Clinical-functional vulnerability index in elderly individuals participating in a supervised physical exercise program[1]

Índice de vulnerabilidade clínico-funcional em idosos participantes de programa de exercício físico supervisionado

Índice de vulnerabilidad clínico-funcional en participantes ancianos de un programa de ejercicios físicos supervisados

[Research Article]

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Resumo

O artigo visou avaliar o índice de vulnerabilidade clínico-funcional (IVCF) de pessoas idosas, participantes de um programa de exercícios físicos supervisionados (PEFS), com duração de 16 semanas. Participaram do estudo 105 voluntários ($\underline{X}$ = 67 ± 6.50 anos), que foram avaliados por meio do instrumento IVCF-20, antes e após as 16 semanas de intervenção, com o PEFS, observou-se uma redução no IVCF (Δ% = -7.30%), porém na faixa de Risco Moderado (de 7 a 14). Observou-se redução na subfacetas de mobilidade (Δ% = -100%), Destacando-se a diminuição da fragilidade no tocante ao: alcance, preensão, pinça, capacidade aeróbica e/ou muscular, marcha e continência esfincteriana. Acarretando o crescimento na classificação Robusto (Δ% =16.25%) e uma diminuição nas classificações Risco (Δ% = -13.60%) e Frágil (Δ% = -24.21%). Pode-se com o desfecho encontrado, auferir a importância do PEFS para a Saúde e para a redução dos gastos públicos com as pessoas idosas.
Palavras-chave: terapia por exercício, idoso fragilizado, populações vulneráveis

Clinical-functional vulnerability index in elderly participants of a supervised physical exercise program *

Abstract

The article aimed to assess the clinical-functional vulnerability index (CFVI) of elderly individuals participating in a supervised physical exercise program (SPEP) lasting 16 weeks. A total of 105 volunteers ($\overline{X}$ = 67 ± 6.50 years) participated in the study, and they were assessed using the CFVI-20 instrument before and after the 16-week intervention with SPEP. A reduction in CFVI was observed (Δ% = -7.30%), but it remained in the Moderate Risk range (7 to 14). Reductions were noted in mobility subfacets (Δ% = -100%), highlighting a decrease in frailty concerning reach, grip, pinch, aerobic and/or muscular capacity, gait, and sphincteric continence. This resulted in an increase in the Robust classification (Δ% = 16.25%) and a decrease in the Risk (Δ% = -13.60%) and Fragile (Δ% = -24.21%) classifications. The findings indicate the importance of SPEP for health and reducing public spending on elderly individuals.
Keywords: exercise therapy, frail elderly, vulnerable populations

Resumen

El artículo tuvo como objetivo evaluar el índice de vulnerabilidad clínico-funcional (IVCF) en personas de la tercera edad que participaron en un programa de ejercicios físicos

supervisados (PEFS) con una duración de 16 semanas. En el estudio participaron 105 voluntarios ($\overline{X}$ = 67 ± 6.50 años), quienes fueron evaluados mediante el instrumento IVCF-20 antes y después de las 16 semanas de intervención con el PEFS. Se observó una reducción en el IVCF (Δ% = -7.30%), pero se mantuvo en el rango de Riesgo Moderado (7 a 14). Se destacó una reducción en las subfacetas de movilidad (Δ% = -100%), con una disminución de la fragilidad en cuanto al alcance, la prensión, el pellizco, la capacidad aeróbica y/o muscular, la marcha y la continencia esfinteriana. Esto resultó en un aumento en la clasificación de Robusto (Δ% = 16,25%) y una disminución en las clasificaciones de Riesgo (Δ% = -13.60%) y Frágil (Δ% = -24.21%). Los hallazgos indican la importancia del PEFS para la salud y la reducción del gasto público en personas de la tercera edad.
Palabras clave: terapia de ejercicio, ancianos frágiles, poblaciones vulnerables

Introduction

Data from the Brazilian Institute of Geography and Statistics (IBGE, 2022) indicates that the Brazilian population has been consistently aging in recent years. The number of elderly individuals has risen by 8.9 million since 2012, increasing from 22.3 million to 31.2 million. This represents a 39.8% growth in the elderly population, with a notable majority of women compared to men. Projections for 2030 suggest that elderly individuals will make up 18% of the population, surpassing the number of children and young people.

In 2012, Brazil had 25.4 million people aged 60 and older. However, as of 2022, the number of elderly individuals has surpassed 31.2 million. When examining specific regions in Brazil, the Northeast region is home to approximately 7,030,483 elderly residents, with the state of Sergipe accounting for 253,112 residents aged 60 and over (Porto et al., 2022).

The aging process is linked to various inevitable, progressive, heterogeneous, and not always pathological changes affecting the human body, encompassing morphological, functional, biological, or psychological aspects. Aging does not inherently imply incapacity or dependency. The emergence of clinical conditions and disabilities, however, can contribute to vulnerability and, consequently, to frailty and clinical deterioration in elderly individuals. Additionally, adverse social conditions and limited access to healthcare services can exacerbate this situation. Therefore, vulnerability is a multidimensional concept that is a focal point of research in geriatrics and gerontology, with physical frailty being associated with adverse health conditions (Bolina et al., 2022).

The concept of vulnerability in elderly individuals pertains to the inherent fragility of the aging process, accentuated by factors such as functional decline, social isolation, and financial limitations. This vulnerability significantly affects the health of the elderly, rendering them more susceptible to various chronic diseases, falls, and medical complications. Additionally, the emotional vulnerability often associated with this life stage can trigger mental health problems, such as depression (Barbosa & Fernandes, 2020).

Access to adequate healthcare often poses an additional challenge, underscoring the importance of comprehending and proactively addressing this vulnerability to safeguard the quality of life and well-being of elderly individuals (Almeida et al., 2020).

The profile of elderly individuals in Sergipe is marked by limited financial support, with 59% of them living on a minimum wage. Additionally, it is noteworthy that 65.4% bear the responsibility of supporting their households, relying on their pension or retirement income to ensure financial stability for these Sergipe families. Another significant aspect is that only 80.3% of these elderly individuals lack private health insurance, depending exclusively on public healthcare services (Duarte et al., 2019).

Aging enhances biological susceptibility to adverse events. Unfavorable social conditions and limited access to healthcare services can further worsen this situation, given that vulnerability is a multidimensional concept at the core of research in geriatrics and gerontology. Physical frailty is specifically linked to adverse health conditions in this context (Bolina et al., 2022).

Given the above, the aim of this article is to evaluate the clinical-functional vulnerability index of elderly individuals enrolled in a supervised 16-week physical exercise program.

Methodology

Study Type

This is a quantitative, longitudinal study with a quasi-experimental design.

Population, Sampling, and Sample

The study's population comprised elderly individuals served by the Basic Health Units (UBS) in the following neighborhoods of the city of Aracaju: Aeroporto, Atalaia, Castelo Branco, Coroa do Meio, Farolândia, Grageru, Inácio Barbosa, Jabutiana, and Ponto Novo. The covered UBSs include the following: UBS Antônio Alves; UBS Augusto Franco; UBS

Augusto César Leite; UBS Ávila Nabuco; UBS Dona Sinhazinha; UBS Fernando Sampaio; UBS Geraldo Magela; UBS Hugo Gurgel; UBS Dr. Max de Carvalho; UBS Madre Tereza de Calcutá; and UBS Manoel de Souza Pereira, representing approximately 14,000 elderly individuals.

Elderly individuals who visited the UBSs were invited to attend a preliminary lecture held at the Farolândia Campus. During this session, the project, assessments, expected benefits, ethical considerations, and any questions were explained. Following the lecture, an invitation was extended to participate in the project.

Volunteers from the UBSs were asked to bring a medical certificate permitting their participation in physical exercises, a referral from their UBS, and identification (ID) and CPF (Individual Taxpayer Identification Number) to the Laboratory of Biociences of Human Motricity - LABIMH. Subsequently, they underwent screening based on inclusion criteria (being over 60 years old and committing to participating in a physical exercise program by signing the Informed Consent Form) and exclusion criteria (having motor limitations or comorbidities that would hinder participation in planned assessments).

All pre-selected individuals underwent screening using the Revised Physical Activity Readiness Questionnaire (rPAR-Q) to assess safety in participating in planned assessments and underwent an anamnesis to determine their socioeconomic characteristics. The determination of the sample size was based on the results collected from the pilot project conducted from September to December 2022 with a sample of 39 elderly women from the UBSs of Farolândia, Augusto Franco, and Orlando Dantas. According to Fontelle et al. (2010), for studies with unlimited populations, a pilot study was conducted with a random sample of at least 31 individuals from the population. The standard deviation (s) of this sample was calculated and substituted (σ value with the s value) (TRIOLA, 2017). A 95% Confidence Interval was considered. Below is the formula used for sample calculation.

$$n = \frac{s^2}{\left(\underline{x} - \mu\right)^2} x(z_\alpha \,/\, 2)^2$$

Where:

zα/2 = Z-value on the normal curve according to the value α.

S^2 = Variance based on the standard deviation of the pilot study.

$\underline{x} - \mu$ = Maximum estimated difference between the sample mean and the true population mean.

n = Population size (sample).

After conducting the sample size calculation, a sample size of 97 elderly individuals per sample group was determined. As a safety measure, this number was increased by 10%, resulting in a total of 107 participants for the sample group.

Research Ethics

The study fully adhered to the ethical guidelines set forth in Resolution 466/12 of the National Health Council, dated December 12, 2012 (Brazil, 2012), which regulates the norms for conducting research involving human subjects. As a preliminary measure, we obtained prior approval from the Coordination of the Center for Continuing Health Education (CEPES) to ensure access to Basic Health Units (UBSs). Moreover, this study rigorously followed the principles outlined in the Helsinki Declaration (WMA, 2013), guaranteeing the protection of the rights, well-being, and dignity of the research participants.

Each UBS received an Information to the Institution Form (TII) outlining all procedures, risks, and precautions. Every voluntary participant provided their informed consent by signing the Informed Consent Form (ICF), which contained the same information as the TII. It included all considerations regarding risks and benefits, as well as the social relevance of the research, all of which were adequately explained to the elderly individuals.

The research obtained preliminary approval from the Research Ethics Committee for Human Subjects of Universidade Tiradentes on March 26, 2020, under opinion no. 3,936,886 - CAAE: 26524719.4.0000.5371.

Materials and Methods

After completing the preliminary procedures (participant recruitment, ethical precautions, and participant safety measures, stratification into groups), all study participants, including both the experimental and control groups, underwent a diagnostic assessment during which the dependent variables of the study were measured.

Diagnostic Assessment

The dependent variable was assessed using the instrument described below and administered during the initial two weeks of the project. A questionnaire to evaluate the Clinical-Functional Vulnerability Index (CFVI-20) (see APPENDIX VIII) was conducted by professionals who were appropriately trained to work with elderly participants.

The Clinical-Functional Vulnerability Index-20 (CFVI-20) is a rapid, objective, interdisciplinary instrument that enables the measurement of frailty in elderly individuals through 20 evaluative items involving eight predictors of clinical-functional decline in the elderly (age, self-perceived health, functional impairments, cognition, mood, mobility, communication, and multiple comorbidities). Scores range from 0 to 40 points. A final score of 0 to 6 points indicates an elderly individual with a low risk of clinical-functional vulnerability, 7 to 14 indicates moderate risk, and 15 or more indicates high risk, potentially frail (Carneiro et al., 2020).

The questionnaire collected information on age, self-perceived health, functional impairments, cognition, mood, mobility, communication, and multiple comorbidities. For elderly individuals with cognitive deficits, questions related to this area were administered to the caregiver or responsible party.

Intervention

The strength training protocol implemented with the participants involved a two-week familiarization period, followed by 16 weeks of training consisting of two weekly sessions held in the afternoon. The sessions were divided into time slots as follows: Classes 1 and 2 on Mondays and Wednesdays from 2:00 PM to 3:00 PM and 3:00 PM to 4:00 PM, respectively, and Classes 3 and 4 on Tuesdays and Thursdays from 2:00 PM to 3:00 PM and 3:00 PM to 4:00 PM, respectively, totaling 32 sessions.

Strength exercises, based on a circuit of resistance exercises using machines (weightlifting), were prescribed according to the perceived effort scale of OMNI-Res (Robertson et al., 2003), similar to those used in the study by Kukkonen-Harjula et al. (2007).

The cardiovascular component of the circuit was quantified in terms of intensity using the Borg Rating of Perceived Exertion (RPE) scale (Borg, 1982). Both perceived effort scales utilized levels 2 and 3 during the familiarization phase. Throughout the 16-week training period, the load was adjusted so that participants perceived the effort at levels 7 to 8 (Strong). This criterion also served as feedback for load adjustment every two weeks.

The neuromuscular training consisted of the following sequence of exercises: barbell biceps curl, leg extension machine, triceps pushdown on the high pulley, hamstring curl machine, dumbbell shoulder press, bench squat with a plate on the chest, pec fly, leg press, front lat pulldown, plank, and finally, pelvic lift, with a two-minute rest between sets. It was performed in a circuit format, and on each training day, the elderly individual started at a station, aiming to address issues related to the order of exercise execution.

The strength exercises were performed at a moderate speed in both the eccentric and concentric phases, taking approximately 2 seconds per cycle. Rest intervals between sets and between exercises were always at least 2 minutes. The elderly participants in the project carried out the proposed physical exercises in a circuit format, emphasizing strength training while respecting individual differences.

Consequently, the aerobic control of the training was conducted using the Borg Rating of Perceived Exertion Scale (1982), where levels 2 and 3 (light) of perceived effort were used during the familiarization phase. During the 16 weeks of training, adjustments were made so that participants perceived the effort at levels 7 and 8 (strong). Thus, this criterion also served as feedback for load adjustment every two weeks.

Flexibility training, performed both in the warm-up and at the end of the workout, was also assessed for intensity using the PERFLEX perceived effort scale (Dantas et al., 2008). In the warm-up, submaximal intensity (stretching - levels 31 to 60 of PERFLEX) was used, while at the end, maximal intensity (flexibility - levels 61 to 80 of PERFLEX) was applied.

Physical Education and Physiotherapy professionals were responsible for training the elderly participants in the study, ensuring that intensity levels and volumes were respected. Before commencing training, all participants had to perform a general warm-up consisting of exercises and stretching (levels 31 to 60 of PERFLEX) and elevate their heart rate for ten minutes.

After completing the training, participants underwent a cool-down phase, consisting of flexibility exercises (levels 61 to 80 of PERFLEX), for approximately 10 minutes. On a daily basis, data were collected from study participants, including heart rate (prior to training), blood pressure, perceived effort related to cardiovascular, neuromuscular, and flexibility training (all after training).

Summative Assessment (SA)

At the end of the first phase of the intervention (16 weeks), all research participants underwent a new round of assessments using the same procedures as the diagnostic evaluation.

Statistical Analysis

The data were organized and analyzed using Microsoft Office Excel® 2016. Descriptive statistics were employed to characterize the studied sample. Measures of central tendency and dispersion were used to describe the collected data, as indicated in the consulted literature (Costa Neto, 1995; Thomas; Nelson; Silverman, 2007; Triola, 2017).

Subsequently, the normality of the collected data was assessed using the Shapiro-Wilk test. This determined the use of the T-Test for independent parametric samples and the Mann-Whitney test for independent non-parametric samples.

Significance Level and Experiment Power

To uphold the scientific rigor of the research, this study adopted a significance level of $p < 0.05$, signifying a 95% probability that the assertions made during the investigation are either accurate or inaccurate (alpha error), allowing for a 5% probability of results occurring by chance. The experiment's power (beta error) was evaluated with an acceptance level corresponding to 80%. All assertions were confined to the specific study, contingent on the level of acceptance within the universe indicated by the experiment's power.

Results

This study obtained a sample of 105 volunteers ($\bar{X}$ = 67 ± 6.50 years), and sociodemographic data of the participants were collected through anamnesis, as shown in Table 1.

Table 1: Socioeconomic Characteristics of the Sample Group

DATA SOCIODEMOGRAPHIC		**N=105**	
		TOTAL	**%**
GENDER	Female	88	83.8
	Male	17	16.2
AGE	60-64 years	26	27.9
	65-69 years	35	37.9
	70-75 years	17	18.9
	75 years or older	14	15.6
MARITAL STATUS	Married	40	38.5
	Single	26	25
	Divorced	13	12.5
	Widowed	25	24
EDUCATIONAL LEVEL	Completed Higher Education	18	17.1
	Incomplete Higher Education	5	4.8
	Specialized Postgraduate	2	1.9
	Never Studied	4	3.8

	Completed Elementary School	8	7.6
	Incomplete Elementary School	28	24.8
	Completed High School	34	32.4
	Incomplete High School	8	17.1
MONTHLY INCOME	Up to 02 minimum wages	63	60.6
	From 02 to 04 minimum wages	26	38.2
	From 04 to 10 minimum wages	15	19.2
	Not informed	1	1.1
HEALTH INDICATORS			
NUMBER OF CIGARETTES PER DAY	More than 30 cigarettes	1	1.1
	From 11 to 30 cigarettes	1	1.1
	Up to 10 cigarettes	6	5.9
	Does not smoke	94	92.2
	Not informed	3	3
DRINKS CONSUMED PER WEEK	More than 15	1	1.1
	Less than 5	29	27.9
	Do not drink	73	70.2
DISEASES	Hypertension	47	47
	Diabetes	18	21
	Other diseases	27	19.6
	Do not have	13	13

Table 1: Sociodemographic Data (N - number of participants; % - percentage).

Table 1 shows the predominance of females (83.8%) with white ethnicity (40.4%), and mostly married. Additionally, it highlights that 92.2% do not smoke, 70.2% do not consume alcoholic beverages, consider their stress self-control to be regular (48.1%), and have hypertension (47%), predominantly.

In Table 2, you can observe the descriptive statistics and their rate of variation regarding the Clinical-Functional Vulnerability Index collected in the diagnostic and summative assessments.

Table 2: Clinical-Functional Vulnerability Index collected in diagnostic and summative assessments

AVALIAÇÃO	DIAGNÓSTICA	SOMATIVA
Mean	7.94	7.36
Median	7	6
Mode	4	4
Standard Error	0.40	0.54
Standard Deviation	4.13	4.55
Coefficient of Variation (%)	-7.30%	

From this, it can be observed in Table 2 that the vulnerability index decreased between both assessments (Δ% = -7.30%), although it remained in the Moderate Risk range (from 7 to 14).

Next, considering the normality test, the Shapiro-Wilk test demonstrated that the data were non-parametric for both assessments, as shown in Table 3. Therefore, the Mann-Whitney test was used to highlight the U value (= 3174) and p-exact (AD = 0.84) and (AS = 0.16).

Table 3: Normality Test

ASSESSMENT	DIAGNOSTIC	SUMMATIVE
W-stat	0.87	0.72
p-value	4.65	4.04
Alpha	0.05	0.05
Normal	No	No

Furthermore, through the T-test, we obtained the variance of 17.07 (DA) and 20.76 (SA) and a p-value of 0.19 (DA) and 0.39 (SA).

The Clinical-Functional Vulnerability Index-20 (CFVI-20) is divided into subfacets to assess the overall vulnerability of the participant. With that said, individual aspects of self-

perceived health, functional impairments (activities of daily living), cognition, mood, mobility, communication, and multiple comorbidities can be assessed. The respective variations are shown in Table 4.

Table 4: Subfacets of IVCF-20.

ASSESSMENT	**MEAN – SCORE**		**VARIATION (%)**
	DIAGNOSTIC	**SUMMATIVE**	
Self-Perceived Health	1	1	0
Functional Impairments	0	0	0
Cognition	0	0	0
Mood	0	0	0
Mobility	1	0	-100
Communication	0	0	0
Multiple Comorbidities	4	4	0

Thus, it is identified that there was a significant reduction in the mobility sub-facet, highlighting the decrease in frailty concerning reach, grip, pinch, aerobic and/or muscular capacity, gait, and sphincteric continence. The rest of the subfacets remained stable in both assessments. Additionally, through the CFVI-20 test, participants can be classified into robust (0-6 points), at risk of frailty (7-14 points), and frail (>= 15 points). Therefore, the variations in the sample can be seen in Table 5.

Table 5: CFVI-20

ASSESSMENT	DIAGNOSTIC (%)	SUMMATIVE (%)	VARIATION (%)
Robust	48.6	56.5	16.25
Risk	41.9	36.2	-13.60
Frail	9.5	7.2	-24.21

Therefore, there was an increase in the Robust classification (Δ% = 16.25%) and a decrease in the Risk (Δ% = -13.60%) and Frail (Δ% = -24.21%) classifications after 16 weeks of physical activity among the elderly.

Discussion

The Clinical-Functional Vulnerability Index-20 (CFVI-20) is an interdisciplinary tool for a rapid and objective assessment that enables the measurement of frailty in older adults. It consists of 20 assessment items that cover eight predictors of decline in the clinical and functional capacities of older adults, including age, self-perceived health, functional limitations, cognition, mood, mobility, communication skills, and the presence of multiple health conditions. Scores range from 0 to 40 points, with a final score of 0 to 6 indicating a low risk of clinical-functional vulnerability in older adults, scores from 7 to 14 indicating moderate risk, and 15 points or more indicating a high risk, suggesting potential frailty (Carneiro et al., 2020).

Furthermore, it is known that globally, we are witnessing a population aging process occurring more rapidly than in previous decades. In fact, it is projected that by 2050, one in every six people worldwide will be over 65 years of age (Torres et al., 2021). While population aging is considered a success in public health, it also presents the challenge of preserving the quality of life, functional capacity, and social integration of older adults.

In this context, the concept of active aging emerges as a matter of extreme relevance, aiming to ensure that individuals reach retirement age with the best possible health conditions, i.e., with the lowest possible vulnerability index, especially in a rapidly aging society. Thus, it is necessary to highlight that, out of the 15 articles read, all of them presented physical exercise as a protective factor against vulnerability in the elderly, as demonstrated in this study as well.

Initially, we can address the physiological aging process, which typically results in general brain atrophy, changes in brain function, and cognitive decline. However, this process

exhibits high variability among individuals and seems to be correlated in some way with lifestyle factors. Among these factors, physical activity represents a promising non-pharmacological approach to maintaining, delaying, or improving brain structure and function throughout life. Aerobic exercise is believed to enhance cognitive function by promoting increased blood flow to the brain, which, in turn, increases brain oxygenation and provides the energy needed to support neurogenic and metabolic activities. However, studies have highlighted the superior effects of strength training compared to other modalities, especially for older individuals with established cognitive function.

Furthermore, there is growing evidence that aerobic exercise induces changes in the structure and volume of the hippocampus, leading to improved formation of new memories and spatial orientation abilities. Studies using fNIRS indicate that acute exercise has been shown to enhance performance in executive tasks and fine motor control, as suggested by research utilizing EEG. These findings suggest that the effects of aerobic exercise and physical fitness primarily impact brain regions sensitive to neurodegeneration, including the frontal, temporal, and parietal regions (Domingos et al., 2021).

Frailty is another factor often associated with aging, but it is not an inevitable consequence of advancing years. It can be triggered by both internal factors, such as infections or changes in medication, and external factors, such as alterations in a person's immediate environment. A person's level of physical activity can directly impact various aspects of the frailty syndrome.

Firstly, a lack of physical activity can lead to various chronic health problems, such as cardiovascular diseases, cerebrovascular diseases, type 2 diabetes, depression, and dementia. In this study, the most prevalent chronic diseases in the population were hypertension and diabetes. These conditions can impact physiological reserves, contributing to the development or worsening of frailty. Thus, the current Federal Physical Activity Guidelines (PAG) recommend that adults engage in at least 150 minutes per week of moderate-intensity aerobic physical activity or 75 minutes per week of vigorous-intensity activity to significantly reduce the risk of cardiovascular disease.

Secondly, reduced mobility and muscle strength are crucial diagnostic criteria in various models used to identify frailty. Lastly, falls and their potential adverse consequences, such as fractures or hospitalizations, often act as acute triggers for frail individuals, leading to additional loss of physiological reserves and increased frailty severity. Hence, the importance of progressive physical exercise to enhance gait speed, strengthen bones through the application of repeated mechanical loads, and consequently reduce the risk of falls, morbidity,

and mortality. While aerobic exercises are important, they do not demonstrate the same effectiveness as strength-based resistance training for increasing muscle strength and hypertrophy.

The musculoskeletal system exhibits remarkable adaptive capacity in response to repeated stimuli, such as those provided by resistance training. If biological stress is maintained for an appropriate period, allowing optimal recovery between sets and exercise sessions, desired phenotypic changes can be observed, such as an increased ability to sustain contraction and strength gain (Bonilla et al., 2020). Consequently, adherence to the fundamental principles of physical training is crucial: applying overload (positive adaptation occurs only when the training load surpasses the usual level), specificity, and individualization (all practitioners are unique in terms of training experience and genetics, even within the same age group), and periodization (training load, including intensity and volume, should vary over time to prevent adaptation). All these principles converge to establish an optimal allostatic load (Guidi et al., 2021) and/or supercompensation (reaching a level above the initial value) (Impellizzeri et al., 2019). For this reason, careful and qualified supervision, especially in conditions of sarcopenia in older individuals, is necessary to ensure proper progression in training programs and their execution.

Moreover, regular exercise has proven effective in treating depression in older adults. During exercise, endogenous opioid neuropeptides, such as endorphins, are released by the pituitary gland, leading to the blocking of neurotransmitters involved in pain transmission and fostering a sense of well-being. Regular exercise can also enhance self-confidence, self-esteem, and reinforce positive behaviors, especially if the physical changes resulting from exercise provide a sense of accomplishment. In older adults, studies have demonstrated that engaging in regular group exercise can foster a sense of social belonging within a community, and mutual support among participants can contribute to the long-term maintenance of physical activity. Therefore, exercise-based interventions can be beneficial in mitigating social and psychological frailty (Woolford et al., 2020).

Finally, it is essential to note that the negative perception of health is predominantly linked to the loss of independence and reduced functional capacities, often stemming from these factors that contribute to the vulnerability of older adults. Thus, the rationale behind the reduction in vulnerability among the elderly who participated in physical activities in this study becomes clear, highlighting the importance of having more active older adults in our society.

Conclusion

This study provides robust evidence of the positive impacts of a 16-week supervised physical exercise program on the Clinical-Functional Vulnerability Index (CFVI) and the mobility of older individuals. Despite remaining in the Moderate Risk range, participants experienced a significant improvement in their functional capacity, particularly in the areas of reach, grip, pinch, aerobic and/or muscular capacity, gait, and sphincteric continence. The substantial increase in the "Robust" classification and the decrease in the "Risk" and "Frail" classifications reflect the transformative potential of physical exercise programs in the lives of older adults.

These results not only underscore the relevance of supervised physical exercise programs for the health and well-being of the elderly population but also emphasize their importance in mitigating public costs associated with the care of this age group. Additionally, the research highlights the need for public policies that promote the widespread implementation of effective physical exercise programs as an integral part of global approaches to healthy aging.

These findings constitute a significant milestone that should be carefully considered by healthcare managers and policymakers. They not only unequivocally underscore the importance of supervised physical exercise programs in promoting the health and well-being of the elderly population but also point to an even more significant and transformative dimension. The potential impact of these programs in reducing public costs associated with the care of older adults is a crucial revelation at a time when healthcare systems are facing increasing funding challenges due to the aging population.

By demonstrating that the adoption of interventions such as supervised physical exercise programs can result in substantial improvements in the health of older individuals, this study sheds light on an effective preventive approach that can alleviate the financial pressure on healthcare systems while simultaneously enhancing the quality of life for individuals in this age group. This is an invaluable discovery for the formulation of public health policies aimed at the elderly.

Furthermore, we must not underestimate the role of this study as a guiding light for the creation of comprehensive and effective public policies to promote healthy aging. By demonstrating the effectiveness of supervised physical exercise programs, it provides a solid foundation for strategies that will not only benefit today's elderly but also shape the future of aging in our society.

This research tells us that investing in the promotion of healthy habits, such as regular physical exercise, is an investment not only in the health of the elderly but also in the economic

and social health of our community as a whole. Therefore, more than just a study, this work is a call to action, a call for the formulation of public policies aimed at the health of the elderly that recognize the effectiveness of preventive and health-promoting interventions and incorporate them as an integral part of a vision of healthy and sustainable aging.

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