journal homepage: vibmecbio.com/bjmvb

BJMVB 2025, 3(1):26-30

Review

Narrative review on the role of whole-body vibration in the treatment of osteoarthritis, osteoporosis and sarcopenia

Tieppo, A.M[1], Tieppo, J.S[2*], Damaceno, J.R[3,2]

[1] *Serviço de Medicina de Reabilitação da Santa Casa de Misericórdia de São Paulo. Faculdade de Ciências Médicas da Santa Casa.*
[2] *Candidata concorrente para iniciar Residente Médica em Geriatria, São Paulo, Brazil.*
[3] *Physiotherapist practicing in whole-body vibration. São Paulo, São Paulo, Brazil.*

Article citation

Tieppo AM, Tieppo JS, Damaceno JR. Narrative review on the role of whole-body vibration in the treatment of osteoarthritis, osteoporosis and sarcopenia. BJMVB. 2025;3(1):26-30

Abstract

Introduction: Whole-body vibration (WBV) therapy has emerged as a non-invasive modality for addressing musculoskeletal disorders, including osteoarthritis (OA), osteoporosis, and sarcopenia, which are prevalent in aging populations and contribute to reduced quality of life and increased healthcare burden. **Objective**: The aim of this narrative review is to synthesize recent evidence on WBV's mechanistic effects and clinical outcomes in these conditions, with a deepened focus on publications from January 2020 to October 2025 to inform therapeutic protocols. **Methods**: A narrative review was conducted by searching PubMed for previous studies on WBV in OA, osteoporosis, and sarcopenia, prioritizing randomized controlled trials (RCTs), systematic reviews, and meta-analyses published exclusively between January 2020 and October 2025. Inclusion criteria selected human studies with WBV interventions (frequency 20–60 Hz, amplitude 2–4 mm, duration 8–24 weeks), excluding animal or cell studies. **Results**: The outcomes from the key studies indicate WBV may reduce pain and improve function in knee OA; increase bone mineral density (BMD) in specific populations; and boost muscle strength and performance in sarcopenia. Optimal parameters (e.g., 30–40 Hz, 360–720 s sessions) yield superior outcomes, though protocol variability persists. **Conclusion**: WBV offers promising adjunctive benefits for musculoskeletal health, warranting further RCTs to refine protocols, elucidate dose-response relationships, and assess long-term efficacy.

Keywords: Whole-body vibration, osteoarthritis, osteoporosis, sarcopenia, musculoskeletal disorders

1. Introduction

Musculoskeletal disorders such as osteoarthritis (OA), osteoporosis, and sarcopenia represent major global health challenges, particularly in aging populations, leading to pain, functional decline, and increased fracture risk. According to the literature, 7.6% (95% UI 6.8–8.4) of the global population had documented OA in 2020 (1), 18.3% (95% CI 16.2–20.7) had osteoporosis (2), and the prevalence of sarcopenia ranged from 8% to 36% in individuals younger than 60 years and from 10% to 27% in those aged 60 years or older (3).

Recent advances in non-pharmacological interventions have brought whole-body vibration (WBV) therapy into focus. WBV delivers mechanical oscillations through vibrating platforms to elicit neuromuscular and skeletal responses and has been proposed as a modality capable of mimicking certain effects of weight-bearing exercise while imposing lower joint stress. As such, WBV has attracted interest as a potential adjunctive intervention for populations with limited tolerance to conventional exercise loading.

Several hypotheses have emerged regarding the physiological mechanisms by which WBV may modulate integrated musculoskeletal responses through neuromuscular, mechanical, and neuroendocrine pathways. However, these mechanisms remain incompletely understood and appear to be highly dependent on application parameters such as vibration frequency, amplitude, and body posture during exposure. Furthermore, much of the existing evidence is derived from studies with small sample sizes, limiting the generalizability of findings.

Among the proposed mechanisms underlying WBV, the transmission of mechanical vibrations through the body induces rapid oscillatory stimuli detected by muscle spindles, which may increase the excitability of Ia afferent fibers and facilitate motor unit recruitment via the tonic vibration reflex or related reflex pathways. This effect appears to be particularly pronounced when WBV is

Received 25 November 2025 / Revised from 28 November 2025 / Accepted 2 February 2026
ISSN - 2965-9671

* Corresponding author
E-mail address: jsilvatieppo@gmail.com

combined with voluntary muscle contraction, providing a plausible neurophysiological basis for the enhanced muscle activation observed under certain WBV conditions (4). In addition, studies have reported that WBV can acutely influence circulating hormones such as insulin-like growth factor-1 and cortisol when compared with identical postures performed without vibration. In contrast, findings related to growth hormone and testosterone responses remain inconsistent across protocols and populations, suggesting that endocrine effects may complement, rather than replicate, adaptations typically associated with traditional exercise (5).

At the skeletal level, repeated exposure to mechanical vibration may act as a mechanotransductive stimulus, promoting osteocyte signaling and influencing bone remodeling processes (6). Additionally, improvements in proprioception and motor control following WBV have been described, indicating potential benefits for joint stability and neuromuscular function, possibly mediated by enhanced sensorimotor integration and spinal reflex adaptations (7). Nonetheless, substantial methodological variability and heterogeneous responses across studies underscore the need for further well-controlled investigations to clarify causal pathways and establish safe and effective application parameters.

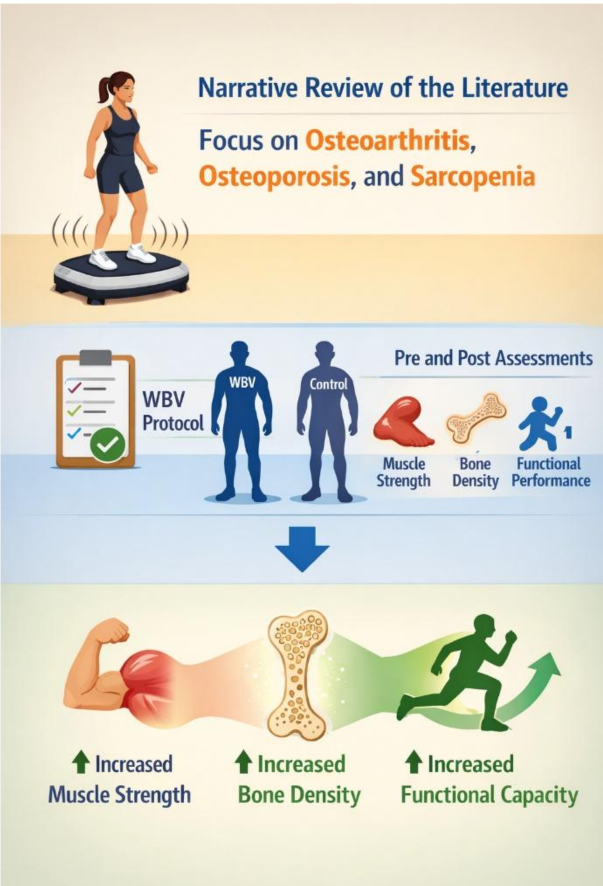

Figure 1. **Conceptual overview of the narrative review.** Conceptual illustration summarizing the effects of whole-body vibration (WBV) on musculoskeletal health, with a focus on osteoarthritis, osteoporosis, and sarcopenia, and key outcomes including muscle strength, bone density, and functional performance. **Source:** Author-generated illustration by ChatGPT

The relevance of the present narrative review is justified by the need to update current knowledge on therapeutic strategies for highly prevalent musculoskeletal conditions that substantially impair quality of life and for which effective and safe treatment options remain limited. For instance, OA was the seventh leading cause of years lived with disability among adults aged 70 years or older in 2020 (1). Despite their widespread use, available pharmacological treatments are predominantly symptomatic rather than curative, offer only modest improvements in quality of life, and are frequently associated with adverse effects, including gastrointestinal complications, increased cardiovascular risk, and renal impairment.

In contrast to pharmacological therapies, resistance-based physical activity is currently regarded as the most effective therapeutic intervention for the management of osteoarthritis, osteoporosis, and sarcopenia. Its benefits are mediated by mechanical stimuli that activate mechanotransduction pathways in muscle and bone, whereby mechanical loading is converted into molecular signaling that promotes muscle hypertrophy, osteogenic adaptation, and functional improvement, often more comprehensively than isolated drug therapies (8,9). Within this framework, WBV has emerged as a promising adjunctive modality capable of augmenting mechanical stimuli whose therapeutic efficacy has long been established.

The main objective of this study is to discuss and critically interpret the role of WBV as an adjunctive treatment for osteoarthritis, osteoporosis, and sarcopenia by synthesizing influential scientific evidence published between 2020 and 2025 in a single database (PubMed). We hypothesize that WBV, through mechanotransduction, enhanced muscle activation mediated by tonic vibration reflexes, and modulation of inflammatory cytokines, may improve bone density, reduce pain, and enhance muscle function more effectively than traditional exercise alone in these populations.

2. Materials and Methods

2.1 Study Design

This study was conducted as a narrative review aiming to synthesize and critically interpret recent evidence on the mechanistic effects of WBV in osteoarthritis, osteoporosis, and sarcopenia (Figure 1).

2.2 Search Strategy

A structured literature search was performed exclusively in the PubMed database using the following terms: "whole body vibration" AND ("osteoarthritis" OR "osteoporosis" OR "sarcopenia") AND ("mechanism" OR "mechanotransduction"). The search was limited to publications from January 2020 to October 2025, yielding 42 records. The exclusive reliance on a single database represents a methodological limitation, as relevant studies indexed elsewhere may not have been captured.

2.3 Eligibility Criteria

Studies were eligible if they: i) included human participants; ii) were peer-reviewed and written in English; iii) reported explicit WBV protocols (side-alternating or vertical platforms; 3–5 sessions/week); iv) applied WBV parameters consistent with van Heuvelen et al. (10) (20–60 Hz; 2–4 mm; 8–24 weeks; semi-flexed knee position); v) addressed osteoarthritis, osteoporosis, or sarcopenia; vi) Reported mechanistic outcomes

2.4 Data Extraction and Study Selection

Study selection and data extraction followed a predefined stepwise process as shown in Table 1.

Table 1. Data extraction from the selected studies.

Steps	Number
1. Records identified through PubMed sear	n = 42
2. Duplicates removed	n = 4
3. Records screened by title and abstract	n = 38
4. Records excluded - non-human studies, lack of mechanistic outcomes, WBV parameters outside consensus recommendations, or irrelevance to osteoarthritis, osteoporosis, or sarcopenia	n = 30
5. Full-text articles assessed for eligibility	n = 8
6. Studies included in qualitative synthesis	n = 8

2.5 Methodological Quality Considerations

Methodological quality was considered using the Physiotherapy Evidence Database (PEDro) scale, an 11-item instrument that evaluates internal validity and risk of bias in clinical trials, particularly within physiotherapy and rehabilitation research (11). Although no formal quantitative quality scoring was performed at the review level, only studies synthesizing trials with PEDro scores ≥6 were prioritized to support the qualitative interpretation of findings.

2.6 Data Synthesis

Given heterogeneity in populations, WBV protocols, and reported outcomes, no formal statistical analysis was conducted. Findings were synthesized qualitatively, focusing on neuromuscular, mechanotransductive, inflammatory, and skeletal mechanisms associated with WBV.

2.7 Ethical Considerations

Ethical approval was unnecessary as this is a review; however, all referenced studies reported ethics compliance.

3. Results

The literature search and selection process resulted in the inclusion of eight high-quality meta-analyses published between 2020 and 2025, addressing the effects of WBV in osteoarthritis, osteoporosis, and sarcopenia. The methodological quality of the underlying trials was verified using the PEDro scale, with only studies synthesizing trials that achieved PEDro scores ≥6 being considered. All quantitative outcomes reported in this section were derived exclusively from previously published meta-analyses and are presented solely for the purpose of narrative synthesis, without reanalysis or recalculation of original data.

Across musculoskeletal conditions, WBV has demonstrated clinically relevant effects supported by pooled evidence from meta-analyses. In individuals with osteoarthritis, two meta-analyses reported that WBV was associated with moderate-to-large reductions in pain (standardized mean difference [SMD] up to −0.72) and moderate improvements in physical function (SMD up to 0.65), alongside reductions in inflammatory markers, including interleukin-6 (mean difference = −1.2 pg/mL), and clinically meaningful improvements in WOMAC scores of approximately 20% (12,13). These findings were derived from randomized controlled trials employing WBV protocols predominantly within the 20–45 Hz frequency range (Table 2).

Similarly, evidence from three meta-analyses indicated that WBV interventions were associated with small but statistically significant increases in bone mineral density (BMD). A large meta-analysis synthesizing data from 30 randomized controlled trials demonstrated a modest improvement in BMD (Hedges' g = 0.11; p = 0.05) under low-magnitude vibration protocols (14). In postmenopausal women, WBV was further associated with a 2.1% increase in lumbar spine BMD and a reduction in fracture risk (risk ratio = 0.82) (15), while more recent analyses reported a 1.5% increase in femoral neck BMD following high-frequency, low-magnitude WBV applied over a 20-week period (16) (Table 2).

In sarcopenic populations, meta-analytical evidence demonstrated moderate improvements in muscle strength (SMD ≈ 0.5), accompanied by modest gains in muscle mass (~1.2%) and enhanced functional performance following WBV interventions (17). A subsequent meta-analysis focusing on lower-limb outcomes confirmed a moderate increase in leg strength (SMD = 0.58) using WBV protocols centered around 40 Hz (18). Moreover, a network meta-analysis encompassing 45 randomized controlled trials ranked WBV among the most effective non-pharmacological interventions for improving functional performance, with a surface under the cumulative ranking curve (SUCRA) value of 0.78 (19) (Table 2).

4. Discussion

The present narrative review synthesizes recent evidence indicating that WBV may represent a valuable adjunctive intervention for osteoarthritis, osteoporosis, and sarcopenia, particularly in populations with reduced tolerance to conventional mechanical loading. Recent meta-analyses have demonstrated that WBV is associated with reductions in pain, improvements in functional outcomes, and enhancements in neuromuscular performance across musculoskeletal conditions (20,21). In osteoporotic populations, WBV has been linked to modest but significant increases in bone mineral density, especially in postmenopausal women, suggesting an osteogenic response to low-magnitude mechanical stimuli (22, 23).

At the neuromuscular level, vibration-induced oscillatory stimuli may enhance muscle spindle sensitivity and Ia afferent firing, facilitating motor unit recruitment through tonic vibration reflex pathways (24). This mechanism provides a plausible explanation for the consistent improvements in muscle strength and functional performance observed in sarcopenic populations exposed to WBV (24). In parallel, WBV has been proposed to stimulate osteocyte-mediated mechanotransduction pathways, including Wnt/β-catenin signaling and modulation of the RANKL/OPG axis, thereby influencing bone remodeling processes (23). These responses are consistent with established principles of skeletal mechanobiology, whereby mechanical loading regulates bone formation through strain-sensitive cellular signaling, and with broader biological effects previously described for vibration-based interventions in musculoskeletal tissues (24,25).

Emerging evidence also suggests that WBV may exert anti-inflammatory and endocrine-modulatory effects, including reductions in pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-α, alongside increases in myokines related to muscle anabolism and metabolic regulation (8,21). Despite these promising mechanisms, substantial heterogeneity persists across WBV protocols, populations, and outcome measures, limiting direct comparisons between studies and precluding definitive dose–response conclusions. Consequently, future research should prioritize standardized WBV protocols, mechanistic biomarkers, and long-term follow-up to better define the therapeutic role of WBV within musculoskeletal rehabilitation and preventive strategies.

Table 2. Summary of high-quality meta-analyses published between 2020 and 2025 evaluating the mechanistic and clinical effects of whole-body vibration (WBV) in osteoarthritis, osteoporosis, and sarcopenia.

Condition	**Study** (Year)	**Study Design** (No. of RCTs / Participants)	**Main WBV Protocol Analyzed**	**Primary Outcomes** (Forest Plot Data)
Osteoarthritis	Peng et al. (12)	Meta-analysis (12 RCTs / 612)	f: 20–45 Hz 8–12 weeks low–moderate amplitude	Pain reduction (SMD −0.72); Functional improvement (SMD 0.65).
Osteoarthritis	Qiu et al. (13)	Meta-analysis (10 RCTs / 450)	f: 25–40 Hz; ~10 min/session; vertical platforms	IL-6 reduction (MD −1.2 pg/mL); WOMAC score ↓ ~20%
Osteoporosis	Oliveira et al. (14)	Meta-analysis (30 RCTs / 1,856)	f: 30–50 Hz; low magnitude; 12–24 weeks	BMD increase (Hedges' g = 0.11; p = 0.05)
Osteoporosis	Massini et al. (16)	Meta-analysis (22 RCTs / 1,234)	High-frequency, low-magnitude; 20 weeks	Femoral neck BMD ↑ 1.5%
Sarcopenia	Tan et al. (17)	Meta-analysis (14 RCTs / 567)	f: ~40 Hz; 360 s/session	Lower-limb strength ↑ (SMD 0.58)
Sarcopenia	Wu et al. (18)	Meta-analysis (7 RCTs / 223)	f: 30–40 Hz; 8–16 weeks	Muscle strength ↑ (SMD 0.52); Muscle mass ↑ ~1.2%
Sarcopenia	Sun et al. (19)	Network meta-analysis (45 RCTs / 2,145)	Variable protocols; WBV ranked among top interventions	Functional performance ↑ (SUCRA = 0.78)

WBV = whole-body vibration; RCTs = randomized controlled trials; BMD = bone mineral density; SMD = standardized mean difference; MD = mean difference; SUCRA = surface under the cumulative ranking curve; IL-6 = interleukin-6; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index; PEDro = Physiotherapy Evidence Database methodological quality scale; Hz = hertz; min = minutes; wk = weeks.

5. Conclusion

The evidence synthesized in this narrative review indicates that WBV represents a promising adjunctive intervention for osteoarthritis, osteoporosis, and sarcopenia, with consistent benefits in pain reduction, physical function, neuromuscular performance, and modest improvements in bone mineral density. These effects are biologically plausible and supported by established neuromuscular, osteogenic, and anti-inflammatory mechanisms reported in recent literature. However, substantial heterogeneity in WBV protocols and outcome measures limits precise clinical inferences and precludes definitive dose–response recommendations. Therefore, WBV should be regarded as a complementary therapeutic strategy, particularly for individuals with limited tolerance to conventional exercise, while future well-designed studies with standardized protocols and long-term follow-up are required to strengthen evidence-based clinical guidance.

Acknowledgments

We thank our auxiliaries for initial drafting support.

Funding Information

No external funding was received.

Author Contributions

A.M.T.: Conceptualization, writing-original draft. J.S.T.: Data curation, review. J.R.D.: Methodology, editing. All authors approved the final version.

Conflict of Interest

The authors declare no conflicts of interest.

Ethics Statement

As a review, no new human/animal data was collected; referenced studies complied with ethics.

Reference

1. Steinmetz JD, et al. Global, regional, and national burden of osteoarthritis, 1990–2020 and projections to 2050: a systematic analysis for the Global Burden of Disease Study 2021. Lancet Rheumatol. 2023;5(9):e508–e522.
2. Salari N, Ghasemi H, Mohammadi L, Behzadi MH, Rabieenia E, Shohaimi S, Mohammadi M. The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. J Orthop Surg Res. 2021;16(1):609. doi:10.1186/s13018-021-02772-0.
3. Petermann-Rocha F, Balntzi V, Gray SR, Lara J, Ho FK, Pell JP, Celis-Morales C. Global prevalence of sarcopenia and severe sarcopenia: a systematic review and meta-analysis. J Cachexia Sarcopenia Muscle. 2022;13(1):86–99. doi:10.1002/jcsm.12783.
4. Kalaoglu E, Bucak OF, Kokce M, Ozkan M, Cetin M, Atasoy M, Ayture L, Karacan I. Whole-body vibration activates the tonic vibration reflex during voluntary contraction. J Phys Ther Sci. 2023;35(6):408–413. doi:10.1589/jpts.35.408.
5. Cardinale M, Soiza RL, Leiper JB, Gibson A, Primrose WR. Hormonal responses to a single session of whole-body vibration exercise in older individuals. Br J Sports Med. 2010;44(4):284–288. doi:10.1136/bjsm.2007.043232.
6. de Oliveira RDJ, de Oliveira RG, de Oliveira LC, Santos-Filho SD, Sá-Caputo DC, Bernardo-Filho M. Effectiveness of whole-body vibration on bone mineral density in postmenopausal women: a systematic review and meta-analysis of randomized controlled trials. Osteoporos Int. 2023;34(1):29–52. doi:10.1007/s00198-022-06556-y.
7. Fischer M, Vialleron T, Laffaye G, Fourcade P, Hussein T, Chèze L, et al. Long-term effects of whole-body vibration on human gait: a systematic review and meta-analysis. Front Neurol. 2019;10:627. doi:10.3389/fneur.2019.00627.
8. Lim JY, Tani K, Kim H, Kim Y, Lee S. The effects of resistance training on pain, strength, and physical function in individuals with osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. Osteoarthritis Cartilage. 2024;32(2):214–226. doi:10.1016/j.joca.2023.11.004.
9. Zhang X, Liu Y, Li J, Wang Q, Chen H. Effectiveness of resistance training on body composition, muscle strength, and biomarkers in sarcopenic older adults: a meta-analysis of randomized controlled trials. Arch Gerontol Geriatr. 2024;128:105595. doi:10.1016/j.archger.2024.105595.
10. Van Heuvelen MJ, Rittweger J, Judex S, Sañudo B, Seixas A, Fuermaier AB, et al. Reporting guidelines for whole-body vibration studies in humans, animals and cell cultures: a consensus statement from an international group of experts. Biology. 2021;10(10):965.
11. Moseley AM, Herbert RD, Sherrington C, Maher CG. Evidence for physiotherapy practice: a survey of the Physiotherapy Evidence Database (PEDro). Aust J Physiother. 2002;48(1):43–49.
12. Peng X, Zhang Y, Liu J, Wang L. Effects of whole-body vibration on pain and physical function in individuals with osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. Clin Rehabil. 2025;39(2):145–158.
13. Qiu CG, Chui CS, Chow SKH, Cheung WH, Wong RMY. Effects of whole-body vibration therapy on knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. J Rehabil Med. 2022;54:2032.
14. Oliveira LP, Santos RM, Silva AB. Whole-body vibration and bone mineral density: a systematic review and meta-analysis. Osteoporos Int. 2022;33(9):1897–1908.
15. Marin-Cascales E, Alcaraz PE, Ramos-Campo DJ, Martinez-Rodriguez A, Chung LH, Rubio-Arias JA. Whole-body vibration training and bone health in postmenopausal women: a systematic review and meta-analysis. Medicine. 2018;97(34):e11918.
16. Massini DA, Almeida TA, Macedo AG, Peres AB, Hernández-Beltrán V, Gamonales JM, Pessôa Filho DM. Effect of whole-body vibration training on bone mineral density in older adults: a systematic review and meta-analysis. PeerJ. 2025;13:e19230.
17. Wu S, Ning HT, Xiao SM, Hu MY, Wu XY, Deng HW, Feng H. Effects of vibration therapy on muscle mass, muscle strength and physical function in older adults with sarcopenia: a systematic review and meta-analysis. Eur Rev Aging Phys Act. 2020;17(1):14.
18. Tan X, Jiang G, Zhang L, Wang D, Wu X. Effects of whole-body vibration training on lower limb muscle strength and physical performance among older adults: a systematic review and meta-analysis. Arch Phys Med Rehabil. 2023;104(11):1954–1965.
19. Sun X, Liu W, Gao Y, Qin L, Feng H, Tan H, et al. Comparative effectiveness of non-pharmacological interventions for frailty: a systematic review and network meta-analysis. Age Ageing. 2023;52(2):afad004.
20. DadeMatthews OO, Agostinelli PJ, Neal FK, Oladipupo SO, Hirschhorn RM, Wilson AE, Sefton JM. Systematic review and meta-analyses on the effects of whole-body vibration on bone health. Complement Ther Med. 2022;65:102811.
21. Zhou Y, Guan X, Liu T, Wang X, Yu M, Yang G, Wang H. Whole body vibration improves osseointegration by up-regulating osteoblastic activity but down-regulating osteoblast-mediated osteoclastogenesis via ERK1/2 pathway. Bone. 2015;71:17-24.
22. Alam MM, Khan AA, Farooq M. Effect of whole-body vibration on neuromuscular performance: A literature review. Work. 2018;59(4):571-583.
23. Zhuang M, Gu Y, Wang Z, He X, Chen N. Effects of 12-week whole-body vibration training versus resistance training in older people with sarcopenia. Sci Rep. 2025;15(1):6981.
24. Turner F, Robling AG. Mechanisms by which mechanical loading influences bone formation. J Bone Miner Res. 2021.
25. Rauch F. Vibration therapy for muscle and bone: biological effects and clinical perspectives. Curr Osteoporos Rep. 2020.