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ORIGINAL ARTICLE

THE IMPORTANCE OF PHYSICAL ACTIVITY IN COUNTERACTING PHYSIOLOGICAL CHANGES IN THE ELDERLY

A importância da atividade física na contrapartida das mudanças fisiológicas em idosos importance of physical activity in counteracting physiological changes in the elderly

La importancia de la actividad física para contrarrestar los cambios fisiológicos en las personas mayore

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ABSTRACT

Introduction: old age is a critical period in human life, when changes in the body contribute to the gradual decline of its morphofunctional structure. **Objective:** the article aims to understand the impact of therapeutic physical activity on the rehabilitation of spatial-temporal-bodily orientation dysfunctions and its psycho-emotional and cognitive repercussions in elderly men staying in a residential home for the elderly. **Method:** this is an analytical, longitudinal, experimental, controlled and non-randomized clinical study looking for functional changes in spatial-temporal-bodily schema dysfunctions, psycho-emotional and cognitive functions in men (≥ 60 years) staying in a residential home for the elderly in the city of São Paulo. **Results**: the results showed an improvement in the psycho-emotional and cognitive functions of the participants when regular physical activity was practiced, especially in terms of medium-term attention, short-term memory, static and dynamic balance, and the ability to move and maintain body posture. There was an improvement in spatial-temporal schema, opto-spatial perception of moving objects, acuity to external stimuli, a reduction in reaction time to sound and visual stimuli and signs of anxiety. Breathing and relaxation exercises increased the subjective feeling of well-being**. Conclusion:** the results corroborate the scientific evidence that regular physical activity is a factor in protecting the health and quality of life of people of all ages.

Keywords: Exercise; Population Aging; Health Promotion. Rehabilitation.

RESUMO

Introdução: a idade avançada é um período crítico da vida humana, quando as mudanças no corpo contribuem para o declínio gradual de sua estrutura morfofuncional. **Objetivo:** o artigo visa conhecer o impacto da atividade física terapêutica na reabilitação de disfunções da orientação espaço-temporal-corporal e suas repercussões psicoemocional e cognitivas em homens idosos hospedados em um residencial para idosos. **Método**: trata-se de um estudo clínico analítico, longitudinal, experimental, controlado e não randomizado, à procura de mudanças funcionais nas disfunções dos esquemas espacial-temporal-corporal, funções psicoemocionais e cognitivas de homens (≥ 60 anos) hospedados em um residencial para idosos na cidade de São Paulo. **Resultados**: os resultados mostraram melhora nas funções psicoemocionais e cognitivas dos participantes quando presente a prática regular de atividade física, especialmente para o grau de atenção de médio prazo, memória de curto prazo, equilíbrio estático e dinâmico, destacando a evolução na capacidade de deslocamento e manutenção da postura corporal. Houve melhora do esquema espaço-temporal, na percepção opto-espacial de objetos em movimento, na acuidade aos estímulos externos, na diminuição do tempo de reação aos estímulos sonoros e visuais e, nos sinais de ansiedade. Os exercícios respiratórios e de relaxamento conferiram aumento da sensação subjetiva de bem-estar. **Conclusão:** os resultados corroboram com as evidências científicas que consagram a atividade física regular como fator de proteção à saúde e da qualidade de vida das pessoas de todas as idades.

Palavras-chave: Exercício Físico; Envelhecimento; Promoção da Saúde; Reabilitação.

RESUMEN

Introducción: la vejez es un período crítico de la vida humana, en el que los cambios en el organismo contribuyen al declive gradual de su estructura morfofuncional. **Objetivo**: el artículo pretende conocer el impacto de la actividad física terapéutica en la rehabilitación de las disfunciones de la orientación espacio-temporal-corporal y sus repercusiones psico-emocionales y cognitivas en ancianos varones alojados en una residencia para la tercera edad. **Método**: se trata de un estudio clínico analítico, longitudinal, experimental, controlado y no aleatorizado que busca cambios funcionales en las disfunciones del esquema espacio-temporal-corporal y en las funciones psicoemocionales y cognitivas en hombres (≥ 60 años) alojados en una residencia para ancianos de la ciudad de São Paulo. **Resultados**: los resultados mostraron una mejora en las funciones psicoemocionales y cognitivas de los participantes cuando se practicaba actividad física regular, especialmente en lo que respecta a la atención a medio plazo, la memoria a corto plazo, el equilibrio estático y dinámico, y la capacidad para moverse y mantener la postura corporal. Se observó una mejora del esquema espacio-temporal, de la percepción opto-espacial de los objetos en movimiento, de la agudeza a los estímulos externos, de la reducción del tiempo de reacción a los estímulos sonoros y visuales y de los signos de ansiedad. Los ejercicios de respiración y relajación aumentaron la sensación subjetiva de bienestar. **Conclusión**: los resultados corroboran la evidencia científica que establece la actividad física regular como factor de protección de la salud y la calidad de vida de personas de todas las edades.

Palabra Clave: Ejercicio Físico; Envejecimiento, Promoción de la Salud; Rehabilitación.

INTRODUCTION

The current demographic landscape reveals a steady increase in the elderly population worldwide. As age advances, morphofunctional changes occur, affecting physical fitness[1]. These changes are exacerbated by natural aging factors and by negative external influences, such as the deterioration of individual physical condition[2]. All stages of life influence levels of biological organization, but aging tends to disrupt this structure adversely, requiring adaptations in response to functional declines. In particular, structural changes in the central nervous system associated with aging are reflected in the dysregulation of spatial, temporal, and body orientation, as well as in psycho-emotional and cognitive functions[3].

Although pharmacological treatment is effective in addressing morphofunctional decline, it may lead to negative pharmacodynamic side effects, especially in cases of polypharmacy. Given that many older adults take multiple medications due to various health conditions, it is important to explore alternatives to manage dysfunctions and reduce the need for medication, prioritizing non-pharmacological approaches that promote quality of life in the elderly[4].

Functional recovery in older adults is addressed by various authors and rehabilitation methods, such as balneotherapy, magnetotherapy, oxygen therapy, physiotherapy, among others. In the context of this article, the focus is on therapeutic physical training as the central method for rehabilitating morphofunctional dysfunctions associated with aging[5].

Systematized physical exercises with therapeutic purposes are an emerging practice in Brazil, aimed at addressing morphofunctional disorders. Preliminary research[6] show promising results that require further investigation, especially when combined with other therapeutic approaches. Therapeutic training has been shown to have a stimulating effect on the body, which may serve as a protective factor against pathologies associated with physical inactivity[7].

Based on the premise that therapeutic physical training (TPT) may have positive impacts on slowing morphofunctional processes associated with aging, this study investigated its influence on improving spatial-temporal-body orientation, psycho-emotional aspects, and cognitive functions. The underlying hypothesis is that TPT can act as a modulating agent, delaying the negative effects of aging and promoting a better quality of life in older adults.

This study offers a significant contribution by providing new insights into the combined mechanisms involved in the rehabilitation of neurofunctional dysfunctions in elderly men. Through specific tests, it assessed the effectiveness of the therapeutic physical training program in enhancing the rate, nature, and rhythm of rehabilitated morphofunctional processes. The practical value of this research lies in the development and application of a targeted intervention for older men with spatial-temporal-body regulation disorders, as well as in the analysis of its impact on their psycho-emotional and cognitive functions—particularly among those residing in nursing homes.

The findings are directed toward health professionals, especially those involved in the rehabilitation of morphofunctional disorders in older adults. Furthermore, the study is also relevant to professionals concerned with promoting social inclusion, given the correlation between improved physical, cognitive, and emotional capacity and the expansion of social relationships. Its central objective is to investigate the impact of TPT on the rehabilitation of regulatory dysfunctions in spatial-temporal-body orientation in elderly men residing in long-term care facilities, as well as its repercussions in the psycho-emotional domain.

METHOD

This study adopts an analytical, prospective, controlled, and non-randomized design. Its framework was developed to establish a series of investigative procedures aimed at collecting reliable data on the effects of TPT as a rehabilitative measure. The objective is to analyze

morphofunctional changes in spatial-temporal-body schemes, as well as in the psycho-emotional and cognitive functions of men aged 60 years or older, residing in a long-term care facility in the city of São Paulo.

The non-probabilistic sample selection was based on judgmental criteria, dividing the residents of the care facility into two groups: Control Group (CG, n=30) and Intervention Group (IG, n=28). Inclusion criteria for the IG required participants to be male, aged 60 or older, present with confirmed morphofunctional dysfunction, and voluntarily and knowingly agree to participate in the study. The CG consisted of residents who either had medical contraindications to TPT or chose not to participate in the training but agreed to undergo the control testing.

The decision to include only male participants was based on two reasons: first, to avoid the need for gender stratification in the data analysis, thereby simplifying the analytical process; and second, to align with the future plans of the Physical Education and Health research group, which intends to replicate this study using an exclusively female sample.

Sample characterization included the assessment of cognitive deficits using the Mini-Mental State Examination (MMSE), a practical screening method for evaluating cognitive impairment in older adults. The MMSE consists of questions divided into seven categories, each designed to assess specific cognitive abilities: temporal orientation (5 points), spatial orientation (5 points), registration of three words (3 points), attention and calculation (5 points), recall of the three words (3 points), language (8 points), and visual constructive ability (1 point)[8].

The MMSE score ranges from 0 to 30 points, indicating the level of cognitive impairment among those assessed, with 0 representing the highest degree of impairment and 30 indicating optimal cognitive performance. It is important to note that the MMSE is not a diagnostic tool for mental disorders but rather an indicator of functions that may require further investigation. Scores equal to or greater than 27 points are considered normal, while scores equal to or below 24 points may indicate cognitive impairment. For individuals with less than four years of formal education, the cutoff point is adjusted to 17 instead of 24. In cases of uncomplicated depression, the cutoff is 25.1, whereas for cognitive impairment associated with depression, it is 19 points. The test can also be administered online.

The IG underwent the experimental protocol, which consisted of the application of TPT. This protocol included a series of exercises developed by the research team, covering static and dynamic balance, coordination, muscle strengthening and stretching, breathing exercises, laterality with forward and lateral body movements (excluding backward walking for safety reasons to prevent falls), body weight transfer, quick reaction to verbal and nonverbal auditory stimuli, and exercises designed to stimulate the vestibulo-ocular system, which is responsible for spatial, temporal, and body perception[9]. The CG was instructed to maintain their routine daily activities.

TPT sessions were held twice a week, with at least one day of rest between sessions, over a period of six consecutive months. Each session lasted an average of 90 minutes and was conducted by a properly trained team. Prior to each session, participants underwent a physical assessment. If they reported any subjective discomfort, they were excluded from that day's training.

Warm-up exercises were included at the beginning of every training session, followed by neuromuscular relaxation techniques at the end. No specific dress code was established, but participants were encouraged to wear comfortable clothing suitable for exercise. TPT was not administered to the CG and any prescribed physical or occupational therapy routines remained unchanged for both groups throughout the study.

In TPT, physical exercises were adapted according to each participant's morphofunctional dysfunction and psychophysical condition. All sessions were supervised by monitors to ensure the correct execution of the activities.

Cognitive functions were assessed in domains such as visuospatial processing skills, spatial and temporal properties, working memory (both phonological and visual), as well as attention and concentration.

To assess spatial and temporal properties, the clock drawing test (CDT) was applied, following the protocol proposed by Sunderland et al. (1989)[10]. This test involves a task in which participants are asked to draw a clock, requiring visuospatial sequencing, numerical ordering, and planning skills. Participants were instructed to draw the clock hands to indicate the time 11:10. Scoring was conducted as described in Table 1.

Table 1 - Scoring scale for the Clock Drawing Test, proposed by Sunderland et al. (1989)[10]

Criteria	Points
Clock face and numbers are correct	10
Minor disorganization of the clock hands	9
More pronounced disorganization of the clock hands	8
Clock hands are completely incorrect	7
Inappropriate use (e.g., digital time indication or circles around numbers)	6
Numbers in reverse order or clustered in one section of the clock face	5
Missing numbers or numbers placed outside the clock boundaries	4
Numbers and clock face disconnected; absence of clock hands	3
Some evidence of understanding the instructions, but minimal resemblance to a clock	2
Did not attempt or failed to produce a recognizable clock	1

Source: Authors (2024).

The memory test was conducted using the WOM-ASM Sequencing Test[1], adapted from the classic WAIS-III forward and backward digit span test. This test assesses the ability to retain phonological and visual information in the short term. Execution time ranges from 30 seconds to 5 minutes. In the task, a series of numbered balls is displayed on the screen, and the participant must memorize and repeat the sequence. The series begins with a single digit and gradually increases to two digits. The test is interrupted when the participant makes a mistake in recalling the sequence[11].

The Bourdon-Wiersma test was used to assess the participants' attention and concentration capacity. For a maximum of 10 minutes, the participants were instructed to select as many four-dot groups as possible from five tables, with two minutes allocated per table, while ignoring groups of three or five dots[12]. Each table consists of 16 rows, with 25 groups of dots per row. This psychometric test is based on the work of French psychologist Benjamin B. Bourdon (1860–1943) and Dutch neurologist Enno Dirk Wiersma (1858–1940). It can be performed online via the Interactive Portal-Book of Self-Development Methods (https://metodorf.com/tests/bourdon/group_bourdon.php?method=groupbourdon&mod=start&page=0&screen=small).

The assessment of participants' psycho-emotional status was carried out using the Spielberger Anxiety Scale, in use since 1970. This inventory comprises 20 items rated on a 4-point Likert scale, where: 1 – almost never; 2 – sometimes; 3 – often; and 4 – almost always. The results provide an indication of the likelihood of an anxiety disorder, though the scale is not intended for diagnostic purposes. Scores closer to 1 suggest minimal anxiety, whereas scores approaching 4 indicate a higher level of anxiety[13].

For statistical analysis, nonparametric Mann-Whitney and Wilcoxon tests were used, along with the Spearman correlation coefficient. All analyses were conducted at a 0.05 significance level using Stata 13® statistical software.

This article was developed based on situations that naturally arose in professional practice, without disclosing the identity of any participants. The content consists of personal notes derived from routine outpatient work carried out by a multidisciplinary rehabilitation health team composed of physical education professionals, physiotherapists, a physician,

occupational therapist and a psychologist, all working in a large residential care facility for older adults in the city of São Paulo.

According to Resolution No. 510, dated April 7, 2016 – Brazilian National Health Council (CNS), Article 1, Sole Paragraph, this type of study is not required to be registered or reviewed by the CEP/Conep system when it aims to theoretically explore situations that spontaneously arise in professional practice, provided no identifying data of the subjects is disclosed.

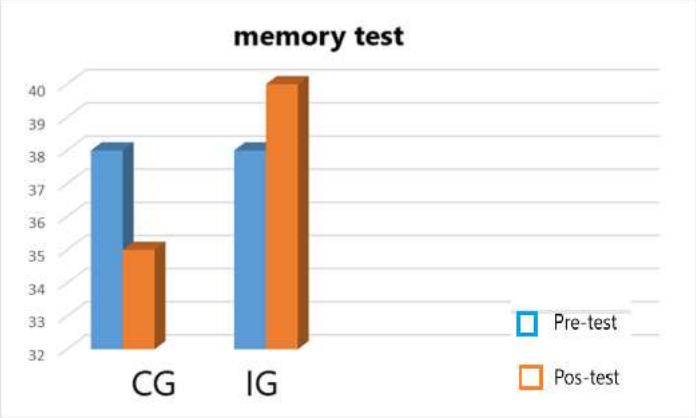
Additionally, we inform the reader that the name of the residential care facility may not be disclosed in the reports. This is a decision made by the administration to preserve the privacy of its residents. Therefore, in accordance with ethical principles and the expressed wishes of the institution that cooperated in the research, the origin of the data will be referred to as "a residential care facility for older adults" in the city of São Paulo.

RESULTS AND DISCUSSION

This study analyzed the results of 58 men aged 60 and over, residing in a nursing home in the city of São Paulo. In the IG, composed of 28 participants, the mean age was 66 ± 3.8 years, while in the CG, with 30 participants, the mean age was 69 ± 4.1 years.

The sample initially presented a reduction in working memory, both visual and auditory, which may impact the assimilation of new information and task performance. The analysis of post-intervention results revealed an improvement in recent memory (past 3 months) in the IG compared to the CG (Figure 1).

Figure 1 – Memory test of men (≥ 60 years old), conducted in the control group and intervention group during the course of therapeutic physical training, São Paulo, Brazil, 2021.



Source: Authors (2023).

Performance on the tests declined with increasing participant age, with the oldest individuals being particularly more sensitive to concentration tasks, resulting in poorer performance. In many cases, test results were interpreted as cognitive decline associated with aging. However, the average post-test score was higher for participants in the IG compared to those in the CG. desempenho nos testes diminuiu com o aumento da idade dos participantes, sendo os idosos longevos particularmente mais sensíveis às tarefas de concentração, resultando em um desempenho inferior. Em muitos casos, os resultados dos testes foram interpretados como um declínio cognitivo associado ao envelhecimento. No entanto, a pontuação média após o teste foi maior para os participantes do GI em comparação com os participantes do GC.

Table 2 – Mean scores, pre- and post-test of cognitive abilities in the control group (CG, n = 30) and intervention group (IG, n = 28), consisting of men (≥ 60 years), during the course of therapeutic physical training, São Paulo, Brazil, 2021**.**

Cognitive ability			**GC (n=30)**	**GI (n=28)**
Clock drawing test	TRV	Pré	62,7	80,4
		Pós	57,1	58,6*
	TRA	Pré	67,4	66,4
		Pós	59,3	51,2*
WOM-ASM Sequencing Test	Visual memory	Pre-test	5,4	5,3
		Post-test	5,3	6,2*
	Auditory memory	Pre-testé	6,2	6,2
		Post-test	6,2	6,7*
Bourdon-Wiersma	Attention/concentration	Pre-test	1,86	1,66
		Post-test	2,14	2,89
Mini-Mental State Examination	MMSE	Pre-test	23,4	21,6
		Post-test	23,6	27,3*

* Significant differences compared to baseline values ($p < 0.05$).
VRT – Visual Reaction Time.
ART – Auditory Reaction Time.

After the intervention, an improvement in current event memory was observed among participants in the IG. Notably, there were positive changes in short-term visual and auditory memory, with 42% of the active group achieving a greater number of words learned and recalled. Meanwhile, 23% showed a slight decrease in the number of words memorized and reproduced, and 35% maintained their initial levels.

Temporal orientation abilities were assessed by having participants count one minute, comparing the individual's perception of time to the examiner's stopwatch-measured minute. In the IG, 97% of participants counted faster than the real-time minute, while 3% counted more slowly. In the CG, 85% counted faster, and 14% slower. Overall, the one-minute count did not match real-time duration across the sample. As a result of the TFT, there remained a discrepancy between the perceived and actual minute; however, the count from IG participants was closer to the real-time standard compared to CG (Table 3).

Particularly relevant was the training of reactions to auditory and visual stimuli in the IG, aiming to correct spatiotemporal disorders. More significant changes were observed in response times to sound and light compared to the CG. Spatial representation was assessed using the clock drawing test. Before the intervention, results showed that 43% of IG participants scored 10 points, 23% scored 8, and 34% scored 7 points. In the GC, 40% scored 10 points, 15% scored 9, another 15% scored 8, and 30% scored 7. These results indicate that more than half of the participants exhibited deficits in opto-spatial gnosis. After the intervention, the percentage of participants scoring ≥ 9 increased (63% scored 10 points and 7% scored 9).

In the Bourdon-Wiersma focused attention test, a significant improvement was observed in the IG, while little change occurred in the CG. After the adapted physical training (APT), 65% of IG participants improved their work quality scores, compared to only 30% in the CG. Both groups displayed cognitive deficits in the Mini-Mental State Examination (MMSE) before

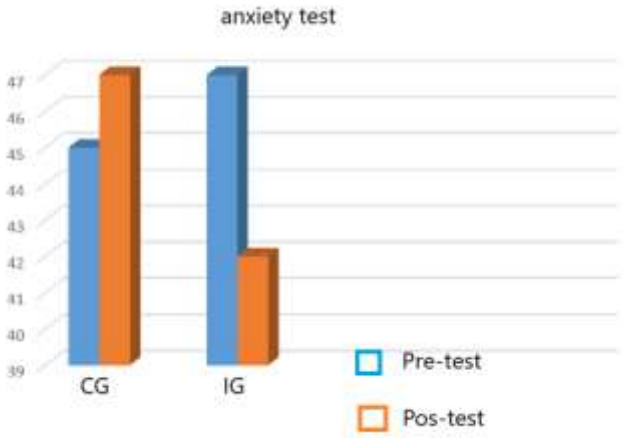
the interventions. However, the mean retest score was significantly higher in IG men compared to those in CG. No significant difference was found in the CG retest.

Across the sample, frequent occurrences of postural orientation disorders were observed, characterized by a reduced ability to maintain proper body alignment. Impairments in gait and dynamic balance were evident, including slow walking, short steps, instability when changing direction, and forward-leaning posture with the gravity line projected anteriorly. These alterations were observed in both groups, with varying degrees of severity.

After the intervention, a significant improvement in gait and upright postural stability was observed in the IG, with the average score increasing from 2.1 to 4.1 points. Mean while, no significant changes were observed in the CG, with the mean remaining close to 2.3 points. The restoration of these functions and the prevention of the progression of such disorders are essential to avoid fall-related injuries, promote self-care, and ensure optimal mobility in elderly men[14].

In this study, signs of reduced overall muscle strength were observed in both groups, resulting in weakness in trunk and limb movements, early fatigue, difficulty maintaining body posture, and varying levels of anxiety. Before the while 34% had moderate to low anxiety. In the CG, these proportions were 62% and 38%, respectively. After the TFT, significant changes in anxiety levels were found in the IG ($p < 0.05$). In the retest conducted with the CG, which only underwent physical therapy sessions, a slight increase in anxiety levels was observed ($p > 0.05$).

Figure 2 – Average anxiety level scores of men (≥ 60 years), based on the Spielberger Anxiety Scale pretest and posttest, for the control and intervention groups, during therapeutic physical training, São Paulo, Brazil, 2021.



Source: Authors (2023).

The reduction in anxiety levels among men in the IG can be partially attributed to the use of neuromuscular relaxation exercises and breathing techniques. This successful approach within TFT allows for the reduction of muscle tension and, consequently, decreased anxiety levels. Lower anxiety levels are also associated with shorter reaction times in bodily movements, enabling quicker muscular and joint responses – an essential factor in preventing traumatic falls among older adults[15].

Before the TFT interventions, 82% and 88% of participants in the IG and the CG, respectively, exhibited cardiovascular regulation with parasympathetic predominance. After the interventions, 60% of IG participants showed a decrease or stabilization in blood pressure. Signs of parasympathetic activity included bradycardia, reduced blood pressure, and vestibular symptoms such as frequent dizziness. In contrast, signs of sympathetic activity were

characterized by tachycardia, increased systemic blood pressure, and subjective complaints of palpitations[16].

In the data analysis, a linear relationship between the autonomic regulation of the cardiovascular system and anxiety levels was tested. However, no significant correlation was found in this sample, which contrasts with suggestions from other authors regarding a direct correlation between anxiety and indicators of autonomic cardiovascular imbalance[17]. The results indicate a non-linear increase in parasympathetic activity of the autonomic nervous system following the TFT, particularly relevant for men exhibiting predominantly sympathetic autonomic responses.

Vestibular exercises applied to elderly men resulted in improvements in static and dynamic balance, as well as in spatial, temporal, and body orientation. The fundamental principle of neurogenesis, which involves the formation, migration, and differentiation of new neurons, suggests that TFT contributes to the development of these new functional neural connections and the replacement of damaged ones[18].

The cognitive improvement resulting from TFT was evidenced by a greater capacity to activate attention and memory. This process was observed after task performance. By understanding, remembering, and executing commands, it is suggested that the stimuli promote the enhancement and development of new neuronal circuitry, thereby improving compromised cognitive functions[19].

In the context of this study, practical guidelines revealed greater acceptance of TFT by participants when specific dysfunctions were considered in the planning of the training sessions. Additionally, it was observed that performing up to three physical goals in a single day was more easily assimilated. TFT was well received when initiated with the relaxation of skeletal muscles of the trunk and limbs and concluded with facial muscle relaxation, due to their greater susceptibility to tension retention. The complexity or difficulty of the exercises tended to discourage participants; therefore, it was prudent to gradually increase the degree of difficulty, starting with simple and easy-to-perform exercises. To avoid fatigue, interval training was recommended, whether carried out individually or in small groups, allowing for better monitoring of execution quality.

Although we still face challenges in clearly explaining the processes through which all the benefits of therapeutic physical training are achieved, the model proposed in this study paves the way for several research hypotheses, especially highlighting its role in promoting individual health. The prevention of health problems through physical activity remains a major concern in public health, given its cost-effective nature.

Our model supports the perspective that such training promotes morphofunctional improvements in elderly individuals, regardless of their health condition or physical capacity. The advantages demonstrated in this article underscore the contribution of this approach to enhancing the bodily, psychological, social, and environmental well-being of older adults, thereby promoting a more fulfilling life.

CONCLUSION

Therapeutic Physical Training, adopted as a non-pharmacological and complementary measure in the treatment and prevention of functional disorders in older men, demonstrated improvements in selective functions of the central nervous system. Notably, it enhanced cognitive functions, especially medium-term attention and short-term memory, resulting in a reduction in the number of errors during daily activities. Additionally, it had a positive impact on both static and dynamic balance, reflected in improved mobility and the ability to maintain an upright posture for longer periods.

An improvement in the spatiotemporal scheme was observed as a result of the intervention, evidenced by enhanced opto-spatial perception of moving objects, which led to

greater acuity in responding to external stimuli, reduced reaction time to auditory and visual inputs, and lower anxiety levels. The breathing techniques incorporated into the training program contributed to increased parasympathetic activity in cardiovascular regulation, fostering a heightened subjective sense of well-being.

This therapeutic approach functioned as a biological stimulus, activating various organs and physiological systems in elderly individuals, in line with scientific evidence that recognizes regular and moderate physical exercise as a key ally in the promotion of health and quality of life.

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