Accepted Article

Journal of Frailty, Sarcopenia and Falls

Original Article

Effects of REAC Neuro Postural Optimization on Gait and Postural Symmetry in Older Adults

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Abstract

Objectives: Functional asymmetry is a hallmark of aging-related motor decline, contributing to impaired gait, balance deficits, and increased fall risk. This study aimed to evaluate the effects of a single session of Neuro Postural Optimization (NPO), a non-invasive neuromodulation protocol based on Radio Electric Asymmetric Conveyer (REAC) technology, on central neurophysiological balance and functional symmetry in older adults. **Methods**: Eighteen participants (mean age: 72.4 ± 6.1 years) underwent a standardized REAC-NPO session. Assessments were performed immediately before and after treatment using the Timed Up and Go (TUG) test, the Gait Speed test, the Five Times Sit-to-Stand (FTSTS), and Handgrip dynamometry. **Results**: Statistically significant improvements were found in TUG (p=0.026), Gait Speed (p=0.041), and FTSTS (p=0.003). No significant change was observed in handgrip strength (p=0.530), supporting a central rather than peripheral mechanism of action. Functional dysmetria, a reproducible and quantifiable indicator of maladaptive central motor control, was completely corrected in all participants immediately after the REAC-NPO session. **Conclusions**: A single REAC-NPO session can restore functional symmetry and improve mobility-related outcomes in older adults. The immediate and complete correction of functional dysmetria supports the potential role of REAC-NPO in fall prevention strategies and functional recovery programs for aging populations.

Keywords: Fall Prevention, Neuromodulation, REAC Technology, Neuro Postural Optimization, Functional dysmetria

Introduction

In the context of neuromotor aging, the concept of functional asymmetry can be clinically interpreted through the phenomenon of functional dysmetria (FD)[1]. Functional dysmetria refers to a centrally mediated, measurable, and repeatable measurable and repeatable expression of maladaptive neurophysiological control, typically manifesting as asymmetrical motor responses or postural imbalances[1,2]. This definition underscores that FD is not related to structural differences between limbs but originates from altered central nervous system regulation.

Salvatore Rinaldi and Vania Fontani are co-inventors of the REAC technology. All other authors declare no conflicts of interest.

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Edited by: *Dawn Skelton*

Accepted *21 September 2025*

This concept enables a more precise understanding of central dysfunction and offers a concrete biomarker for evaluating therapeutic interventions aimed at restoring symmetry[1,2].

The progressive decline in neuromotor coordination, postural control, and gait performance due to aging is a major contributor to falls, functional dependency, and institutionalization in older adults[3,4]. A central feature of these impairments is the loss of functional symmetry in postural and motor patterns, reflecting an imbalance in adaptive neurophysiological mechanisms[5,6]. This functional asymmetry, often manifested as altered gait, balance deficits, and postural instability, is a key factor underlying increased fall risk and reduced quality of life in older adults[7,8].

Traditional interventions, such as physical therapy[9] or pharmacological treatments[10], often provide only temporary or modest improvements, as they may not effectively address the underlying dysregulation of central neural circuits. Furthermore, many of these approaches require prolonged administration or active patient participation, which may limit their applicability in frail elderly populations. There is an urgent need for innovative approaches that can restore functional symmetry by rebalancing central control mechanisms and optimizing neurobiological processes.

Radio Electric Asymmetric Conveyer (REAC) technology, developed by Rinaldi and Fontani, offers a novel neuromodulation strategy aimed at restoring endogenous bioelectrical activity (EBA) in dysfunctional adaptive circuits[11-13]. The REAC Neuro Postural Optimization (NPO) protocol delivers a brief, targeted stimulus via an Asymmetric Conveyor Probe (ACP) applied to the auricular region[2,14]. This stimulation modulates the bioelectrical activity of the central nervous system, with a particular focus on the cerebellum and brainstem circuits, which play a pivotal role in maintaining postural symmetry and coordinated motor function[2].

Previous studies have demonstrated the ability of REAC-NPO to correct functional dysmetria (FD), a manifestation of stress-related maladaptive asymmetries in motor responses. Notably, these effects have been shown to persist for up to 18 years after a single session[1], highlighting the long-term stability of this intervention. Building on this evidence, the present study specifically investigates its applicability in older adults, a population at high risk for functional decline and falls. The present study aims to evaluate whether a single session of REAC-NPO can produce measurable improvements in functional symmetry and mobility in older adults, as assessed by standardized clinical tests. Given its unique mechanism of action on central circuits, REAC-NPO represents a promising candidate for integration into public health strategies aimed at fall prevention and functional recovery in aging populations.

Characteristic	Value
Age, mean ± SD (years)	72.4 ± 6.1
Age range (years)	60–84
Sex, n (%)	Female: 10 (55.6%); Male: 8 (44.4%)

Table 1. Participants' demographic characteristics (N=18).

Materials and Methods

Participants

Participants were recruited from the EPIDOSO II Project cohort, a longitudinal study involving elderly individuals living in Vila Clementino, São Paulo[15]. Eligibility criteria included age ≥ 60 years and the presence of mobility difficulties, defined by a Timed Up and Go (TUG)[16] completion time between 10 and 29 seconds. The TUG is a functional mobility assessment in which the individual is asked to rise from a seated position, walk a short distance, turn around, return, and sit down again. Cognitive ability to understand and provide informed consent was also required (Table 1).

Importantly, participants were not selected based on a specific medical diagnosis. Instead, they were included on the basis of mobility impairment, a multifactorial condition that commonly results from the complex interaction of aging-related processes and comorbidities. This approach ensured the recruitment of a representative sample of older adults experiencing functional decline, regardless of the underlying etiology.

Intervention

Each participant received a single REAC-NPO[2] session using the BENE 110 medical device (ASMED, Scandicci, Italy). The asymmetric conveyer probe (ACP) was positioned in contact with the auricular area to deliver a brief, painless radioelectric stimulus conveyed asymmetrically. This interaction with altered endogenous bioelectrical activity aims to modulate central neural circuits involved in motor control.

The REAC-NPO protocol is administered using pre-set parameters that cannot be modified by the operator, and completed in a few milliseconds, ensuring consistency across sessions. The treatment is non-invasive, painless, and does not produce any subjective perception by the patient, making it highly suitable for use in frail or elderly populations.

Outcome

Outcome measures included the Timed Up and Go (TUG) test[16,17]. Additional measures were the Gait Speed test[18,19], the Five Times Sit-to-Stand (FTSTS)[20], and Handgrip dynamometry[21]. All assessments were conducted immediately before and after the treatment session.

Test	Pre Mean (± SD)	Post Mean (± SD)	p-value	Cohen's d
Timed Up and Go (s)	13.80 ± 3.44	13.03 ± 3.29	0.026[a]	0.229
Gait Speed (s)	8.23 ± 2.55	7.69 ± 2.09	0.041[a]	0.232
Five Times Sit-to-Stand Test	21.09 ± 6.63	19.03 ± 6.65	0.003[a]	0.310
Handgrip Strength (kg)	19.71 ± 6.91	19.47 ± 6.52	0.530	0.036

Table 2. Pre- and post-treatment performance on functional tests (mean ± SD), with statistical significance and effect sizes (Cohen's d). Values are presented as mean ± SD. [a]p < 0.05 compared with pre-treatment values.

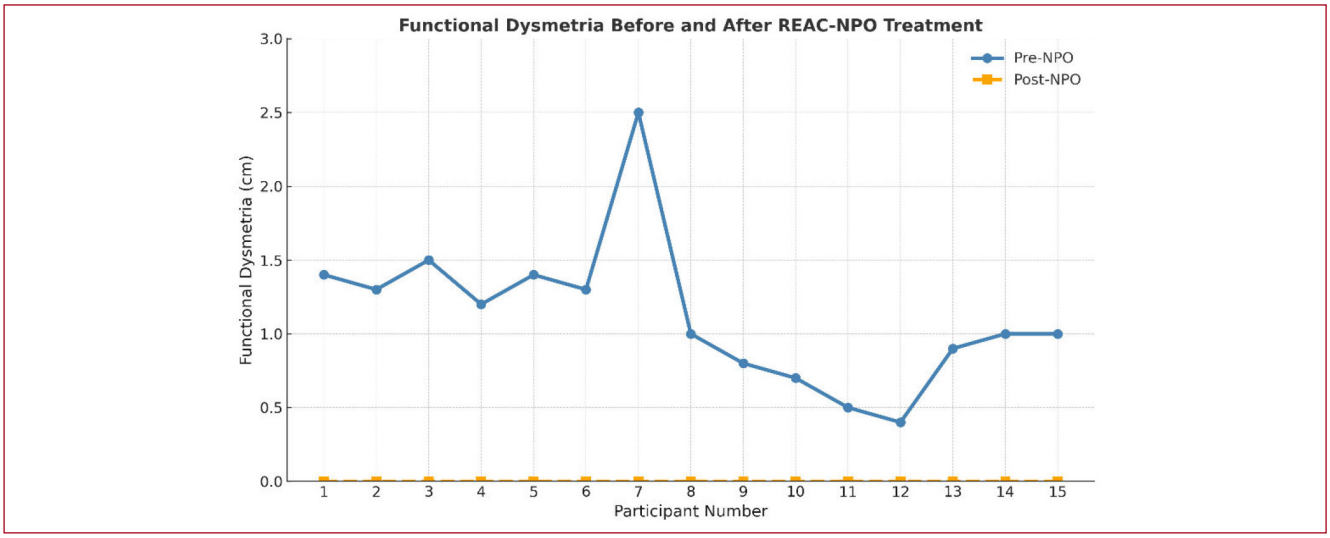

Figure 1. Individual FD values before and after a single REAC-NPO session in 15 older adults. Pre-treatment measurements (blue line) show variable asymmetry in quadriceps activation, while post-treatment values (orange line) are uniformly 0.0 cm, indicating complete correction. Three of the 18 participants originally enrolled were excluded from this analysis due to missing FD data.

Statistical Analysis

Data were analyzed using paired t-tests (significance threshold: $p < 0.05$). Cohen's d was used to calculate effect sizes. A post hoc power analysis was conducted, and an a priori sample size estimation was performed using G*Power software (version 3.1.9.7). The expected effect size (Cohen's d = 0.85) was based on previous findings demonstrating the stable correction of functional dysmetria following a single REAC-NPO session, as observed in a large-scale study involving approximately 30,000 patients[1]. With $\alpha = 0.05$ and desired power = 0.95, the analysis indicated that a sample of 18 participants was sufficient to detect clinically meaningful effects. This confirms the adequacy of the sample size in this study.

Results

The findings demonstrated statistically significant improvements in functional mobility, particularly in the Timed Up and Go (TUG) test[16], following a single REAC-NPO session. The TUG showed a mean reduction of 10.71% (pre-treatment mean: 13.80 ± 3.44 s; post-treatment mean: 13.03 ± 3.29 s; $p = 0.026$), confirming enhanced central neuromotor control. Significant improvements were also observed in the Gait Speed test[19] and Five Times Sit-to-Stand Test (FTSTS), while no significant changes were observed in handgrip strength[21] ($p = 0.4294$). Table 2 summarizes the key results.

Functional dysmetria (FD)[1], a validated indicator of maladaptive central motor control, in 15 individuals, was evaluated by measuring the asymmetry in coordinated quadriceps activation between the two limbs, expressed as the difference in functional excursion[1]. Pre-treatment FD values ranged from 0.4 cm to 2.5 cm (mean 1.20 ± 0.55 cm). Immediately after the session, all participants exhibited complete correction, with FD reduced to 0.0 cm, indicating the full restoration of symmetrical motor response at the central level[2] (Figure 1).

A paired-samples t-test revealed a highly significant reduction in FD ($t = 11.83$, $p < 0.0001$), with a very large effect size (Cohen's $d = 2.19$), underscoring both the robustness and the clinical relevance of the intervention. The uniform post-treatment value of 0.0 cm across all subjects supports the specificity of the neuromodulatory effect[2] and is consistent with previous findings showing that FD correction following REAC-NPO is stable over time and not reproducible by placebo[1].

All participants completed the tests before and after the intervention without dropouts. The most substantial improvement was observed in the FTSTS[20], with a mean reduction of 2.06 seconds and the highest effect size ($d = 0.310$), suggesting enhanced coordination, postural transition, and neuromuscular activation in the lower limbs. Improvements in TUG[16] and Gait Speed[19], though characterized by smaller effect sizes, were nonetheless statistically significant and clinically relevant.

As expected, handgrip strength[21], an indicator of peripheral muscular force not centrally mediated, did not change significantly. This result reinforces the central action of the REAC-NPO protocol.

No adverse events were reported during or after the treatment session. Additionally, all participants exhibited immediate and stable correction of functional dysmetria (FD) following the REAC-NPO session[1], reinforcing FD correction as a hallmark outcome of REAC-NPO's action on central motor control circuits[2]. The stable disappearance of FD, previously demonstrated to be unachievable by placebo in double-blind studies[2], further supports the specific and reproducible efficacy of the treatment.

Discussion

The findings of this study show that a single session of REAC Neuro Postural Optimization (NPO) can produce immediate, measurable, and clinically meaningful improvements in both functional mobility and postural symmetry in older adults. A central element in interpreting these results is functional dysmetria (FD), an objective, reproducible, and quantifiable indicator of asymmetric central motor control[1,2]. FD does not stem from anatomical or structural differences between limbs; rather, it reflects maladaptive patterns of neural coordination generated within cerebellar–brainstem circuits and their supraspinal connections[2,22,23]. Its complete resolution after REAC-NPO indicates the restoration of balanced motor command distribution to both sides of the body[1,2].

The uniform post-treatment correction of FD in all participants, combined with a very large effect size, underscores the specificity and reproducibility of the neuromodulatory action of REAC-NPO. These outcomes align with large-scale and long-term studies showing that FD correction is stable for years after a single session and cannot be reproduced by placebo[1,2]. Such reproducibility across diverse populations and clinical conditions[13,14,23] strengthens the case for considering FD not only as a reliable endpoint for central motor control interventions but also as a clinically valuable biomarker for monitoring therapeutic efficacy.

Crucially, the improvements in the Timed Up and Go (TUG)[16], Gait Speed[19], and Five Times Sit-to-Stand (FTSTS)[20] tests indicate that FD correction translates into tangible functional benefits. These gains are clinically relevant because they target domains closely linked to fall risk, gait stability, and independence in daily activities[3,7,8,24] key priorities in geriatric medicine. The lack of change in handgrip strength[21] further supports the interpretation that REAC-NPO acts through central neuromodulation rather than peripheral muscle strengthening.

From a neurophysiological perspective, the rapid reorganization of motor control patterns following REAC-NPO likely reflects modulation of maladaptive endogenous bioelectrical activity in networks that govern posture and locomotion[2,22,23]. This enables the restoration of coherent and symmetrical motor responses without requiring extensive repetition or compensatory strategies. In contrast, conventional physiotherapy approaches primarily target peripheral musculoskeletal adaptations and often require prolonged training to achieve partial and less stable improvements[25].

In aging populations, symmetry in posture and gait is not merely a sign of biomechanical harmony but a cornerstone of physiological efficiency, stability, and energy economy[26]. Loss of symmetry is a well-established predictor of frailty, increased fall incidence, and decreased quality of life[24]. Interventions that can restore symmetry at its central neural origin may therefore be pivotal in prevention strategies, rehabilitation programs, and the maintenance of autonomy in older adults.

The standardized, operator-independent nature of REAC-NPO, along with its non-invasive and imperceptible application, makes it especially suitable for elderly and frail individuals who may not tolerate prolonged or physically demanding treatments. These characteristics also favor its integration into preventive health programs, early screening initiatives, and routine geriatric care.

Future research should explore the long-term impact of REAC-NPO on outcomes such as fall incidence, hospitalization, and institutionalization rates, as well as its cost-effectiveness in public health contexts. Expanding its application to other conditions characterized by central motor asymmetry such as post-stroke deficits, movement disorders, and postural instability in neurodegenerative diseases[22,23] could broaden its clinical relevance. Moreover, evaluating the combined effects of REAC-NPO with complementary REAC protocols or conventional rehabilitation strategies may reveal synergistic benefits, optimizing both neurological reorganization and functional recovery. A limitation of this study is the small sample size, which, although supported by power

analysis, restricts the generalizability of the findings. Another limitation is the heterogeneity of participants' underlying clinical conditions. We intentionally did not restrict enrollment to a specific disease, but rather to the presence of mobility difficulties (TUG 10–29 s). This choice reflects the real-world scenario of aging populations, where motor impairment is rarely attributable to a single diagnosis but instead arises from multifactorial causes. While this heterogeneity may limit homogeneity, it increases the external validity and clinical transferability of our findings. Moreover, the primary endpoint of this study: functional dysmetria (FD) is a centrally mediated biomarker independent of the underlying pathology, supporting the relevance of our results across diverse clinical backgrounds. However, previous studies have consistently demonstrated the long-term stability of NPO effects[1,2], suggesting that the improvements observed here may also persist over time. Additionally, although standardized protocols were used, the absence of a control group limits the ability to fully exclude potential learning effects. Nevertheless, the immediate and uniform correction of functional dysmetria observed after NPO, together with previous evidence on the long-term stability of its outcomes[1,2], strongly suggests that the improvements are treatment-related rather than due to simple test repetition. Future studies with larger samples, randomized controlled designs, and extended follow-up periods are warranted to further confirm and expand these results.

Conclusions

A single session of REAC Neuro Postural Optimization (NPO) produced measurable improvements in functional mobility and postural symmetry among older adults. These findings confirm the capacity of REAC-NPO to restore functional symmetry through central neuromodulation mechanisms, supporting the long-term stability of its effects, even in individuals with neurodegenerative conditions such as Parkinson's and Alzheimer's disease. The treatment is non-invasive, painless, imperceptible to the patient, and delivered with standardized, operator-independent parameters, ensuring consistency across sessions. This combination of safety, effectiveness, and ease of administration makes REAC-NPO a promising therapeutic option for inclusion in public health strategies aimed at fall prevention, functional recovery, and the promotion of healthy aging.

Ethics Approval

The study was conducted at the Center for the Study of Aging, Department of Preventive Medicine, Federal University of São Paulo (UNIFESP), São Paulo, Brazil. It received ethical approval from the UNIFESP Research Ethics Committee (Approval Report: CEP/UNIFESP no. 1293/2020; Opinion number: 4.460.858; December 14, 2020).

Consent to Participate

Written informed consent was obtained from all participants prior to enrollment in the study.

Author Contributions

Conceptualization: A.A.V.S.M., L.R.R., S.R., V.F. Data curation: A.A.V.S.M., J.A.A.N., M.P.M., V.M.F. Formal analysis: A.A.V.S.M., L.R.R., M.P.M., S.R., V.F. Investigation: A.A.V.S.M., J.A.A.N., M.P.M., V.M.F. Methodology: A.A.V.S.M., S.R., V.F. Resources: A.C.B., L.R.J., L.R.R., S.R. Supervision: L.R.R., S.R., V.F. Validation: A.A.V.S.M., A.C.B., L.R.J., L.R.R., S.R., V.F. Visualization: A.A.V.S.M., M.P.M., S.R., V.F. Writing – original draft: A.A.V.S.M., J.A.A.N., M.P.M., V.F. Writing – review & editing: A.A.V.S.M., A.C.B., L.R.J., L.R.R., M.P.M., S.R., V.M.F., V.F. All authors have read and approved the final version of the manuscript.

References

1. Fontani V, Rinaldi A, Rinaldi C, Araldi L, Azzara A, Carta AM, et al. Long-Lasting Efficacy of Radio Electric Asymmetric Conveyer Neuromodulation Treatment on Functional Dysmetria, an Adaptive Motor Behavior. Cureus. 2022;14(6):e25768.
2. Rinaldi S, Mura M, Castagna A, Fontani V. Long-lasting changes in brain activation induced by a single REAC technology pulse in Wi-Fi bands. Randomized double-blind fMRI qualitative study. Sci Rep. 2014;4:5668.
3. Wang J, Li Y, Yang GY, Jin K. Age-Related Dysfunction in Balance: A Comprehensive Review of Causes, Consequences, and Interventions. Aging Dis. 2024;16(2):714-37.
4. Scheicher ME, Pereira NMR. Postural Imbalance in the Elderly: Main Aspects. In: Zawada Jr ET, editor. Geriatric Medicine and Gerontology. Rijeka: IntechOpen; 2018.
5. Promsri A, Pitiwattanakulchai P, Saodan S, Thiwan S. Age-Related Changes in Postural Stability in Response to Varying Surface Instability in Young and Middle-Aged Adults. Sensors (Basel). 2024;24(21).
6. Leite-Almeida H, d'Ascanio P, Faraguna U, Manzoni D. Editorial: Asymmetry in the central nervous system: Functional implications. Front Syst Neurosci. 2022;16:1002965.
7. Le Ray D, Guayasamin M. How Does the Central Nervous System for Posture and Locomotion Cope With Damage-Induced Neural Asymmetry? Front Syst Neurosci. 2022;16:828532.
8. Blaszczyk JW, Prince F, Raiche M, Hebert R. Effect of ageing and vision on limb load asymmetry during quiet stance. J Biomech. 2000;33(10):1243-8.
9. Taylor LM, Parsons J, Moyes SA, Binns E, Cavadino A, Taylor D, et al. Effects of an Exercise Program to Reduce Falls in Older People Living in Long-Term Care: A Randomized Controlled Trial. J Am Med Dir Assoc. 2024;25(2):201-8 e6.
10. van der Velde N, Seppala LJ, Hartikainen S, Kamkar N, Mallet L, Masud T, et al. European position paper on polypharmacy and fall-risk-increasing drugs recommendations in the World Guidelines for Falls Prevention and Management: implications and implementation. Eur Geriatr Med. 2023;14(4):649-58.
11. Rinaldi A, Marins Martins MC, De Almeida Martins Oliveira AC, Rinaldi S, Fontani V. Improving Functional Abilities in Children and Adolescents with Autism Spectrum Disorder Using Non-Invasive REAC Neuro Psycho Physical Optimization Treatments: A PEDI-CAT

Study. J Pers Med. 2023;13(5):792.
12. Silva A, Barcessat AR, Gonçalves R, Landre C, Brandã o L, Nunes L, et al. REAC Neurobiological Modulation as a Precision Medicine Treatment for Fibromyalgia. Journal of Personalized Medicine. 2023;13(6):902.
13. Pereira Motta M, Oliveira ASB, Andre Nogueira JA, Vieira de Souza Moscardi AA, Favaro VM, Simcsik AO, et al. Efficacy of REAC Neurobiological Optimization Treatments in Post-Polio Syndrome: A Manual Muscle Testing Evaluation. J Pers Med. 2024;14(10):1018.
14. Goncalves de Oliveira Cruz AV, Goes Goncalves R, Nunes L, Douglas Quaresma de Oliveira J, Lima Monteiro ES, Soares Eneias I, et al. Neuro Postural Optimization Neuromodulation Treatment of Radio Electric Asymmetric Conveyer Technology on Stress and Quality of Life in Institutionalized Children in a Capital City of the Brazilian Amazon. Cureus. 2022;14(7):e26550.
15. Ramos LR, Toniolo J, Cendoroglo MS, Garcia JT, Najas MS, Perracini M, et al. Two-year follow-up study of elderly residents in S. Paulo, Brazil: methodology and preliminary results. Rev Saude Publica. 1998;32(5):397-407.
16. Podsiadlo D, Richardson S. The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc. 1991;39(2):142-8.
17. Kear BM, Guck TP, McGaha AL. Timed Up and Go (TUG) Test: Normative Reference Values for Ages 20 to 59 Years and Relationships With Physical and Mental Health Risk Factors. J Prim Care Community Health. 2017;8(1):9-13.
18. Mehdipour A, Malouka S, Beauchamp M, Richardson J, Kuspinar A. Measurement properties of the usual and fast gait speed tests in community-dwelling older adults: a COSMIN-based systematic review. Age Ageing. 2024;53(3).
19. Studenski S, Perera S, Patel K, Rosano C, Faulkner K, Inzitari M, et al. Gait speed and survival in older adults. JAMA. 2011;305(1):50-8.
20. Albalwi AA, Alharbi AA. Optimal procedure and characteristics in using five times sit to stand test among older adults: A systematic review. Medicine (Baltimore). 2023;102(26):e34160.
21. Mathiowetz V, Kashman N, Volland G, Weber K, Dowe M, Rogers S. Grip and pinch strength: normative data for adults. Archives of physical medicine and rehabilitation. 1985;66(2):69-74.
22. Fontani V, Rinaldi S, Castagna A, Margotti ML. Noninvasive radioelectric asymmetric conveyor brain stimulation treatment improves balance in individuals over 65 suffering from neurological diseases: pilot study. Ther Clin Risk Manag. 2012;8:73-8.
23. Olazaran J, Gonzalez B, Lopez-Alvarez J, Castagna A, Osa-Ruiz E, Herrero-Cano V, et al. Motor effects of REAC in advanced Alzheimer's disease: results from a pilot trial. J Alzheimers Dis. 2013;36(2):297-302.
24. Bortone I, Sardone R, Lampignano L, Castellana F, Zupo R, Lozupone M, et al. How gait influences frailty models and health-related outcomes in clinical-based and population-based studies: a systematic review. J Cachexia Sarcopenia Muscle. 2021;12(2):274-97.
25. Todhunter-Brown A, Sellers CE, Baer GD, Choo PL, Cowie J, Cheyne JD, et al. Physical rehabilitation approaches for the recovery of function and mobility following stroke. Cochrane Database Syst Rev. 2025;2(2):CD001920.
26. Kuo AD, Donelan JM. Dynamic principles of gait and their clinical implications. Phys Ther. 2010;90(2):157-74.