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DOI: http://dx.doi.org/10.31584/jhsmr.20261506

Received: 27 March 2026

Revised: 8 May 2026

Accepted: 23 May 2026

Published online: 11 November 2026

Please cite this article as: Chauhan U, Saxena A. Nordic walking and its influence on cardiorespiratory health: a scoping review. J Health Sci Med Res 2026 doi: http://dx.doi.org/10.31584/jhsmr.20261506

Early Version — Uncorrected: This accepted manuscript has not been typeset or proofread. Content and formatting may change prior to final publication and should not be regarded as the final Version of Record.

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Review Article

Nordic Walking and its Influence on Cardiorespiratory Health: A Scoping Review

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Running Title: "Nordic Walking effect on heart and lungs."

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Abstract:

Cardiorespiratory health represents the ability of the heart and lungs to supply oxygenated blood to working muscles, while maintaining pulmonary function and quality of life. Regular aerobic exercise is important for the prevention and management of cardiopulmonary impairments. Nordic walking engages both upper and lower extremities, causing greater oxygen consumption and higher energy expenditure, leading to improved cardiopulmonary health. Aiming to systematically synthesize the available evidence on the effects of Nordic walking on cardiorespiratory health, this scoping review search was conducted across PubMed, ScienceDirect, Physiotherapy Evidence Database, and Scopus between January 2015 and November 2025. The articles were selected based on the inclusion and exclusion criteria, complying with the Population–Concept–Context framework. Data were extracted using the standardized charting form, capturing study characteristics, intervention protocols, and cardiorespiratory outcomes. Out of 256 records identified, seven studies met the inclusion criteria. The included study outcomes were Volume of Oxygen Maximum/ Volume of Oxygen Peak, six-minute walk test, metabolic equivalents, heart rate, and blood pressure in cardiac patients, post-menopausal women, older adults, and normal individuals. Most studies reported improvements in aerobic capacity, functional endurance, and exercise tolerance following Nordic walking across both clinical and community populations. Nordic walking appears to be an effective, safe, and low-cost exercise intervention for improving cardiorespiratory fitness, functional capacity, and exercise tolerance.

Keywords: Aerobic exercise, exercise tolerance, Nordic walking, oxygen consumption

Introduction

Cardiac and respiratory health encompasses pulmonary function, functional capacity, and overall quality of life, and primarily refers to long-lasting diseases with high global prevalence. Both chronic heart and lung-related diseases contribute to global illness, death, and disability. The World Health Organization reports that cardiac and vascular illnesses cause about 17.9 million deaths every year, which is approximately one-third of worldwide deaths[1]. Chronic lung disease, which refers to chronic obstructive pulmonary disease and asthma, affects about 545 million people globally, with chronic obstructive pulmonary disease being the 3rd leading cause of death[2]. The combined disability-adjusted life years related to

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cardiorespiratory disorders have increased in the last two decades, as illustrated by the Global Burden of Disease 2020 study, primarily driven by high tobacco use, the ageing population, air pollution, and increasing physical inactivity[3]. The rate of cardiac disease has increased nearly twofold in India in the last 25 years, and the prevalence of chronic obstructive pulmonary disease has also increased to 5.5% in adults aged 30 years and older, which shows that there is an urgent requirement for prevention at the population level, along with interventions for rehabilitation[4]. Emerging technological advancements and increasing societal comfort levels are leading to increased sedentary behavior and inactivity in human beings, contributing to crucial modifiable risk factors for the development and progression of non-communicable diseases[5]. For the prevention and management of cardiorespiratory conditions, physiotherapy plays an important role by providing evidence-based structured exercise protocols that effectively reduce blood pressure, enhance oxygen consumption, and improve pulmonary function. Although strong evidence supports conventional exercise-based interventions, there are multiple barriers, such as a lack of motivation, limited access to facilities, musculoskeletal pain, and lower exercise tolerance among diverse populations[6]. Physiotherapy, including aerobic training, reduces these limitations through tailored exercise protocols according to patient health status and breathing retraining with functional training strategies. These interventions enable effective participation in physiotherapy sessions, even for individuals with comorbidities and reduced functional capacity[7]. Nordic walking is a new form of cardiovascular activity involving a special type of walking with specially designed poles in both hands, which allows for proper and coordinated movements of the upper and lower body. It primarily originated in the country of Finland for skiers as a form of summer training. Afterwards, it gained worldwide publicity and popularity as a recreational and therapeutic activity[8]. Nordic walking engages and activates all the body muscles, which is about 90.0% compared to normal walking, and that results in an increased stride length, improved postural control, and improved upper-limb engagement during the movement or walking with Nordic poles[9]. NW results in increased oxygen consumption and energy expenditure by about 20.0–46.0% compared with conventional walking at the same speed, making it an effective but low-impact exercise suitable for varied populations[10]. Due to these strengths and benefits, Nordic walking is increasingly being explored as a rehabilitation strategy for individuals with chronic cardiorespiratory diseases, obesity, diabetes, and musculoskeletal limitations. Various randomised controlled trials have evaluated the effects of Nordic walking on cardiovascular and respiratory functions, functional endurance, exercise capacity, and quality of life during

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the last ten years. When randomised controlled trials of patients with coronary artery disease were compared with standard walking studies, the results showed significant enhancements in functional capacity, peak oxygen uptake (VO_2 peak), and exercise tolerance[11]. Similarly, randomised controlled trials conducted in persons with chronic respiratory diseases, including chronic obstructive pulmonary disease, demonstrated high attainment in six-minute walk distances, reduced dyspnea, and improved lower-limb endurance in Nordic walking groups compared with a conventional aerobic training group[12]. Despite these promising findings, the existing research is widely dispersed across different clinical populations and used varied intervention durations, techniques, and outcome measurements. The purpose of this scoping review was to systematically examine and map the available evidence regarding the influence of Nordic walking on cardiorespiratory health outcomes in healthy individuals, as well as those with chronic cardiorespiratory conditions. Our research question was: "What is the existing evidence on the effects of Nordic walking on cardiorespiratory health outcomes across different populations, and what knowledge gaps remain in the current literature?"

Materials and Methods

The review protocol was registered on the Open Science Framework with registration DOI: https://doi.org/10.17605/OSF.IO/YQXC9. This scoping review was guided by a methodological framework proposed by Arksey and O'Malley and later enhanced by Levac et al. [13,14], and it was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews guidelines. This approach was selected because it enables a broad, structured examination of the research landscape, helping to clarify key concepts, identify existing knowledge gaps, and determine the types and sources of available evidence related to the topic. The researchers developed a comprehensive search strategy by examining the proper databases. For this review, literature published between January 2015 and November 2025 was systematically searched across multiple databases, such as PubMed, ScienceDirect, the Physiotherapy Evidence Database (PEDro), and Scopus**.** Methodological quality of the included randomized controlled trials was assessed using the Physiotherapy Evidence Database (PEDro) scale.

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Inclusion and exclusion criteria:

The inclusion criteria for this scoping review were established according to the Population–Concept–Context(PCC) framework[15]. **Population:** Studies included in this review involved participants aged 18 years or older, with or without cardiopulmonary conditions (e.g., cardiovascular diseases or pulmonary disorders) or participants from the general population undergoing cardiopulmonary fitness training. **Concept:** The core concept of interest for this review was Nordic walking as an intervention aimed to improve cardiopulmonary health. Therefore, studies that determined the impact of Nordic walking on cardiac and respiratory-related parameters such as aerobic capacity, oxygen consumption, heart rate responses, pulmonary function, functional endurance, cardiopulmonary fitness, or overall cardiovascular and respiratory health were eligible. **Context:** Research conducted in hospital settings, community settings, fitness settings, and rehabilitation settings was included in the review. Articles that were published in the English language between January 2015 and December 2025 and available in the full text with peer review were included. The exclusion criteria of this review were studies that involved **a population of** children or adolescents, or that focused on individuals with conditions not related to any heart- or lung-related health. In terms of **concept**, any study that did not consider its primary intervention to be Nordic-walking training, or merged it with other interventions without differentiating its individual effect, was excluded. Regarding **context**, rejected studies on the basis of study designs were reviews, protocols, letters to the editor, conference abstracts, dissertations, and non-peer-reviewed sources. For maintaining consistency and proper methodological purpose, research studies that were not published within the years 2015–2025, not available in the English language, and without full-text accessibility were also excluded. Studies found on databases were then collated and uploaded to Mendeley Reference Manager to avoid duplicating articles[16]. Initially, articles were screened on the basis of title and abstract by Rayyan Software[17], then the selection criteria were applied to the available full-text articles. Screening of articles was done by two independent reviewers. If any disagreements arose between the reviewers, they were resolved by discussion. Exclusion and inclusion of research studies in this review at each step are shown in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension (PRISMA), flowchart **Figure 1**[18].

Results

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In this scoping review, a total of 256 articles were initially identified through the electronic databases specified in the methodology. After removing duplicates and screening titles and abstracts, a substantial number of studies were excluded due to reasons such as the non-availability of the full text, use of non-Nordic walking interventions, lack of cardiopulmonary outcome measures, inclusion of pediatric populations, and publication types, such as protocols, reviews, or conference abstracts. Following the full-text screening, 7 interventional studies met the eligibility criteria in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) flow diagram**.** The methodological quality of recruited articles was assessed using the Physiotherapy Evidence Database (PEDro) scoring and level of incidence, as shown in **Table 1**. In spite of the fact that all the included studies fulfilled the eligibility criteria supporting validity, major methodological limitations were also observed in most of the trials, in which the key concern was the lack of concealed allocation in all the recruited studies. This increases the risk of selection bias. Similarly, in the majority of studies, inadequate or absent random allocation was reported**,** with only two studies [11,19] meeting this criterion, further weakening the internal validity. Conversely, participant and therapist blinding were not achieved in any study, whereas assessor blinding was seen in only one included study,[11] and due to this concern, detection and performance bias will be raised mainly for the outcome and subjective assessment. In contrast, several studies demonstrated strengths in adequate follow-up, except one[20], and in point estimates and variability reporting by all. Similarly, intervention effectiveness was provided by studies that included between-group comparisons. In sample size only, two of the included studies had more than 50 participants [11,21.] Overall, the included studies with moderate Physiotherapy Evidence Database scores (4–6/10) showed that interventions may be beneficial to participants, whereas several methodological weaknesses include poor randomization, lack of blinding, and absence of intention-to-treat analysis, making the results less reliable, which limits the strength of these findings. Out of seven studies, only four of the included studies were regarded as moderate to higher in methodological quality, because these studies used structured training protocols, supervised intervention, and objective outcome measures, i.e., VO_2max, functional test, and heart rate. [19,21,22,24] One study strengthened internal validity using a controlled pre-post design with individualised intensity based on physiological parameters.[22] Similarly, studies included cardiac populations with intensity ranges of 50-70% VO_2max or Borg scale 12-14, used a controlled or comparative design, but still included risk of bias due to a lack of blinding.[11,19]

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However, Nordic walking was incorporated into more comprehensive rehabilitation programs, making it difficult to identify its unique effect alone. As a result, this reduces the internal validity and weakens the interpretation. [11,20] In another study, the methodological quality was lower due to the unsupervised intervention design. In this study, participants were only encouraged to try Nordic walking without strict monitoring or control over the frequency, intensity, and duration. This lack of control over the parameters introduces variability and reduces the attribution that the intervention is directly responsible for the benefit. [23] As a result, it highlighted that further well-designed randomized controlled trials with stronger methodological quality are required to confirm these outcomes.

The characteristics of these seven included studies are summarised in **Table 2**. The included studies were conducted across various countries, including Poland (n = 3)[19,20,22], Greece (n = 1)[21], Japan (n = 1)[23], Slovakia (n = 1)[11], and another European setting for the long-duration fitness study (n = 1)[24]. All studies involved adult populations aged 18 years and above, with samples comprising lung transplant candidates[20], older adults[23], post-percutaneous coronary intervention adults[19], postmenopausal women[21,22], individuals with coronary artery disease[11], and adults participating in structured fitness programs[24]. A majority of the studies implemented Nordic walking in clinical or rehabilitation settings, particularly among individuals with cardiovascular or pulmonary conditions[11,19,20]. Other studies involved community-dwelling older adults or participants in structured exercise programs[23]. Across the included studies, Nordic-walking interventions ranged from 3 weeks to 25 weeks, with frequencies varying between once weekly and four sessions per week. The outcome measures showed considerable variability but predominantly focused on domains related to cardiopulmonary health, such as aerobic capacity-volume of oxygen peak, volume of oxygen maximum[22,24], functional endurance, 6-minute walk test[11,20], metabolic equivalents[11], heart rate responses[22], blood pressure[22], and physical activity levels[23]. In addition to the main outcomes, other outcomes involved gait speed, dyspnea, exercise tolerance, and indicators for quality of life[21,23,24].

Independently, data were extracted by the reviewers using a standardized extraction form, collecting information on the characteristics of the participants, study design, intervention protocols, and outcome measures, providing variability in all the reported outcomes involving differences in these variables, like cardiopulmonary, functional, and quality-of-life. After which, outcome measures were grouped into broader domains, such as functional performance, aerobic capacity, and patient-reported outcomes. This approach

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allowed for meaningful comparisons while preserving clinical relevance. To ensure accuracy and consistency, discrepancies in the extracted data were resolved by discussions and consensus. A quantitative meta-analysis was not performed due to heterogeneity in the outcome measures, intervention duration, and study populations. Instead, a structured narrative synthesis was performed, focused on the direction and consistency of the effects rather than the pooled estimates. To support the comparative interpretation of the effect sizes, statistical significance was reported. This narrative approach is recommended when heterogeneity precludes statistical pooling and enables the transparent synthesis of complex and diverse evidence.

Most of the included studies (n = 6) involving Nordic walking as a primary intervention illustrate significant improvements in cardiopulmonary fitness and functional capacity. In randomized clinical studies that involved patients with coronary artery disease and post-coronary, wide improvements were reported, mainly in aerobic capacity, walking speed, endurance, and exercise tolerance[11,19]. In older individuals, enhancement in physical activity levels and other mobility measures was noted[23]. One of the included studies highlighted the improvement in cardiovascular profiles by showing reductions in blood pressure and heart rate[22]. Overall, the findings from the included studies in this scoping review highlight that Nordic walking is an effective, accessible, and low-cost modality for improving cardiopulmonary health in various health conditions and in various clinical populations.

Discussion

This scoping review focused on summarising the current evidence and research conducted in hospitals, communities, and fitness-based rehab settings regarding the effects of Nordic walking on cardiopulmonary health in adults. For this review, seven studies met the eligibility criteria. They were published between 2018 and 2023 and provide growing support for Nordic walking as a beneficial form of aerobic training for diverse populations. The findings illustrate that there continue to be improvements in key components of cardiopulmonary health parameters, including aerobic capacity, functional endurance, cardiovascular efficiency, and exercise tolerance. From the included studies, it was found that oxygen maximum (VO_2 max) increased from 27.68 ± 4.89 to 32.14 ± 4.79 mL/kg/min, representing a mean improvement of +4.45 mL/kg/min ($p < 0.01$). This improvement lies within or exceeds the commonly accepted minimal clinically important difference (MCID) range of approximately 1.5–3.5 mL/kg/min for VO_2 max[19,24], Volume of Oxygen Peak[22], and metabolic equivalent[11]. All were repeatedly observed, indicating an improvement in aerobic

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capacity due to Nordic-walking interventions. Based on comparisons of Nordic-walking training with other conventional rehabilitation training, it was observed that patients with coronary artery disease and patients undergoing cardiac rehabilitation exhibited significant cardiopulmonary gains in heart- and lung-related parameters[20,21]. These improvements in the cardiac and respiratory parameters indicate that Nordic walking offers, or supports, an effective alternative to conventional aerobic training, such as treadmill walking or cycling, mainly seen in individuals who have less baseline endurance or comorbidities affecting mobility[20].

In the included studies, functional endurance of the participants was determined by a test named the six-minute walk test, which showed significant improvements from 310 m at baseline to 374 m post-intervention, representing an improvement of about +64 m ($p < 0.05$). This change exceeds the commonly accepted MCID value for 6MWD, which is typically reported to be around 25–35 m in patients with chronic respiratory diseases, indicating a clinically meaningful improvement[20], which was also seen in several other studies [19,24]. As six-minute walk test results strongly support and are associated with the daily functional capacity of lungs and long-term cardiovascular health, this enhancement is clinically significant and supports Nordic-walking training. Nordic walking also focuses on the coordinated movement of both limbs with Nordic sticks in both hands, which positively contributes to increased stride length, upper body musculature engagement, and greater whole-body oxygen demand, and thereby facilitates or improves cardiopulmonary adaptations compared to normal standard walking [12,23]. Conversely, the Nordic-walking training results demonstrate improvements in gait speed and overall physical activity levels in the older-age patients, positively signifying more functional improvements in this population[9]. Therefore, there is an increase in the mobility of older-age patients, reducing the sedentary lifestyle, which collectively highlights the significance of Nordic-walking training.

As Nordic walking engages the upper body fully during the time of walking with specially designed poles that function in a coordinated pattern, it is an effective aerobic exercise that transforms normal walking into full-body, active walking. There is an increase in the overall muscle recruitment by the coordinated involvement or action of the arms and legs, resulting in higher metabolic demand and oxygen consumption compared to conventional walking. A strong cardiovascular training stimulus is provided by Nordic walking due to the strong workload on the musculature during training. As the movement of the arms in Nordic-walking training is repetitive, it increases blood flow to the upper skeletal muscles, which further improves venous return and increases the preload, resulting in increased stroke volume

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and overall cardiac output. By continuing training, adaptation occurs in the body, which overall improves myocardial efficiency and results in a decrease in pulse rate[11,20,22]. These types of improvements have been seen in both healthy participants and patients with cardiac and pulmonary diseases following Nordic walking programs[11,20,22]. At the vascular level, regular Nordic-walking training increases shear stress within the arteries, which stimulates nitric oxide release and improves endothelial function. Enhanced endothelial activity promotes better vasodilation, lowers peripheral vascular resistance, and improves blood flow to the working muscles. These vascular adaptations reduce cardiac afterload and optimize systemic oxygen delivery, especially in individuals with coronary artery disease, leading to improved exercise tolerance and functional capacity[11,22]. In addition, Nordic walking favourably influences autonomic regulation by attenuating excessive sympathetic activity and increasing parasympathetic tone, which improves heart rate variability and post-exercise heart rate recovery, indicating better cardiovascular stability and efficiency[24].

During Nordic-walking training, maintenance of the upright posture is achieved using poles with greater thoracic mobility and stronger respiratory muscles. This promotes respiratory function. Rib cage mobility and expansion are also enhanced by the continuous use of poles in both hands, which activates the primary muscles of inspiration, i.e., the diaphragm, and results in more tidal volume and ventilation. Repeated deep breathing enhances thoracoabdominal coordination and reduces the work of breathing, which is especially beneficial for individuals with impaired lung function[12,20]. Structured Nordic walking programs with a frequency of 2-4 sessions per week, moderate intensity of 50-75% of maximum heart rate, and sessions lasting for 40 to 60 minutes[11,12,19] have been shown to improve pulmonary function measures, such as forced vital capacity and forced expiratory volume in one second, peak expiratory flow, and mid-expiratory flow in individuals with chronic obstructive pulmonary disease and Parkinson's disease[12,25]. These improvements indicate better airway openness, stronger expiratory muscles, and enhanced small-airway function. Improved ventilation–perfusion matching increases gas exchange efficiency, raising oxygen saturation and lowering ventilatory demands during exercise. Consequently, exertional dyspnea is reduced, allowing patients to exercise more comfortably at higher intensities[12,25].

At the peripheral muscular and metabolic level, Nordic walking induces important oxidative adaptations in the working muscles. Furthermore, Nordic walking promotes greater utilization of fat as a fuel source, thereby improving metabolic economy and endurance

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capacity[11,19]. Neurophysiological mechanisms also contribute to the cardiopulmonary benefits of Nordic walking. Enhanced arm swing, increased proprioceptive input, and improved postural alignment stimulate sensorimotor integration and improve gait coordination. In individuals with Parkinson's disease, correction of the typically flexed posture allows better chest wall expansion and lung volume excursion, thereby supporting improved ventilatory mechanics[25]. Moreover, increases in brain-derived neurotrophic factors following Nordic-walking training support autonomic and cardiorespiratory integration and enhance overall exercise tolerance in postmenopausal women and elderly populations[24].

Positive effects on exercise tolerance and functional capacity have been shown by Nordic walking. Furthermore, several studies have reported findings regarding its superiority over conventional exercises. In some studies[20,21], significant improvements have been shown within-group by Nordic-walking interventions; however, between-group analyses have failed to show any significant results. This finding suggests that the benefits may be due to structured aerobic training rather than the specific use of poles. In addition, another study, which showed improvements in only selected cardiopulmonary outcomes and other parameters, did not reach statistical significance, which limits the strength of its conclusions regarding universal efficacy[19]. Common issues were small sample sizes with short durations of intervention, lack of participant blinding, and limited control over training intensity, which decrease the statistical power and external validity[22]. Moreover, fluctuations in supervision and pole-use technique may also have influenced some outcome measures. Additionally, the current evidence supports Nordic walking as a safe and feasible aerobic modality, but not as a clearly superior alternative to conventional walking, highlighting the need for a larger sample size and well-designed randomized controlled trials.

Limitations of this review: despite promising results, in all included studies, methodological heterogeneity across studies was observed in terms of variability in intervention duration (3–25 weeks), training frequency (1–4 sessions/week), and population characteristics. This diversity limits direct comparability but reflects the flexibility of Nordic walking as an accessible exercise modality adaptable to various health needs and environments. Most studies used small sample sizes and short follow-up periods, indicating a need for larger, high-quality randomised trials to strengthen the causal inference and examine the long-term cardiopulmonary outcomes. Most Nordic walking studies have been conducted in European countries, mainly in Poland, Greece, and Central Europe, and have involved older adults, postmenopausal women, and patients enrolled in structured rehabilitation programs, which

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limits the generalizability of the review to other geographic regions and population groups[19,21]. Similarly, several studies recruited relatively homogeneous samples with good baseline functional capacity, thereby limiting the number of individuals with severe cardiopulmonary disease. [22] Therefore, for future recommendations, research should include multi-center randomized controlled trials in different geographic regions, with wide age ranges and both male and female gender samples, along with different diseases, to enhance the external validity and support the broader clinical implementations of Nordic-walking interventions. One of the limitations in the review was that the investigations focused on individuals other than those with chronic respiratory diseases. Thus, chronic respiratory disease remains scarce, despite Nordic walking's potential to increase respiratory efficiency and to reduce dyspnea.

Future research in Nordic walking should prioritize multi-center randomized controlled trials with blinded outcomes and proper allocation concealment assessment to improve the internal validity and reduce the risk of bias. Standardization of Nordic-walking intervention parameters, which involves pole-handling techniques, intensity of training, and the proper frequency of sessions and duration, is essential to help with proper and meaningful comparisons between studies. To evaluate sustainability, longer follow-up periods are also required for cardiopulmonary outcomes, along with functional gains and the supervised training phase. In population terms, studies should extend to healthy older adults and include patients with different disease severities and varying cultural and socioeconomic backgrounds. To improve external validity, more women and men across different age groups should be recruited. Outcome measures should include the major cardiopulmonary measures, i.e., VO_2peak, 6-minute walk test, functional performance, and patient-reported outcomes, such as quality of life and fatigue.

This scoping review overall shows that Nordic walking is a secure, effective, and easily adaptable exercise that positively enhances cardiopulmonary health across a range of adult populations; the physiological impact of Nordic walking on cardiopulmonary health is shown in **Figure 2**. Progressive improvements in functional endurance, exercise tolerance, aerobic capacity, and cardiovascular efficiency were seen in the research, and they are included in this scoping review. Mobility and physical activity levels may also be improved or positively enhanced by training with Nordic walking poles, particularly among older adults and those individuals who are undergoing cardiac rehabilitation. Hence, the collective evidence and all the studies included support the use of Nordic walking instead of conventional walking as a

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beneficial cardiopulmonary training strategy. However, for future recommendations, further high-quality studies with larger sample sizes, long-term follow-ups, and additional randomised controlled trials with proper protocols should be conducted. They are required to strengthen the existing evidence base. Future research should also explore the applicability across diverse cultural and clinical contexts, including chronic respiratory conditions. Overall, Nordic walking represents a promising, low-cost intervention with meaningful implications for promoting cardiopulmonary fitness and functional health in adult populations.

Conclusion:

Nordic walking appears to be an effective, safe, and low-cost exercise intervention for improving cardiorespiratory fitness, functional capacity, and exercise tolerance.

References

1. Timmis A, Vardas P, Townsend N, Torbica A, Katus H, De Smedt D, et al. European Society of Cardiology: cardiovascular disease statistics 2021. Eur Heart J 2022;43(8):716-799.
2. Agustí A, Celli BR, Criner GJ, Halpin D, Anzueto A, Barnes P, et al. Global initiative for chronic obstructive lung disease 2023 report: GOLD executive summary. J Pan Afr Thorac Soc 2024; 5:92.
3. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet 2020;396(10258):1204-22.
4. Prabhakaran D, Jeemon P, Roy A. Cardiovascular Diseases in India: Current Epidemiology and Future Directions. Circ 2016;133(16):1605-20.
5. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Impact of Physical Inactivity on the World's Major Non- Communicable Diseases. Lancet 2012; 380(9838): 219–229.
6. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ 2006;174(6):801-9.

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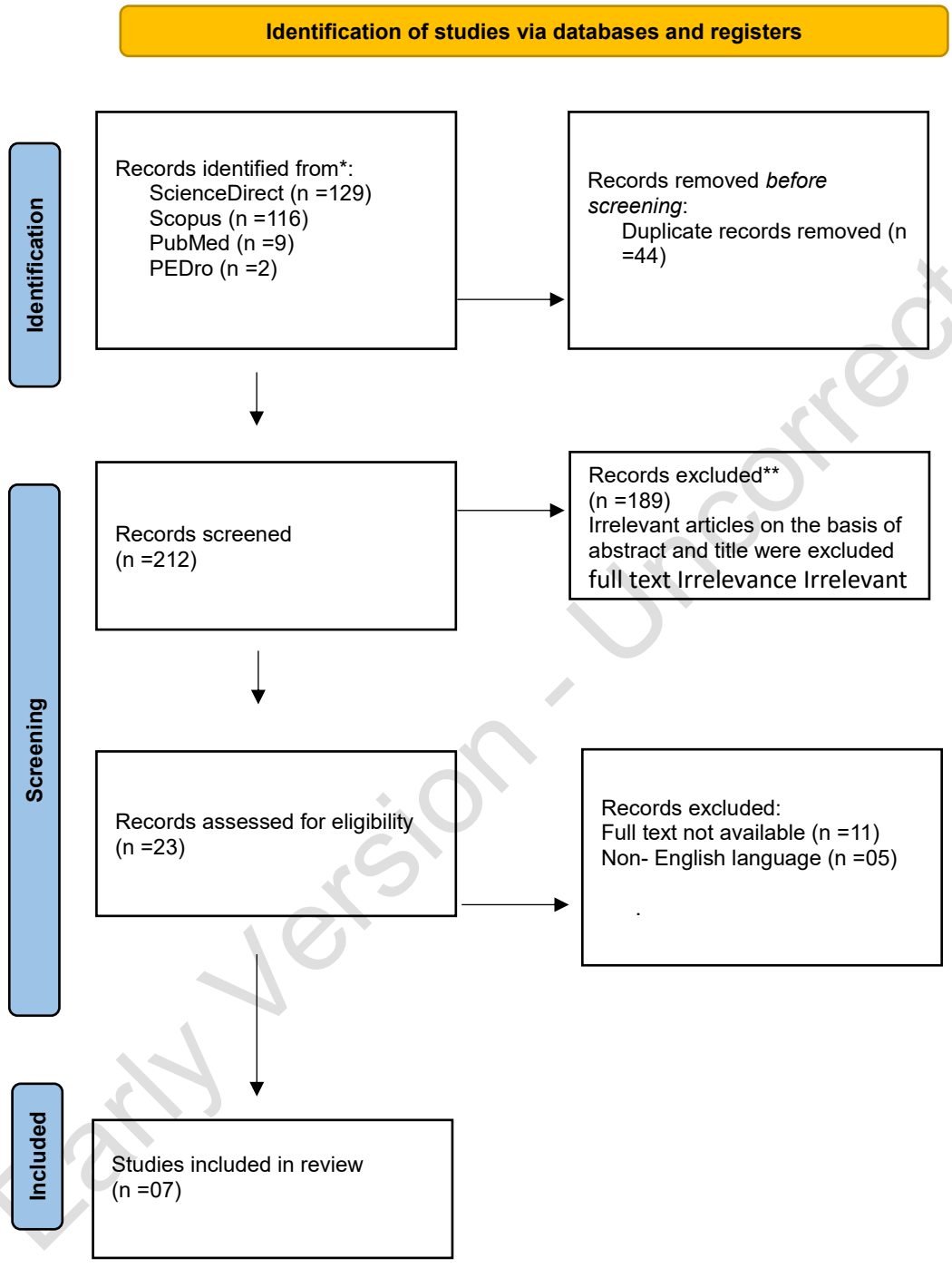
7. Hiya F, Lamour JM, Khan AA, Wood R, Rodriguez de la Vega PE, Castro G, et al. Parenting Practices Are Associated With Out-of-School Physical Activity in US Adolescents in 2014. J Phys Act Health 2024;21(6):578-585.
8. Tschentscher M, Niederseer D, Niebauer J. Health benefits of nordic walking: A systematic review. Am J Prev Med 2013;44(1):76–84.
9. Porcari JP, Hendrickson TL, Walter PR, Terry L, Walsko G. The physiological responses to walking with and without Power Poles on treadmill exercise. Res Q Exerc Sport 1997 ;68(2):161-6.
10. Church TS, Earnest CP, Morss GM. Field testing of physiological responses associated with Nordic Walking. Res Q Exerc Sport 2002;73(3):296-300.
11. Nagyova I, Jendrichovsky M, Kucinsky R, Lachytova M, Rus V. Effects of Nordic walking on cardiovascular performance and quality of life in coronary artery disease. Eur J Phys Rehabil Med 2020;56(5):616-624
12. Breyer MK, Breyer-Kohansal R, Funk GC, Dornhofer N, Spruit MA, Wouters EF, et al. Nordic walking improves daily physical activities in COPD: a randomised controlled trial. Respir Res 2010;11(1):112.
13. Arksey H, O'malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol 2005;8(1):19-32.
14. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci 2010;5:69.
15. 15.Chan SL, Ho CZH, Khaing NEE, Ho E, Pong C, Guan JS, et al. Frameworks for measuring population health: A scoping review. PLoS One 2024;19(2):e0278434.
16. Kwon Y, Lemieux M, McTavish J, Wathen N. Identifying and removing duplicate records from systematic review searches. J Med Libr Assoc 2015;103(4):184-8
17. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev 2016;5(1):210.
18. Kahale LA, Elkhoury R, El Mikati I, Pardo-Hernandez H, Khamis AM, Schünemann HJ, et al. Tailored PRISMA 2020 flow diagrams for living systematic reviews: a methodological survey and a proposal. F1000Res 2021;10:192.
19. Januszek R, Kocik B, Siłka W, Gregorczyk-Maga I, Mika P. The Effects of Cardiac Rehabilitation including Nordic Walking in Patients with Chronic Coronary Syndromes after Percutaneous Coronary Interventions in Elective Mode. Medicina (Kaunas) 2023;59(7):1355.

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20. Ochman M, Maruszewski M, Latos M, Jastrzębski D, Wojarski J, Karolak W, et al. Nordic Walking in Pulmonary Rehabilitation of Patients Referred for Lung Transplantation. Transplant Proc 2018;50(7):2059-2063.
21. Panou H, Giovanis V, Tsougos E, Angelidis G. Influence of the Nordic Walking Intervention Program on the improvement of functional parameters in older women. Topics in Geriatr Rehabil 2019;35(2):129-33.
22. Cebula A, Tyka AK, Tyka A, Pałka T, Pilch W, Luty L, et al. Physiological response and cardiorespiratory adaptation after a 6-week Nordic Walking training targeted at lipid oxidation in a group of post-menopausal women. PLoS One 2020;15(4):e0230917.
23. Nemoto Y, Sakurai R, Ogawa S, Maruo K, Fujiwara Y. Effects of an unsupervised Nordic walking intervention on cognitive and physical function among older women engaging in volunteer activity. J Exerc Sci Fit 2021;19(4):209-215.
24. Domaszewska K, Koper M, Wochna K, Czerniak U, Marciniak K, Wilski M, et al. The Effects of Nordic Walking With Poles With an Integrated Resistance Shock Absorber on Cognitive Abilities and Cardiopulmonary Efficiency in Postmenopausal Women. Front Aging Neurosci 2020;12:586286.
25. Matos LM, da Veiga RG, Santos AG, Dias CP, Santos LL, Rocha RS, et al. Influence of Nordic Walking and Respiratory Muscle Training in Patients with Parkinson: Randomized Clinical Trial. Health Sci J 2020:

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Figure 1 Flow diagram of PRISMA showing studies exclusion and inclusion at each step.



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Figure 2 Integrated physiological impact pathway of Nordic walking on cardiopulmonary health

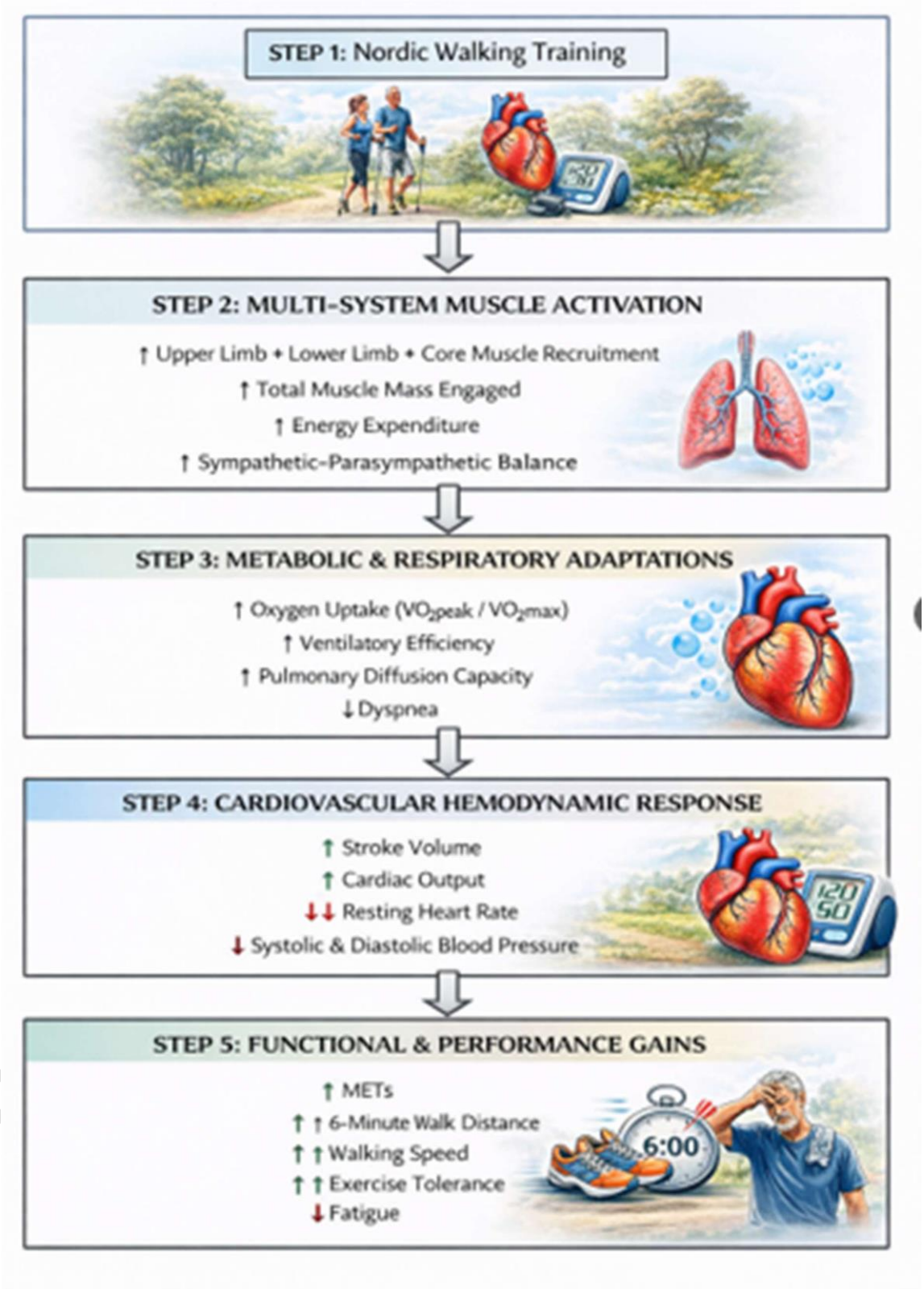


Table 1 PEDro Scoring of individual studies

Criterion	Study						
	Ochman et al., 2018[20]	**Panou et al., 2019[23]**	**Januszek et al., 2023[21]**	**Cebula et al., 2020[22]**	**Nemoto et al., 2021[25]**	**Nagyova et al., 2020[11]**	**Domaszewska, K et al., 2020[24]**
Eligibility criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Random allocation	0	0	1	0	0	1	0
Concealed allocation	0	0	0	0	0	0	0
Baseline comparability	0	1	1	0	1	1	1
Blinded participants	0	0	0	0	0	0	0
Blinded therapists	0	0	0	0	0	0	0
Blinded assessors	0	0	0	0	0	1	0
Adequate follow-up	0	1	1	1	1	1	1

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Criterion	Study						
	Ochman et al., 2018[20]	**Panou et al., 2019[23]**	**Januszek et al., 2023[21]**	**Cebula et al., 2020[22]**	**Nemoto et al., 2021[25]**	**Nagyova et al., 2020[11]**	**Domaszewska, K et al., 2020[24]**
Intention to treat analysis	0	0	0	0	0	0	0
Between-group comparisons	0	1	1	0	1	1	1
Point estimates and variability	1	1	1	1	1	1	1
Total PEDro score	1/10	4/10	5/10	2/10	4/10	6/10	4/10
Sample size≥50	No	Yes	No	No	No	Yes	No
Level of evidence	2	2	2	2	2	1	2

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Table 2 Characteristics of studies included in the review

Author / Year	Country	Study Design	Population	Intervention (Nordic Walking FITT Principle)	Outcome Measures	Key Findings
Ochman et al., 2018[20]	Poland	Prospective Interventional	Lung transplant candidates (n=22)	F = 3days/week I = Moderate to high T = 20-60 minute/session T = 12-week supervised NW program	6MWD, dyspnea, QoL, lung function	Improved endurance and functional capacity
Panou et al., 2019[23]	Greece	Controlled Interventional	Older women (NW n=35; Control n=25)	F = 3days/week I = Moderate T = 45 minute/session T = 25-week supervised NW program	Aerobic endurance, strength, balance	Improved endurance and functional capacity
Januszek et al., 2023[21]	Poland	Randomised Clinical Trial	Post-PCI adults (n=40)	F = 2days/week I = Moderate T = 30 minute/session T = 6-week supervised NW program + cardiac rehab	VO_2peak, IPAQ, 6MWD, QoL	Higher VO_2peak and better QoL

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Author / Year	Country	Study Design	Population	Intervention (Nordic Walking FITT Principle)	Outcome Measures	Key Findings
Cebula et al., 2020[22]	Poland	Pre–Post Study	Post-menopausal women (n=18)	F = 3days/week I = Moderate T = 90 minute/session T = 6-week supervised NW program	VO_2max, HR, BP	Improved aerobic capacity and BP
Nemoto et al., 2021[25]	Japan	3-Group Comparative Study	Older adults ≥70 yrs (NW n=16)	F = ≥1 session/week I = Self selected (light to moderate) T = Self selected T = 3 months NW program	Gait speed, PA level	Improved gait speed and physical activity
Nagyova et al., 2020[11]	Slovakia	Pseudo-RCT	CAD adults (NW≈53; Control≈30)	F = 4 session/week I = Moderate (Borg scale 12-14) moderate to somewhat hard T = 40 minutes/session T = 3 weeks NW program	METs, 6MWT, EF, SF-36 QoL	Improved METs, 6MWT, and exercise capacity

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Author / Year	Country	Study Design	Population	Intervention (Nordic Walking FITT Principle)	Outcome Measures	Key Findings
Domaszewska, K et al., 2020[24]	Europe	Interventional Exercise Study	Adults	F = 2 session/week I = 50% HRR (1-8th Session) 60-70% HRR(9-16th session) T = 60 minutes/session T = 8 weeks NW program	VO_2peak, CRF parameters	Improved VO_2peak and fitness

n-sample size, NW- Nordic Walking, 6MWD- Six-Minute Walk Distance, QoL- Quality of Life, PCI- Percutaneous Coronary Intervention, **VO_2peak** – Peak Oxygen Consumption, **IPAQ** – International Physical Activity Questionnaire, **6MWT** – Six-Minute Walk Test, **VO_2max** – Maximum Oxygen Consumption, **HR** – Heart Rate, **BP** – Blood Pressure, **PA** – Physical Activity, **CAD** – Coronary Artery Disease, **METs** – Metabolic Equivalents, **EF** – Ejection Fraction, **SF-36** – Short Form–36 Health Survey Questionnaire, **CRF** – Cardiorespiratory Fitness, **FITT** – Frequency, Intensity, Time, Type, **HRR** – Heart Rate Recovery

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