# Mobile application: physical therapy interventions for frail older adults

*Aplicativo móvel: intervenções fisioterapêuticas à idosos frágeis*

*Aplicación móvil: intervenciones fisioterapéuticas a personas mayores frágiles*

**Wagner Elias de Melo Moreira[1], Gustavo Detomi Rodrigues[2], Jorge Luiz de Carvalho Mello[3], Paulo Roberto Maia[4], Diba Maria Sebba Tosta de Souza[5]**

**ABSTRACT |** The aim of this study was to build and validate an algorithm and develop a software for the multidimensional diagnosis of functional clinical vulnerability and physical therapy for older adults. This is an analytical and observational study applied in technological production, based on software engineering and user-centered design. The algorithm was developed based on studies in health databases, validated by 13 physical therapists and the software was built using the JAVA language from the algorithm's conversion. The Delphi technique and statistical analysis via the Content Validity Index (CVI) were used to validate the algorithm. The consensus was reached in the first evaluation round and the agreement between judges by the CVI was 1.0. The "Gerontofisio" mobile application was built for use on smartphones and tablets and registered at the Brazilian National Institute of Industrial Property number: BR512020002269-3; the application consists of 34 screens that guide gerontological physical therapists in decision making, serving as a support tool in the applied fields in health, health administration, illness, medical assistance and diagnostic therapy. The algorithm was built and validated, the mobile application software for the multidimensional diagnosis of clinical functional vulnerability and physical therapy treatment in older adults was developed and is valid in the field of physical therapy and should contribute to physical therapists and older adults.

**RESUMO |** O objetivo deste estudo foi construir e validar um algoritmo e desenvolver um software do tipo aplicativo móvel para o diagnóstico multidimensional da vulnerabilidade clínico funcional e tratamento fisioterapêutico em idosos. Trata-se de um estudo analítico, observacional, aplicado na modalidade de produção tecnológica, baseado na engenharia de software e fundamentada no design centrado no usuário. O algoritmo foi elaborado a partir de estudos em bases de dados da área da saúde, validado por 13 fisioterapeutas e a construção do software deu-se através da linguagem JAVA, a partir da conversão do algoritmo. Para validação do conteúdo do algoritmo, foi utilizada a técnica Delphi e análise estatística do Índice de Validade de Conteúdo (IVC). O consenso foi atingido logo na primeira rodada de avaliação, a concordância entre juízes pelo IVC foi de 1,0. O aplicativo móvel Gerontofisio foi construído para uso em smartphones e tablets, registrado no Instituto Nacional da Propriedade Industrial número: BR512020002269-3 e possui 34 telas que orientam fisioterapeutas gerontólogos nas tomadas de decisão, servindo como ferramenta de apoio nos campos de aplicação em saúde, administração sanitária, doença, assistência médica e terapia diagnóstica. Dessa forma, o algoritmo foi construído e

[1]Universidade do Vale do Sapucaí (UNIVAS) – Pouso Alegre (MG), Brasil. E-mail: wagner.fisioterapia@yahoo.com.br. ORCID-0000-0002-8287-7476

[2]Universidade Federal de São João del-Rei (UFSJ) – São João del-Rei (MG), Brazil. E-mail: detomigustavo@gmail.com. ORCID-0000-0001-8382-3368

[3]Universidade do Vale do Sapucaí (UNIVAS) – Pouso Alegre (MG), Brazil. E-mail: jorgeluis_melo@yahoo.com.br. ORCID-0000-0002-2206-4211

[4]Universidade do Vale do Sapucaí (UNIVAS) – Pouso Alegre (MG), Brazil. E-mail: prmmaia2012@gmail.com. ORCID-0000-0003-0044-195X

[5]Universidade do Vale do Sapucaí (UNIVAS) – Pouso Alegre (MG), Brazil. E-mail: souzadiba@gmail.com. ORCID-0000-0002-4743-2455

validado, o software do tipo aplicativo móvel para o diagnóstico multidimensional da vulnerabilidade clínico funcional e tratamento fisioterapêutico em idosos foi desenvolvido, é válido na área de fisioterapia e deve contribuir para fisioterapeutas e pessoas idosas.

**Descritores** | Aplicativos Móveis; Geriatria; Idoso Fragilizado; Fisioterapeutas.

**RESUMEN** | El objetivo de este estudio fue construir y validar un algoritmo y desarrollar un software de aplicación móvil para el diagnóstico multidimensional de la vulnerabilidad funcional clínica y el tratamiento de fisioterapia en ancianos. Es un estudio analítico, observacional, aplicado en la modalidad de producción tecnológica, basado en la ingeniería de software y basado en el Diseño Centrado en el Usuario. El algoritmo se desarrolló a partir de estudios en bases de datos del área de salud, validados por 13 fisioterapeutas y la construcción del software se realizó a través del lenguaje JAVA, a partir de la conversión del algoritmo. Para validar el contenido del algoritmo se utilizó la técnica Delphi y el análisis estadístico del Índice de Validez de Contenido (IVC). Se alcanzó consenso en la primera ronda de evaluación, el acuerdo entre jueces para el IVC fue 1.0. La aplicación móvil Gerontofisio fue construida para su uso en teléfonos inteligentes y tabletas, registrada en el Instituto Nacional de la Propiedad Industrial número: BR512020002269-3, cuenta con 34 pantallas que guían a los fisioterapeutas gerontólogos en la toma de decisiones, sirviendo como herramienta de apoyo en los campos de aplicación en Salud, Administración de la salud, Enfermedad, Atención médica y Terapia diagnóstica. Así, se construyó y validó el algoritmo, se desarrolló el software de aplicación móvil para el diagnóstico multidimensional de la vulnerabilidad funcional clínica y el tratamiento de fisioterapia en ancianos, que es válido en el campo de la fisioterapia y debe contribuir a fisioterapeutas y personas mayores.

**Palabras clave** | Aplicaciones Móviles; Geriatría; Anciano Frágil; Fisioterapeutas.

## INTRODUCTION

The demographic transition process changed the pattern of illness of the population[1]. Therefore, scales for the evaluation of daily activities are commonly used due to being quick instruments for risk assessment, screening and stratification[2], indicating the degree of independence of an individual in performing these activities and, indirectly, their health status and possible need for care[3].

Comprehensive Geriatric Assessment (CGA) is one of the main instruments used to identify frail older adults due to allowing a global and broad diagnostic process involving the patient and their family, observing older adults' health as a whole[4]. However, CGA can be considered slow, with an unfavorable cost-benefit ratio to public health[5].

Brazilian scientists developed the clinical-functional vulnerability index-20 (IVCF-20) as an easy-to-use screening instrument to identify frail older adults in primary care[5]. In addition to CGA and IVCF-20, other instruments are used by physical therapists in the functional evaluation of older adults, such as the Tinneti scale and the timed up and go test, which provide information on mobility and the risk of falls[6,7]; the Barthel index and the Katz scale, which measure the performance of basic activities of daily living[3,8]; and the Lawton scale for instrumental activities of daily living[9]; the modified physical performance test to assess the level of physical functionality[10].

However, suggesting solutions that preserve biodiversity is necessary, encouraging the replacement of physical paper-based tests by software[11]. Digital instruments provide greater information security, and paper is currently considered a transmission vehicle of Sars-CoV-2 (covid-19), due to coronavirus persisting between four and five days on this type of surface[12].

Thus, a greater concern exists when considering older adults, since the risk of death in this group is higher due to comorbidities associated with the process of human frailty[13]. This population thus requires a new perspective on health, in which gerontechnology can be useful to evaluate, diagnose and assist in professional decision making[14].

Gerontechnology is the multidisciplinary study of aging and technology to reduce discomfort and years of morbidity, aiming to increase the functional autonomy of older adults[14]. Thus, several mobile applications are described in the literature to improve the health and care of this population, with positive results regarding their functionalities[15]. However, many of these applications are used by older adults and their caregivers, stressing the need for new apps whose content is managed and supervised by professionals in the area.

Mobile applications are conceptualized as a set of tools designed to perform specific tasks and jobs, with good performance, ease of transport and storage[16]. In the health area, they can improve accessibility to treatments, providing quick and accurate diagnoses[15,17].

However, in gerontological physical therapy, these applications require specificity, with technical applications aimed to screening older adults in situations of functional clinical vulnerability, prevention and rehabilitation of functional deficits caused by aging or other factors resulting from senility[18,19].

Considering the definition of the functional clinical vulnerability stratum suggested by Moraes et al.[5], the level of functionality on older adults represent risk factors, diseases and multiple comorbidities, in addition to a functional heterogeneity, with clinical complexity and need for different specialized gerontogeriatric follow-up.

This study aims to build and validate an algorithm and develop a mobile application software for the multidimensional diagnosis of functional clinical vulnerability and physical therapy in older adults, considering the constant need of evaluation of their health conditions by physical therapists, the health professional responsible for the maintenance of the functionality of body organs and systems, and to encourage the preservation of natural resources.

## METHODOLOGY

This is an analytical and observational study applied in technological production, based on software engineering and based on User-Centered Design. The researcher and the participants abide to the terms contained in The National Health Council Resolution (CNS) 466/2012, and the materials and information obtained were used exclusively for the objectives of this research.

The recommendations of Haynes, Richard and Kubany[20] – which suggest between six and twenty judges – were adopted. The population of judges in this study consisted of thirteen physical therapists, selected by convenience and who signed the informed consent form. Physical therapists who had graduated for at least five years and specialization as the minimum degree were included. Physical therapists with inactive registration at the Regional Council of Physical and Occupational Therapy or who refused to participate in the research after signing the informed consent form were excluded.

## Construction and validation of the algorithm

The elaboration of the algorithm was divided into two stages: the survey of the content via an integrative review of the literature related to the functionality of older adults, which gathered 43 articles and a guideline. Studies in English, Portuguese and Spanish language were selected using the descriptors: Frail Elderly; Postural Balance; Gait Analysis; Geriatric Assessment; Activities of Daily Living and Exercise Therapy, available on the Health Sciences Descriptors website. Book chapters, theses, dissertations, monographs and articles that, after reading the abstract, did not meet the proposed objectives were excluded.

The electronic databases consulted were the Latin American and Caribbean Literature on Health Sciences (LILACS), Medical Literature Analysis and Retrieval System Online (MEDLINE) and Scientific Electronic Library Online (SciELO), without temporal delimitation, since the intention was to select studies that met the pre-established objectives.

The studies were classified according to the level of evidence following the recommendations of Melnyk and Fineout-Overholt[21], namely, level I were obtained from systematic review or meta-analysis of relevant randomized controlled trials or clinical guidelines based on randomized clinical studies; level II, obtained from at least one randomized clinical trial; level III, obtained from well-designed clinical trials without randomization; level IV, obtained from well-designed cohort and case-control studies; level V, obtained from systematic review of descriptive and qualitative studies; level VI, obtained from a single descriptive or qualitative study; and finally, level VII, obtained from the opinion of authorities and/or report from expert committees.

The classification of studies according to these recommendations assist professionals in the critical evaluation of research and, consequently, in decision making on the incorporation of evidence into clinical practice.

The second stage comprised the formulation and assembly of the algorithm using the virtual platform Lucidchart®. The algorithm has two assessment systems, one for broad information and the other specific to the area of physical therapy. The broad evaluation covers multidimensional aspects of the health condition of older adults. The physical therapy evaluation is related to dysfunctions involving the musculoskeletal and respiratory systems.

The sequencing of the information was planned to first identify older adults at risk of functional decline, vulnerability and/or frailty (broad evaluation), and only two or more positive responses in this assessment are required. After this stage, the patient can be referred to primary care follow up services or to undergo a gerontological physical therapeutic evaluation (specific evaluation).

In the case of a positive response in the physical therapy evaluation, the algorithm suggests rehabilitation objectives. If no positive response is achieved, the professional is instructed to reevaluate and/or refer the patient to other specialties in the health area.

The instrument was validated by judges answering a questionnaire created by the authors; all have training in the health area and work in geriatrics-gerontology. The questionnaire presents the algorithm items and the evaluation is made with a Likert scale, allowing the verification of the agreement of the physical therapists on the information that helps in the assessment and identification of the risk of functional decline, vulnerability and/or frailty in older adults and guidance to professionals on conducts applicable to this population. For the validation process, 17 physical therapists working in the area of gerontology in Higher Education Institutions and Long-Term Care Facilities for Older Adults (ILPI) were invited via e-mail. For participants who agreed, the researcher met them for a face-to-face presentation of the algorithm, questionnaire and informed consent form.

After the validation of the instrument, a pilot study was conducted to test the adequacy of the algorithm in ten older adults of the community.

## Mobile app development

The construction of a mobile application requires an algorithm to guide the information technology professional. After validation, the algorithm was converted into a programming language translated into lines of code by a computer science professional. The mobile application software was developed for use on mobile devices and tablets. User-centered design was chosen and the computer professional consulted the researcher during development about the needs of the physical therapists to apply the algorithm's assessment procedure; to the researcher participated in the usability tests of the application.

After converting the algorithm into a mobile application, three tests were performed with the software.

The first test observed the evaluations of the algorithm, and the creation of a menu was requested, so users could choose to quickly apply the evaluation to the patient (express evaluation) or register it and keep their evaluations and personal information saved (registered evaluation). The addition of sections for emergency phone numbers in case of complications, the algorithm in image format, the references used and the name of the owners of the mobile application were added after the first test.

The new features were tested in the second test, and the correction of some spelling errors and inclusion of the application logo on the home screen were requested. Finally, in the third test, all tools were tested and no new adjustments were required.

The mobile application runs offline and does not require the creation of profiles or specific accounts for access. The application software was developed in Android Package (package file for Google's Android® operating system) and the software engineering was performed using the Java programming language, with graphical interface in XML, using the IDE Android Studio, Model View Controller architecture, SQLite database and Scrum technique.

## Statistical analysis

The content validity index (CVI) was calculated to validate the questionnaire as a whole, and its result must be greater than 0.90 (>90%) to be considered validated. The purpose was to measure the percentage of judges who agreed on certain aspects of the instrument and its items[22]. A Likert scale with scores ranging from one to four was used: 4=fully adequate; 3=Adequate; 2=partially adequate; and 1=inadequate. The CVI score was calculated by the sum of agreement of the items that were marked as "4" or "3" by the 13 judges.

The Delphi technique was also used to find consensus between the judges in the answers "Totally adequate" and "Adequate"[23]. Minitab version 18.1 and Statistical Package for Social Sciences, version 22.0 were used.

## RESULTS

Figure 1 describes how the algorithm was constructed from the researched literature.

**ALGORITHM FOR MULTIDIMENSIONAL DIAGNOSIS OF
FUNCTIONAL CLINICAL VULNERABILITY AND PHYSICAL THERAPY FOR OLDER ADULTS**

**ANAMNESIS**

**WARNING SIGNS**

- Age over 75 years[5,24]
- Do you live alone?[3,24]
- Do you live in a long-term care facility for older adults?[9,24]
- Do you have more than five confirmed diseases?[4,24]
- Do you use more than five medications daily?[5,24]
- Do you have postural instability/fall?[5,7,9,24]
- Do you have brain failure (depression/dementia)?[6,25]
- Are you dependent on activities of daily living?[5,8,24,26]
- Has a body mass index above 27 kg/m2 or less than 22 kg/m2?[5,24]
- Do you have blood pressure above 140x90 mmHg or below 100x60 mmHg?[27]
- Do you have a heart rate greater than 90 bpm or less than 50 bpm?[2,27]
- Do you have oxygen saturation less than 90%?[2,28]

POSITIVE ANSWER IN AT LEAST TWO ITEMS?

NO → Forwarding to Family Health Strategy and/or Reference Center of Social Assistance

YES → **PATIENT AT RISK OF FUNCTIONAL DECLINE/VULNERABILITY/OR FRAGILITY**

**PHYSICAL THERAPY EVALUATION**

- Calves smaller than 31cm[29,33]
- Difficulty to walk[29,33]
- Two or more falls in the last year[29,33]
- Patient uses their arms or is unable to get up and sit in the chair[29,33]
- Patient presents imbalance when standing[29,33]
- Patient cannot walk straight[29,33]
- Limited general joint range of motion?[29,33]
- Decreased general muscle strength, below third degree[29,33]
- Dry or productive cough[13,18,19,28,29]
- Spontaneous ventilation with oxygen support[13,18,19,28,29]

POSITIVE ANSWER IN AT LEAST ONE ITEM?

NO → Re-evaluate in 30 days and/or refer to a specialty (Medicine, Nutrition, Speech-Language Therapy, Psychology, Pharmacy, Occupational Therapy, Social Assistance, Physical Education, Nursing and Dentistry)

YES → **SUGGESTION OF PHYSICAL THERAPY PROCEDURES**

The duration, intensity, speed, frequency and type of exercise should vary according to individual needs, following the Cardiogeriatrics Guidelines of the Brazilian Society of Cardiology.

The exercises should:
- Strengthen the muscles of the upper limbs, trunk and lower limbs[34,35]
- Improve balance, proprioception and flexibility[36-38]
- Improve cardiorespiratory fitness[19,39]
- Stimulate the vestibular system[40,41]
- Strengthen the respiratory muscles[19,42-44]
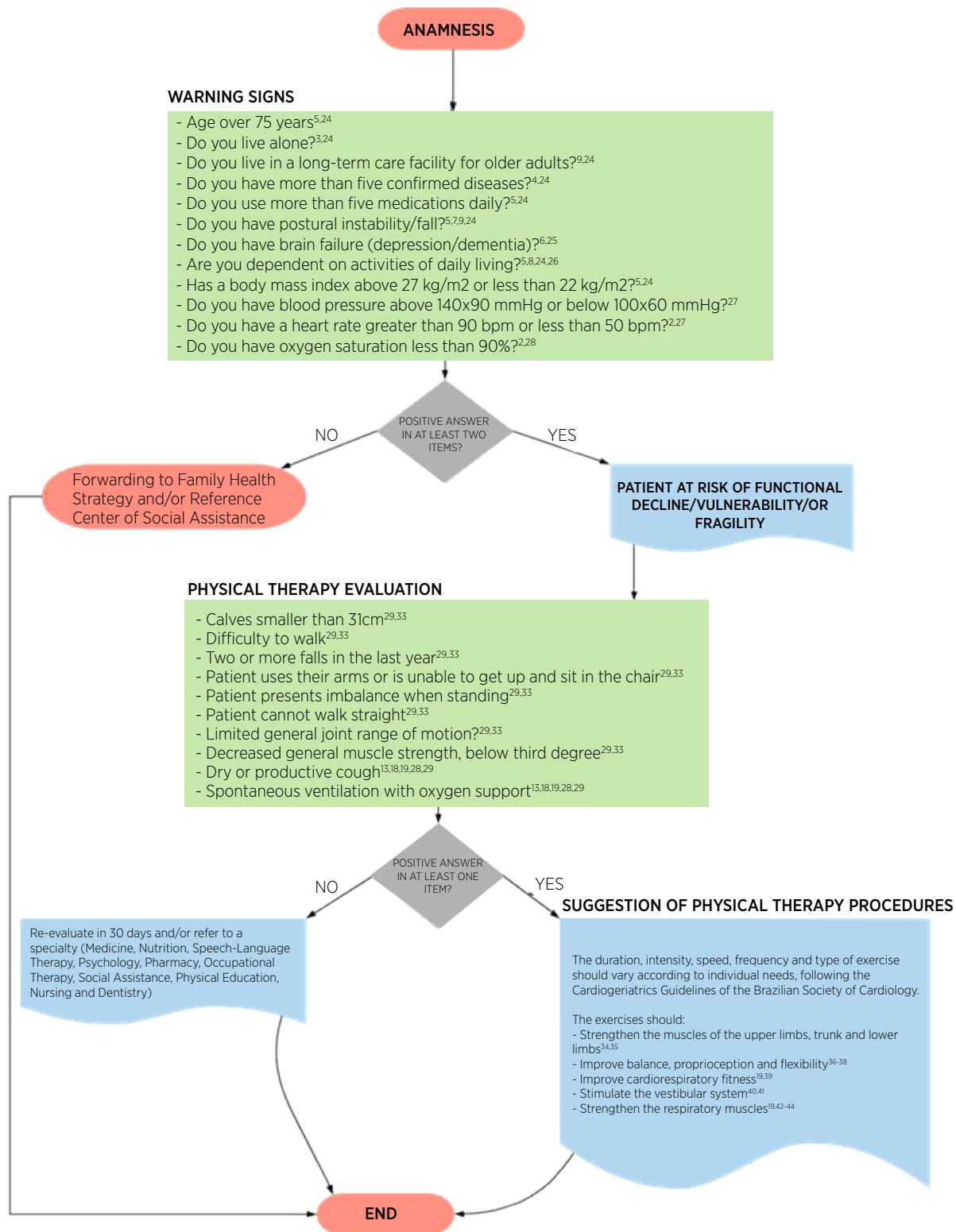
**END**

Figure 1. Algorithm for multidimensional diagnosis of functional clinical vulnerability and physical therapy treatment for older adults

Table 1 shows the evaluation of the studies considering the level of evidence following the recommendations by Melnyk and Fineout-Overholt[21].

Table 1. Level of evidence of algorithm studies, Pouso Alegre (MG), Brazil, 2020

| Studies | Level of evidence |
|---|---|
| Minosso et al.[3] | 4 |
| Saraiva et al.[4] | 6 |
| Moraes et al.[5] | 4 |
| Piovesan et al.[6] | 6 |
| Alexandre et al.[7] | 6 |
| Ferretti-Rebustini et al.[8] | 6 |
| Wu et al.[13] | 6 |
| Pillatt, Nielsson e Schneider[18] | 1 |
| Moreira et al.[19] | 4 |
| Faller et al.[24] | 1 |
| Folstein, Folstein e McHugh[25] | 4 |
| Katz et al.[26] | 4 |
| Feitosa-Filho et al.[27] | 7 |
| Mendes et al.[28] | 4 |
| Cordeiro et al.[29] | 4 |
| Giaquini, Lini e Doring[30] | 4 |
| Bushatsky et al.[31] | 6 |
| Clares, Freitas e Borges[32] | 4 |
| Alexandre et al.[33] | 4 |
| Soukkio et al.[34] | 2 |
| Carral et al.[35] | 2 |
| Yamamoto et al.[36] | 2 |
| Rodriguez-Larrad et al.[37] | 2 |
| Criekinge et al.[38] | 2 |
| Allison, Brooke-Wavell e Folland[39] | 2 |
| Jia et al.[40] | 2 |
| van Vugt et al.[41] | 2 |
| Marioni et al.[42] | 2 |
| Fonseca et al.[43] | 3 |
| Marco et al.[44] | 5 |

All judges agreed with the applicability of the algorithm, and Table 2 shows the agreement for the Content Validity Index.

From the analysis, we observed that the consensus was reached in the first round of evaluation; no question received a score equal to or less than two (partially adequate or inadequate) and no suggestions and opinions were given by the judges. Therefore, the questionnaire did not require a second round of evaluation. Table 3 shows the data.

Table 2. Items of the questionnaire and Content Validity Index, Pouso Alegre (MG), Brazil, 2020

| Trial item | CVI |
|---|---|
| Dimension "Warning signs" | |
| • Age over 75 years | 1.0 |
| • Do you live alone? | 1.0 |
| • Do you live in a long-term care facility for older adults? | 1.0 |
| • Do you have more than five confirmed diseases? | 1.0 |
| • Do you use more than five medications daily? | 1.0 |
| • Do you have postural instability/fall? | 1.0 |
| • Do you have brain failure (depression/dementia)? | 1.0 |
| • Are you dependent on activities of daily living? | 1.0 |
| • Do you have a Body Mass Index above 27 kg/m2 or less than 22 kg/m2? | 1.0 |
| • Do you have blood pressure above 140 × 90 mmHg or below 100 ×60 mmHg? | 1.0 |
| • Do you have a heart rate greater than 90 bpm or less than 50 bpm? | 1.0 |
| • Do you have oxygen saturation less than 90%? | 1.0 |
| "General assessment response" dimension | |
| • Referral to the Family Health Strategy and/or Social Assistance Reference Center | 1.0 |
| • Elderly at risk for functional decline/vulnerability and/or frailty | 1.0 |
| • Calves smaller than 31 cm | 1.0 |
| • Difficulty to walk | 1.0 |
| • Two or more falls in the last year | 1.0 |
| • Uses arms or is unable to get up and sit in chair | 1.0 |
| • Presents imbalance when standing | 1.0 |
| • Cannot walk straight | 1.0 |
| • Limited general joint range of motion | 1.0 |
| • Decreased overall muscle strength, below the third degree | 1.0 |
| • Dry or productive cough | 1.0 |
| • Spontaneous ventilation with oxygen support | 1.0 |
| "General assessment response" dimension | |
| • Re-evaluate in 30 days and/or refer to specialties (Medicine, Nutrition, Speech Therapy, Psychology, Pharmacy, Occupational Therapy, Social Assistance, Physical Education, Nursing and Dentistry) | 1.0 |
| Suggestion of physiotherapeutic approaches: | |
| • Strengthen the muscles of the upper limbs, trunk and lower limbs | 1.0 |
| • Gain balance, proprioception and flexibility | 1.0 |
| • Improve cardiorespiratory fitness | 1.0 |
| • Stimulate the vestibular system | 1.0 |
| • Strengthen respiratory muscles | 1.0 |
| Opinion "General Presentation of the Algorithm" | |
| • The ease of reading, clarity and understanding of information | 1.0 |
| • As for the sequence of information | 1.0 |
| • As for layout/color | 1.0 |
| Attitude of the professional | |
| • Is the algorithm suitable for physical therapists? | 1.0 |
| **Total score** | **1.0** |

General CVI >0.90=Validated.

Table 3. Evaluation of the content of the algorithm items by the Delphi technique, Pouso Alegre, Minas Gerais, Brazil, 2020

| Delphi Technique Evaluation | | | | | | |
|---|---|---|---|---|---|---|
| Questions | Proper | | Fully Adequate | | Total | |
| | N | % | N | % | N | % |
| Dimension "Warning signs" | | | | | | |
| • Age over 75 years | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you live alone? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you live in a long-term care facility for older adults? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have more than five confirmed diseases? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you use more than five medications daily? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have postural instability/fall? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have brain failure (depression/dementia)? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Are you dependent on activities of daily living? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have a Body Mass Index above 27 kg/m2 or less than 22 kg/m2? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have blood pressure above 140 × 90 mmHg or below 100 ×60 mmHg? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have a heart rate greater than 90 bpm or less than 50 bpm? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| • Do you have oxygen saturation less than 90%? | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| | | | | | | |
| "General assessment response" dimension | | | | | | |
| • Referral to the Family Health Strategy and/or Social Assistance Reference Center | 07 | 53.8 | 06 | 46.2 | 13 | 100 |
| • Elderly at risk for functional decline/vulnerability and/or frailty | | | | | | |
| | 05 | 38.5 | 08 | 61.5 | 13 | 100 |
| Dimension "Physical therapy evaluation" | | | | | | |
| • Calves smaller than 31cm | 06 | 46.2 | 07 | 53.8 | 13 | 100 |
| • Difficulty to walk | 06 | 46.2 | 07 | 53.8 | 13 | 100 |
| • Two or more falls in the last year | 06 | 46.2 | 07 | 53.8 | 13 | 100 |
| • Uses their arms or is unable to get up and sit in the chair | 06 | 46.2 | 07 | 53.8 | 13 | 100 |
| • Presents imbalance when standing | 04 | 30.7 | 09 | 69.3 | 13 | 100 |
| • Cannot walk straight | 05 | 38.5 | 06 | 61.5 | 13 | 100 |
| • Limited general joint range of motion | 06 | 46.2 | 05 | 53.8 | 13 | 100 |
| • Decreased overall muscle strength, below the third degree | 00 | 00 | 13 | 100 | 13 | 100 |
| • Dry or productive cough | 08 | 61.5 | 05 | 38.5 | 13 | 100 |
| • Spontaneous ventilation with oxygen support | 09 | 69.3 | 04 | 30.7 | 13 | 100 |
| | | | | | | |
| "General assessment response" dimension | | | | | | |
| • Re-evaluate in 30 days and/or refer to a specialty (Medicine, Nutrition, Speech-Language Therapy, Psychology, Pharmacy, Occupational Therapy, Social Assistance, Physical Education, Nursing and Dentistry) | 00 | 00 | 13 | 100 | 13 | 100 |
| Suggestion of physical therapy interventions: | | | | | | |
| • Strengthen the muscles of the upper limbs, trunk and lower limbs | 11 | 84.6 | 02 | 15.4 | 13 | 100 |
| • Gain balance, proprioception and flexibility | 12 | 92.3 | 01 | 7.7 | 13 | 100 |
| • Improve cardiorespiratory fitness | 04 | 30.7 | 09 | 69.3 | 13 | 100 |
| • Stimulate the vestibular system | 03 | 23.0 | 10 | 77.0 | 13 | 100 |
| • Strengthen respiratory muscles | 11 | 84.6 | 02 | 15.4 | 13 | 100 |
| Opinion "General Presentation of the Algorithm" | | | | | | |
| • The ease of reading, clarity and understanding of information | 00 | 00 | 13 | 100 | 13 | 100 |
| • As for the sequence of information | 01 | 7.7 | 12 | 92.3 | 13 | 100 |
| • As for layout/color | 08 | 61.5 | 05 | 38.5 | 13 | 100 |
| Attitude of the professional | | | | | | |
| • Is the algorithm suitable for physical therapists? | 00 | 00 | 13 | 100 | 13 | 100 |

The mobile application for multidimensional diagnosis of clinical functional vulnerability and physical therapy for older adults was created. The software consists of 34 screens that describe procedures, evaluation, diagnosis and treatment, serving as a support tool in the fields of health, health administration, disease, medical care and diagnostic therapy. The application was registered on the National Institute of Industrial Property (INPI), under the number BR512020002269-3, brand GERONTOFISIO.

## DISCUSSION

This study presents the creation of an algorithm then developed into a software to assist physical therapists in the decision making process about multidimensional diagnosis of functional clinical vulnerability and physical therapy for older adults.

The validation process identified agreement between the judges; thus, the algorithm was considered appropriate.

This result corroborates those of other studies found in the literature[45,46]. Although a pilot study has been conducted, its reliability and internal consistency will be tested on a larger sample of the population in the future. The experience of physical therapists shows us the need to expedite the assessment process.

The creation of "Gerontofisio" derives from this necessity, an easy-to-use mobile application. This tool can help physical therapy work, which is essential for the prevention of injuries, health promotion and rehabilitation[47]. Mobile application use by health professionals reaches 45% to 85%[48]. Therefore, the design choice adopted was user-centered, aiming to involve the user in the design of computerized systems[49].

Unlike what was presented in this study but still aiming to expedite evaluation processes, Nuñez et al.[50] developed a mobile application from instruments adapted to Brazilian Portuguese, validated for the older adult population and widely used in the literature. Their application assists healthcare professionals to assess the fall risk of such population. The software was developed for mobile devices on the Android platform and to run offline, like the one developed in this study.

A study by Santos et al.[51] sought to improve the posture, balance and gait of older adults, culminating in the creation of a functional exercise application to guide and stimulate the practice of physical activity, focusing on the lower limbs. In another study by Santos et al.[16], an application capable of accurately and safely identifying signs of frailty syndrome in older adults was developed.

Other studies aim at the creation of mobile applications for the very older adult population, listing applications to this population to guide them in the practice of physical activities, fall prevention, activities of daily living and care[15,16]. Gerontofisio provides information that may be useful to detect vulnerability at multidimensional level and guide physical therapists in relation to the therapeutic objectives for older adult treatment.

The proposal to assess multidimensional vulnerability in the application considered the clinical signs for frailty and functional decline. The selection of assessment items included adequate internal and external factors, capable of informing whether or not the patient is at risk of fuctional decline, vulnerability and/or frailty.

Physical therapy is key in active aging and facing functional disability, factors with direct influence on the quality of life of the older adult population. Physical therapists use their knowledge and resources to ensure the highest standard of motor functionality and physical independence in older adults; these statements are corroborated by multiple studies[18,52-54].

The "Gerontofisio" application can contribute to the development of important future scientific studies that aim to evidence its efficacy and usability. This study can be considered innovative when considering aging and the areas of interest of physical therapy and health.

One of the contributions of this study is that the physical therapists who judged it acquired the content to assist them in making quick and assertive decisions in the diagnosis and treatment of older adults in a process of clinical functional vulnerability. Regarding physical therapists working in the field of gerontology, they can improve their approach skills with this population by using the application to establish parameters for patient follow-up and standardize their own evaluation protocols, since the instruments were based on evidence found in the integrative review of the literature.

The main limitation of the "Gerontofisio" mobile application refers to physical therapy treatment, in which the suggestion of rehabilitation procedures is presented as therapeutic goals. Although this limitation is not an impairment to this project, we expect to develop correction alternatives, such as the inclusion of audiovisual resources with kinesiotherapy exercises.

"Gerontofisio" may become a positive option in the area since it provides instant, clear and free of charge evaluation of the clinical conditions of older adults and a physical therapy evaluation with the suggestion of rehabilitation objectives.

## CONCLUSION

The algorithm was constructed and validated, the mobile application software for multidimensional diagnosis of functional clinical vulnerability and physical therapy for older adults was developed and is valid in the area of physical therapy; it should be useful for physical therapists and older adult patients alike.

## REFERENCES

1. Campos MO, Rodrigues-Neto JF, Silveira MF, Neves DMR, Vilhena JM, Oliveira JF, et al. Impacto dos Fatores de Risco para Doenças Crônicas não Transmissíveis na qualidade de vida. Cien Saude Colet. 2013;18(3):873-82. doi: 10.1590/S1413-81232013000300033.

2. Curzel J, Forgiarini LA Jr, Rieder MM. Avaliação da independência funcional após alta da unidade de terapia intensiva. Rev Bras Ter Intensiva. 2013;25(2):93-8. doi: 10.5935/0103-507X.20130019.

3. Minosso JSM, Amendola F, Alvarenga MRM, Oliveira MAC. Prevalência de incapacidade funcional e dependência em idosos atendidos em um centro de saúde-escola da Universidade de São Paulo. Cogitare Enferm. 2010;15(1):12-8. doi: 10.5380/ce.v15i1.17138.

4. Saraiva LB, Santos SNSA, Oliveira FA, Moura DJM, Barbosa RGB, Almeida ANS. Avaliação Geriátrica Ampla e sua Utilização no Cuidado de Enfermagem a Pessoas Idosas. J Health Sci. 2017;19(4):262-7. doi: 10.17921/2447-8938.2017v19n4p262-267.

5. Moraes EN, Carmo JA, Moraes FL, Azevedo RS, Machado CJ, Montilla DER. Índice de Vulnerabilidade Clínico Funcional-20 (CVIF-20): reconhecimento rápido do idoso frágil. Rev Saude Publica. 2016;50:81. doi: 10.1590/S1518-8787.2016050006963.

6. Piovesan AC, Soares ES, Camillo AA, Corazza ST, Mezzomo SP. Avaliação do Teste de Tinetti e Mini-Exame do Estado Mental em idosas moradoras da comunidade Roberto Binatto, Santa Maria (RS). Rev Kairos. 2015;18(1):341-52. doi: 10.23925/2176-901X.2015v18i1p341-352.

7. Alexandre TS, Meira DM, Rico NC, Mizuta SK. Accuracy of Timed Up and Go Test for screening risk of falls among community-dwelling elderly. Braz J Phys Ther. 2012;16(5):381-8. doi: 10.1590/S1413-35552012005000041.

8. Ferretti-Rebustini REL, Balbinotti MAA, Jacob Filho W, Rebustini F, Suemoto CK, Pasqualucci CAG, et al. Validity of the Katz Index to assess activities of daily living by informants in neuropathological studies. Rev Esc Enferm USP. 2015;49(6):944-50. doi: 10.1590/S0080-623420150000600010.

9. Araújo GKN, Souto RQ, Alves FAP, Sousa RCR, Ceballos AGC, Santos RC et al. Capacidade funcional e fatores associados em idosos residentes em comunidade. Acta Paul Enferm. 2019;32(3):312-8. doi: 10.1590/1982-0194201900043.

10. Kaushal N, Langlois F, Desjardins-Crépeau L, Hagger MS, Bherer L. Investigating dose-response effects of multimodal exercise programs on health-related quality of life in older adults. Clin Interv Aging. 2019;14(1):209-17. doi: 10.2147/cia.s187534.

11. Moraes GHSM, Cappellozza A, Meirelles FS. Será o fim do papel? Os avanços tecnológicos e seus possíveis impactos no consumo de papel. Internext. 2011;6(2):48-65. doi: 10.18568/1980-4865.6248-65.

12. Oliveira AC, Lucas TC, Iquiapaza RA. O que a pandemia da Covid-19 tem nos ensinado sobre adoção de medidas de precaução? Texto Contexto Enferm. 2020;29(1):e20200106. doi: 10.1590/1980-265X-TCE-2020-0106.

13. Wu F, Zhao S, Yu B, Chen YM, Wang W, Song ZG, et al. A new coronavirus associated with human respiratory disease in China. Nature. 2020; 579(7798):265-9. doi: 10.1038/s41586-020-2008-3.

14. Seino S, Kitamura A, Tomina Y, Tanaka I, Nishi M, Nonaka K, et al. Community-Wide Intervention Trial for Preventing and Reducing Frailty Among Older Adults Living in Metropolitan Areas: Design and Baseline Survey for a Study Integrating Participatory Action Research With a Cluster Trial. J Epidemiol. 2019;29(2):73-81. doi: 10.2188/jea.JE20170109.

15. Amorim DNP, Sampaio LVP, Carvalho GA, Vilaça KHC. Aplicativos móveis para a saúde e o cuidado de idosos. Rev Eletron Comun Inf Inov Saude. 2018;12(1):58-71. doi: 10.29397/reciis.v12i1.1365.

16. Santos TS, Brito TA, Yokoyama-Filho FS, Guimarães LA, Souto CS, Souza SJN, et al. Desenvolvimento de aplicativo para dispositivos móveis voltado para identificação do fenótipo de fragilidade em idosos. Rev Bras Geriatr Gerontol. 2017;20(1):70-6. doi: 10.1590/1981-22562017020.160025.

17. Pereira IM, Bonfim D, Peres HHC, Góes RF, Gaidzinski RR. Tecnologia móvel para coleta de dados de pesquisas em saúde. Acta Paul Enferm. 2017;30(5):479-88. doi: 10.1590/1982-0194201700069.

18. Pillatt AP, Nielsson J, Schneider RH. Efeitos do exercício físico em idosos fragilizados: uma revisão sistemática. Fisioter Pesqui. 2019;26(2):210-7. doi: 10.1590/1809-2950/18004826022019.

19. Moreira WEM, Cassimiro MS, Sales ACM, Pires RLCC, Carvalho PMM. Comparação do Pico de Fluxo Expiratório e a Cirtometria Torácica entre Idosas, Antes e Após a Realização de Fisioterapia Respiratória. Rev Bras Cienc Saude. 2020;24(Supl 2):141-52. doi: 10.22478/ufpb.2317-6032.2020v24nSupl.2.39669.

20. Haynes SN, Richard DCS, Kubany ES. Content validity in psychological assessment: a functional approach to concepts and methods. Psychol Assess. 1995;7(3):238-47. doi: 10.1037/1040-3590.7.3.238.

21. Melnyk BM, Fineout-Overholt E. Evidence-based practice in nursing & healthcare: a guide to best practice. Philadelphia: Lippincott Williams & Wilkins; 2005.

22. Alexandre NMC, Coluci MZO. Validade de conteúdo nos processos de construção e adaptação de instrumentos de medidas. Cien Saude Colet. 2011;16(7):3061-8. doi: 10.1590/S1413-81232011000800006.

23. Hohmann E, Cote MP, Brand JC. Research Pearls: Expert Consensus Based Evidence Using the Delphi Method. Arthroscopy. 2018;34(12):3278-82. doi: 10.1016/j.arthro.2018.10.004.

24. Faller JW, Pereira DN, Souza S, Nampo FK, Orlandi FS, Matumoto S. Instruments for the detection of frailty syndrome in older adults: A systematic review. PLoS One. 2019;14(4):e0216166. doi: 10.1371/journal.pone.0216166.

25. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-98. doi: 10.1016/0022-3956(75)90026-6.

26. Katz S, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA. 1963;185(12):914-9. doi: 10.1001/jama.1963.03060120024016.

27. Feitosa-Filho GS, Peixoto JM, Pinheiro JES, Afiune Neto A, Albuquerque ALT, Cattani AC, et al. Atualização das Diretrizes em Cardiogeriatria da Sociedade Brasileira de Cardiologia-2019. Arq Bras Cardiol. 2019;112(5):649-705. doi: 10.5935/abc.20190086.

28. Mendes TAB, Andreoli PBA, Cavalheiro LV, Talerman C, Laselva C. Adequação do uso do oxigênio por meio da oximetria de pulso: um processo importante de segurança do paciente. Einstein (São Paulo). 2010;8(4):449-55. doi: 10.1590/S1679-45082010AO1377.

29. Cordeiro RC, Dias RC, Dias JMD, Perracini M, Ramos LR. Concordância entre observadores de um protocolo de avaliação

fisioterapêutica em idosas institucionalizadas. Fisioter Pesqui. 2002;9(2):69-77. doi: 10.1590/fpusp.v9i2.79663.

30. Giaquini F, Lini EV, Doring M. Prevalência de dificuldade de locomoção em idosos institucionalizados. Acta Fisiatr. 2017;24(1):1-6. doi: 10.5935/0104-7795.20170001.

31. Bushatsky A, Alves LC, Duarte YAO, Lebrão ML. Fatores associados às alterações de equilíbrio em idosos residentes no município de São Paulo em 2006: evidências do Estudo Saúde, Bem-Estar e Envelhecimento (SABE). Rev Bras Epidemiol. 2018;21(Suppl 2):E180016.SUPL.2. doi: 10.1590/1980-549720180016.supl.2.

32. Clares JWB, Freitas MC, Borges CL. Fatores sociais e clínicos que causam limitação da mobilidade de idosos. Acta Paul Enferm. 2014;27(3):237-42. doi: 10.1590/1982-0194201400040.

33. Alexandre TS, Duarte YAO, Santos JLF, Lebrão ML. Prevalência e fatores associados à sarcopenia, dinapenia e sarcodinapenia em idosos residentes no Município de São Paulo – Estudo SABE. Rev Bras Epidemiol. 2018;21(Suppl 2):E180009.SUPL.2. doi: 10.1590/1980-549720180009.supl.2.

34. Soukkio P, Suikkanen S, Kaaria S, Kautiainen H, Sipila S, Kukkonen-Harjula K, et al. Effects of 12-month home based physiotherapy on duration of living at home and functional capacity among older persons with signs of frailty or with a recent hip fracture – protocol of a randomized controlled trial (HIPFRA study). BCM Geriatr. 2018;18:232. doi: 10.1186%2Fs12877-018-0916-y.

35. Carral JMC, Rodríguez AL, Cardalda IM, Bezerra JPAG. Muscle strength training program in nonagenarians – a randomized controlled trial. Rev Assoc Med Bras. 2019;65(6):851-6. doi: 10.1590/1806-9282.65.6.851.

36. Yamamoto S, Iwata A, Yano Y, Ohmine T, Honma K, Senzaki K, et al. Preliminary study on the effects of movement velocity training of the upper limbs on gait ability in older adults: a nonrandomized controlled trial. Clin Interv Aging. 2019;14(1):781-8. doi: 10.2147/CIA.S202897.

37. Rodriguez-Larrad A, Arrieta H, Rezola C, Kortajarena M, Yanguas JJ, Iturburu M, et al. Effectiveness of a multicomponent exercise program in the attenuation of frailty in long-term nursing home residents: study protocol for a randomized clinical controlled trial. BMC Geriatr. 2017;17:60. doi: 10.1186/s12877-017-0453-0.

38. Criekinge TV, Saeys W, Hallemans A, Vereeck L, Hertogh W, Walle PV, et al. Effectiveness of additional trunk exercises on gait performance: study protocol for a randomized controlled trial. Trials. 2017;18:249. doi: 10.1186/s13063-017-1989-1.

39. Allison SJ, Brooke-Wavell K, Folland J. High and odd impact exercise training improved physical function and fall risk factors in community-dwelling older men. J Musculoskelet Neuronal Interact [Internet]. 2018 [cited 2021 Aug 18];18(1):100-7. Available from: http://www.ismni.org/jmni/pdf/71/jmni_18_100.pdf

40. Jia X, Jiang C, Tao J, Li Y, Zhou Y, Chen L. Effects of core strength training combined with Tai Chi Chuan for the musculoskeletal system and cardiopulmonary function in older adults. Medicine (Baltimore). 2018;97;(35): e12024. doi: 10.1097/md.0000000000012024.

41. van Vugt VA, van der Wouden JC, Bosmans JE, Smalbrugge M, van Diest W, Essery R, et al. Guided and unguided internet-based vestibular rehabilitation versus usual care for dizzy adults of 50 years and older: a protocol for a three-armed randomised trial. BMJ Open. 2017;7(1):e015479. doi: 10.1136/bmjopen-2016-015479.

42. Marioni G, Fermo S, Lionello M, Fasanaro E, Giacomelli L, Zanon S, et al. Vestibular rehabilitation in elderly patients with central vestibular dysfunction: a prospective, randomized pilot study. Age (Dordr). 2013;35(6):2315-27. doi: 10.1007/s11357-012-9494-7.

43. Fonseca MA, Cader SA, Dantas EHM, Bacelar SC, Silva EB, Leal SMO. Programas de treinamento muscular respiratório: impacto na autonomia funcional de idosos. Rev Assoc Med Bras. 2010;56(6):642-8. doi: 10.1590/S0104-42302010000600010.

44. Marco E, Coll-Artés R, Marín M, Coll-Fernández R, Pascual MT, et al. Recomendaciones sobre programas de rehabilitación pulmonar en pacientes con enfermedad pulmonar obstructiva crónica de la Sociedad de Rehabilitación Cardiorrespiratoria. Rehabilitación. 2016;50(4):233-62. doi: 10.1016/j.rh.2016.04.004.

45. Cunha DR, Salomé GM, Massahud MR Jr, Mendes B, Ferreira LM. Construção e validação de um algoritmo para aplicação de laser no tratamento de ferida. Rev Lat Am Enfermagem. 2017;25(1):e2955. doi: 10.1590/1518-8345.1998.2955.

46. Valim MD, Marziale MHP, Hayashida M, Rocha FLR, Santos JLF. Validade e confiabilidade do questionário de adesão às precauções-padrão. Rev Saude Publica. 2015;49:87. doi: 10.1590/S0034-8910.2015049005975.

47. Aveiro MC, Aciole GG, Driusso P, Oishi J. Perspectivas da participação do fisioterapeuta no Programa Saúde da Família na atenção à saúde do idoso. Cien Saude Colet. 2011;16(Suppl 1):1467-78. doi: 10.1590/S1413-81232011000700082.

48. Oliveira TR, Costa FMR. Desenvolvimento de aplicativo móvel de referência sobre vacinação no Brasil. J Health Inform [Internet]. 2012 [cited 2021 Aug 18];4(1):23-7. Available from: http://www.jhi-sbis.saude.ws/ojs-jhi/index.php/jhi-sbis/article/view/161/109

49. Barra DCC, Paim SMS, Dal Sasso GTM, Colla GW. Métodos para desenvolvimento de aplicativos móveis em saúde: Revisão Integrativa da Literatura. Texto Contexto Enferm. 2017;26(4):e2260017. doi: 10.1590/0104-07072017002260017.

50. Nuñez Filha MCD, Pinto EBC, Leite HJD. Desenvolvimento de um aplicativo para identificação do risco de quedas em idosos. Rev Pesqui Fisioter. 2018;8(3):354-60. doi: 10.17267/2238-2704rpf.v8i3.2047.

51. Santos CMVT, Andrade JA, Amorim AC, Garcia PA, Carvalho GA, Vilaça KHC. Aplicativo em plataforma móvel "Idoso Ativo": exercícios para membros inferiores aliando tecnologia e saúde. Fisioter Mov. 2018;31(1):e003117. doi: 10.1590/1980-5918.031.AO17.

52. Ely JC, Fermino AF, Bassani GR, Oliveira HS, Walter J, Amaral SHE, et al. Atuação fisioterápica na capacidade funcional do idoso institucionalizado. Rev Bras Cienc Envelhecimento Hum. 2009;6(2):293-297. doi: 10.5335/rbceh.2012.247.

53. Aciole GG, Batista LH. Promoção da saúde e prevenção de incapacidades funcionais dos idosos na estratégia de saúde da família: a contribuição da fisioterapia. Saude Debate [Internet]. 2013 [cited 2021 Aug 18];37(96):10-9. Available from: https://www.scielo.br/j/sdeb/a/Kr5rYshxg6YPRTLMhcbxvPk/?lang=pt&format=pdf

54. Gontijo RW, Leão MRC. Eficácia de um programa de fisioterapia preventiva para idosos. Rev Med Minas Gerais. 2013;23(2):173-80. doi: 10.5935/2238-3182.20130028.

**ERRATUM**

The version of the article "**Mobile application: physical therapy interventions for frail older adults**" published in **volume 28, number 2, 2021**, made available at first presented errors related to the author's orcid number and corresponding address.

**Instead of:**
ORCID-
**Should read:**
ORCID-0000-0002-8287-7476

**Instead of:**
Rua Aracy Sampaio, 26 – Pouso Alegre (MG), Brazil – Zip code: 18540-000
**Should read:**
Rua Aracy Sampaio, 26 – Dores de Campos (MG), Brazil – Zip code: 36213-000