparison of Sociodemographic Characteristics of Group 1 and Group 2.*

| | | **Group 1 (n=30)** Mean±SD | **Group 2 (n=28)** Mean±SD | **p** |
|---|---|---|---|---|
| **Age (years)** | | 76.03±7.64<br>77.50 (65-88) | 74.25±6.84<br>74.50 (65-91) | 0.33 |
| **Gender (%)** | Female | 22 (%73.3) | 19 (%67.9) | |
| | Male | 8 (%26.7) | 9 (%32.1) | 0.64 |
| BMI (kg/m2) | | 28.64±5.02<br>26.36 (21.87-39.35) | 27.22±4.97<br>26.03 (18.87-39.26) | 0.29 |
| Education (%) | Primary school | 18 (%60) | 12 (%42.9) | |
| | Secondary school | 3 (%10) | 4 (%14.3) | |
| | High school | 7 (%23.3) | 6 (%21.4) | |
| | University | 2 (%6.7) | 6 (%21.4) | 0.34 |
| **Profession (**%) | Not working | 12 (%40.0) | 5 (%17.9) | |
| | Retired | 17 (%56.7) | 19 (%67.9) | |
| | Working | 1 (%3.3) | 4 (%14.3) | 0.09 |
| **25OH Vit-D (ng/ml)** | | 16.36±10.26<br>14.50 (3-47) | 16.00±6.73<br>14 (5-31) | 0.77 |

*(SD: Standard Deviation, BMI: Body Mass Index)*

***Table 2.*** *Comparison of baseline balance and fall parameters between groups.*

| | **Group 1 (n=30)** Mean±SD | **Group 2 (n=30)** Mean±SD | **p** |
|---|---|---|---|
| **BBS** | 19.2±5.68<br>19 (4-33) | 43.03 ±3.03<br>44 (34-56) | **0.000*** |
| **Number of falls** | 2.03 ±1.58<br>2 (0-5) | 0.75±0.88<br>0.5 (0-3) | **0.02*** |
| **KATstatic** | 1111.90±324.77<br>1076 (210-1800) | 629.25±114.77<br>640 (105-810) | **0.000*** |
| **Hendrick II FRA** | 8.06±2.62<br>8 (3-13) | 3.46±1.31<br>3 (0-7) | **0.000*** |
| **TUG** | 38.40±10.27<br>36.50 (20-59) | 20.42±4.84<br>19 (8-26) | **0.000*** |
| **SLS** | 2.23±2.67<br>1 (0-9) | 16.64±11.37<br>17 (10-50) | **0.000*** |
| **NHP** | 545.81±238.65 | 178.18 ± 151.86 | **0.000** |
| **BDI** | 14.52± 16.92 | 10.87± 3.25 | **0.000** |

*(SD: Standard Deviation, BBS: Berg Balance Scale, TUG: Timed up go, SLS: Single leg stance, NHP: Hendrick II FRA: Hendrich II Fall Risk, Nottingham Health Profile, BDI: Beck Depression Inventory)*

***Table 3.*** *Changes in clinical parameters in Group 1 and Group 2 after 6 weeks of exercise program.*

| | **Group 1 (n=)** Mean SD Min-Max | **p (Group 1 BT-AT)** | **Group 2 (n=)** Mean SD Min-Max | **p (Group 2 BT-AT)** | **p (Group 1-2 AT)** |
|---|---|---|---|---|---|
| BBS | 21.20±3.75<br>20 (8-39) | 0,345 | 55.03 ±0.63<br>55 (47-56) | 0,02 | 0,000 |
| KAT Static | 989.60±253.67<br>889(198-1654) | 0,245 | 329.25±114.77<br>340 (105-510) | 0,01 | 0.017 |
| Hendrick II FRA | 7.12±1.43<br>7 (2-12) | 0,198 | 1.46±1.31<br>1 (0-6) | 0,000 | 0,000 |
| TUG | 29.31±9.47<br>27.50 (19-55) | 0,154 | 14.42±4.84<br>13 (8-26) | 0,02 | 0,000 |
| SLS | 4.11±1.57<br>3 (1-10) | 0,332 | 26.64±11.37<br>30 (10-50) | 0,000 | 0,000 |
| NHP | 487.67± 298.54 | 0,456 | 66.45 ±35.43 | 0,001 | 0,000 |
| BDI | 13.62± 15.62 | 0,238 | 7.0±1.9 | 0,000 | 0,000 |

*(SD: Standard Deviation, BT: Before Treatment, AT: After Treatment, BBS: Berg Balance Scale, TUG: Timed up go, SLS: Single leg stance, NHP: Hendrick II FRA: Hendrich II Fall Risk, Nottingham Health Profile, BDI: Beck Depression Inventory).*

measurements in the control group. In addition, the frequency of falls over the past year was higher among the frailty syndrome patients. When the balance parameters of the frailty syndrome group and the control group were examined after the six-week balance exercise program, improvements were found in all balance parameters of the control group, especially in the KAT 4000 static balance test and BBS measurements.

In the multi-center study, conducted by S. Eyigor et al. in 2015, which included 1126 older adult people, the percentage of frail older adults was reportedly 39.2% [29]. Fried and Frail frailty scales were used in the study by Sibel Akın et al., which included 906 older adult people in 2015. According to the Fried fragility scale, the percentage of frail older adults was 27.8% [30]. In the study by Sedat Özdemir et al., wherein 399 elderly individuals were included in 2017, the percentage of frail older adults was 65.5%, based on the cardiovascular health study frailty index [31]. In the study published by Jair Almeida Carneiro et al., wherein 360 older adult people in Brazil were included in 2015, the Edmonton Vulnerability Scale was used, and the percentage of frail older adults was 47.2% [32]. In a study by Buchmann et al. at the University of Berlin, Germany in 2019, the percentage of frail and pre-fragile among 1486 older individuals was 31.9%. Conversely, the percentage of non-fragile older adults was 68.1% [33]. In the present study, the percentage of frail individuals was 17.12 % according to the Fried criteria. In comparison to the other studies [29-31], the fragility rates were lower than those, obtained by other studies in Turkey [29-31]. These variations were possibly due to the different methods, used to determine frailty, the region where the study was conducted, and the development of the research center in terms of health. Moreover, the studies were conducted in different years.

Balance pertains to the postural adjustments, that maintain the center of gravity on the support surface at rest and during activity. As a result of the age-related changes in the vestibular, visual, and somatosensory systems, which effectively provide postural control and balance, the balancing capability of older individuals is impaired. This decline has been associated with reductions in cognitive, behavioral, and executive functions [34]. Frailty syndrome is a multifaceted syndrome with physical, psychological-cognitive, and social aspects [35]. Many studies mentioned the beneficial effects of mobilization therapy on preserving health status and addressing fragility among elderly patients [36]. However, the relationship between balance therapy and fall prevention has not been investigated. Most of the previous studies aimed to prevent falls. Fragility is also characterized by an increased risk of falls and fractures. Balancing and walking problems as well as limited mobility are two determining factors for falls [37]. There have been few studies on the role of balance exercises in the management of older adults with frailty syndrome. Based on the present study, performing balance exercises effectively reduced the frequency of falls in individuals with frailty syndrome.

The balance parameters of frailty syndrome patients did not improve after a six-week exercise program. Multiple studies have documented improvements in balance among older patients, following a balance exercise program [7,38]. However, the presence of frailty syndrome among these individuals was not determined. Therefore, it is important to diagnose these patients during the pre-frailty stage and initiate appropriate treatment programs, and balance exercise studies.

This study was limited because a balance device was not used, and the balance exercise treatment regimen was capped at six weeks. Thus, the long-term effects of balance exercises were not evaluated, and only the short-term results of the training were described. Moreover, since there was no follow-up evaluation period, the long-term results of the training were not determined. Further studies, examining long-term effects, should be considered because a six-week exercise program may be insufficient to fully assess balance.

## Conclusion.

The present study showed that balance disorders contribute to the disease picture in older adult patients with frailty. Moreover, frail patients experience a more severe type of balance disorder, compared to the normal population. After the six-week balance exercise program, the balance parameters of the patients with frailty syndrome did not improve. This hypothesis needs to be investigated in further clinical studies with a larger number of patients. The study showed the importance of selecting an appropriate duration for balance-oriented rehabilitation practices among older adult patients with frailty syndrome.

## Declarations.

**Ethics approval and consent to participate:**

This research was carried out in Ufuk University Faculty of Medicine, Department of Physical Medicine and Rehabilitation with the approval of Ufuk University Senate Ethics Commission with an approval number 31032015-6.

A written informed consent was obtained from the participants.

**Consent for publication:**

Not applicable.

**Availability of data and materials:**

We approve the availability of our data upon request.

**Competing interests:**

The authors declare that they have no competing interests.

**Funding:**

The authors received no financial support for the research, authorship, and/or publication of this article.

**Authors' contributions:**

**Sevil Karagül:** Conceptualization, Writing-Original Draft, Data Curation.
**Sibel Kibar:** Conceptualization ,Writing- Editing, Supervision.
**Saime Ay:** Conceptualization, Methodology, Formal analysis.
**Deniz Evcik:** Conceptualization, Methodology.
**Süreyya Ergin:** Conceptualization, Supervision.
**Acknowledgements:** Not applicable

## REFERENCES

1. Aliberti MJR, Cenzer IS, Smith AK, et al. Assessing risk for adverse outcomes in older adults: the need to ınclude both physical frailty and cognition. J Am Geriatr Soc. 2019;67:477-483.

2. Ishii H, Tsutsumimoto K, Doi T, et al. Effects of comorbid physical frailty and low muscle mass on incident disability in community-dwelling older adults: A 24-month follow-up longitudinal study. Maturitas. 2020;139:57-63.
3. Campbell AJ, Buchner DM. Unstable disability and the fluctuations of frailty. Age Ageing. 1997;26:315-318.
4. Clegg A, Young J, Iliff e S, et al. Frailty in elderly people. Lancet. 2013;381:752-762.
5. Papageorgiou D, Kosenai K, Gika E, et al. Quantification of frailty syndrome in ICU patients with clinical frailty scale. Folia Med (Plovdiv). 2020;62:655-661.
6. Duarte M, Freitas SMSF. Review of force plate-based posturography for balance assessment. Int J Environ Res Public Health. 2010;14:183-192.
7. Morris AJ, Christie AD. The effect of a mentally fatiguing task on postural balance control in young and older women. Exp Gerontol. 2020;132:110840.
8. Rosenberg IH. Summary comments. Am J Clin Nutr. 1989;50:3.
9. Walston J, Buta B, Xue QL. Frailty screening and ınterventions: considerations for clinical practice. Clin Geriatr Med. 2018;34:25-38.
10. Wleklik M, Denfeld Q, Lisiak M, et al. Frailty syndrome in older adults with cardiovascular diseases-what do we know and what requires further research? Int J Environ Res Public Health. 2022;19:2234.
11. Ishii H, Tsutsumimoto K, Doi T, et al. Effects of comorbid physical frailty and low muscle mass on incident disability in community-dwelling older adults: A 24-month follow-up longitudinal study. Maturitas. 2020;139:57-63.
12. Wolfe F, Clauw DJ, Fitzcharles MA, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. Arthritis Care Res (Hoboken). 2010;62:600-610.
13. Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine. position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc. 2011;43:1334-1359.
14. Lee PG, Jackson EA, Richardson CR. Exercise prescriptions in older adults. Am Fam Physician. 2017;95:425-432.
15. Zeeh J, Reinhardt Y, Heppner HJ. Stürze im Alter [Falls in elderly people]. MMW Fortschr Med. 2017;159:52-58.
16. Berg KO, Maki BE, Williams JI, et al. Clinical and laboratory measures of postural balance in an elderly population. Arch Phys Med Rehabil. 1992;73:1073-1080.
17. Sahin F, Yilmaz F, Ozmaden A, et al. Reliability and validity of the Turkish version of the Berg Balance Scale. J Geriatr Phys Ther. 2008;31:32-37.
18. Podsiadlo D, Richardson. The Timed" Up & Go": A test of basic functional mobilitv for frail elderlv persons. lAGS. 1991;39:142-148.
19. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Phys Ther. 2000;80:896-903.
20. Okumiya K, Matsubayashi K, Nakamura T, et al. The timed "up & go" test is a useful predictor of falls in community-dwelling older people. J Am Geriatr Soc. 1998;46:928-930.
21. Hansen MS, Dieckmann B, Jensen K, et al. The reliability of balance tests performed on the kinesthetic ability trainer (KAT 2000). Knee Surg Sports Traumatol Arthrosc. 200;8:180-185.
22. Hendrich LA, Bender SP, Nyhuis A. Validation of the hendrich II fall risk model:a large concurrent case/control study of hospitalized patient. Nursing Research. 2003;16:9-21.
23. Atay S, Turgay SA, Aycan Ö. Validity and reliability study of Hendrich II Fall Risk Model. 12. National Congress with International Participation Congress, Abstract Book. Alter Yay. Sivas 218. 2009.
24. Michikawa T, Nishiwaki Y, Takebayashi T, et al. One-leg standing test for elderly populations. J Orthop Sci. 2009;14:675-685.
25.Kücükdeveci AA, McKenna SP, Kutlay S, et al. The development and psychometric assessment of the Turkish version of the Nottingham Health Profile. Int J Rehabil Res. 2000;23:31-38.
26. Hunt SM, McKenna SP, McEwen J, et al. A quantitative approch to perceived health status: a validation study. J Epidemiol Community Health. 1980;34:281-286.
27. Beck AT, Steer RA, Garbin MG. Psychometric properties of the Beck Depression Inventory: twenty-five years of evaluation. Clin Psychol Review. 1988;8:77-100.
28. Hisli N. Beck Depresyon Envanteri'nin üniversite öğrencileri için geçerliği, güvenirliği. Türk Psikoloji Dergisi. 2989;7:3-13.
29.Eyigor S, Kutsal YG, Duran E, et al. Frailty prevalence and related factors in the older adult— FrailTURK Project. Age (Omaha). 2015;37:1-13.
30. Akın S, Mazıcıoglu MM, Mucuk S, et al. The prevalence of frailty and related factors in community-dwelling Turkish elderly according to modified Fried Frailty Index and FRAIL scales. Aging Clin Exp Res. 2015;27:703-709.
31. Özdemİr S, Öztürk ZA, Türkbeyler İH, et al. Determination of frailty prevalence by using discrete measures geriatric patients in clinic. KSU Medical Journal. 2017;12:1-5.
32. Carneiro JA, Cardoso RR, Durães MS, et al. Frailty in the elderly: prevalence and associated factors. Rev Bras Enferm. 2017;70:747-752.
33. Buchmann N, Spira D, König M, et al. Frailty and the metabolic syndrome - results of the berlin aging study ıı (BASE-II). J Frailty Aging. 2019;8:169-175.
34. Holtzer R, Friedman R, Lipton RB, et al. The relationship between specific cognitive functions and falls in aging. Neuropsychology. 2007;21:540-548.
35. Bauer JM, Sieber CC. Sarcopenia and frailty: a clinician's controversial point of view. Exp Gerontol. 2008;43:674-678.
36. Mühlberg W, Sieber C. Sarcopenia and frailty in geriatric patients: implications for training and prevention. Z Gerontol Geriatr. 2004;37:2-8.
37. Abbatecola AM, Ferrucci L, Marfella R, et al. Insulin resistance and cognitive decline may be common soil for frailty syndrome. Arch Intern Med. 2007;167:2145-2146.
38. Means KM, Rodell DE, O'Sullivan PS. Balance, mobility, and falls among community-dwelling elderly persons: effects of a rehabilitation exercise program. Am J Phys Med Rehabil. 2005;84:238-250.