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Original Research

Safety and efficacy of Nordic walking training in adult patients with asthma: A pilot randomised controlled trial with a mixed-methods approach

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A B S T R A C T

Introduction: Nordic walking (NW) may benefit patients with asthma by enhancing functional exercise capacity and reducing symptoms, though evidence remains limited. This study assessed NW safety and effects in patients with asthma and explored their experiences.

Methods: A mixed-method two-arm, parallel, pilot randomised controlled trial was conducted in A Coruña between (July 2021 - May 2025). Adults with asthma attended three educational sessions before randomization to NW group (NWG) or control group (CG). The NWG performed NW 3 days/week, during eight weeks, at 70-85% of maximum heart rate. Both groups maintained usual care. The primary outcome was the 6-min walking distance (6MWD). Secondary outcomes included 1-min Sit-to-Stand Test, physical activity (PA) and adverse events. Experiences were explored through individual interviews.

Results: Thirty-four participants with asthma (mean ± SD age 45.4 ± 11.4 years, 82.4% female) were randomly allocated to NWG (n = 17) or CG (n = 17). NW adherence was 80.1 + 16.1%. No adverse effects occurred. Post-intervention, the NWG increased 6MWD by 12.1 ± 30.4 m (m) (P = .119), whereas the CG decreased by 13.6 ± 41.3m (P = .193), without significant between-groups differences (P = .067; Cohen's d = 0.7; 95% confidence interval (CI) 0.-1.3). The NWG spent more time in vigorous PA compared to CG (P = .016, r = 0.4, 95% CI 0.8-52.4). All NWG participants recommended NW, citing health improvements and finding it manageable, comfortable, and implementable.

Conclusion: Although between-groups differences were not significant, NW was safe, feasible, accessible and perceived as beneficial by individuals with asthma. Given the demonstrated safety, future studies should tailor NW intensity to fitness and asthma control levels.

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1. Introduction

Asthma affects an estimated 1-29% of the global population [1–9]% of individuals in Europe [2]. It is a chronic respiratory condition characterised by symptoms such as wheezing, shortness of breath, chest tightness, and cough, associated with variable expiratory airflow limitation [3]. The primary goal of asthma management is sustained symptom control, encompassing the absence of symptoms, improved sleep quality, and the ability to participate in unrestricted physical activity (PA) [3].

The Global Initiative for Asthma emphasises the importance of regular exercise, highlighting its general health benefits for individuals with asthma [3]. This aligns with the principles of pulmonary rehabilitation (PR), an interdisciplinary intervention combining exercise training, education, and behavioural strategies to improve the health-related quality of life (HRQoL) of people with chronic respiratory disease [4]. Among patients with asthma, PR has demonstrated to improve physical fitness [5], asthma symptoms, asthma control, lung function [6], and HRQoL [7]. However, PR may not be suitable to all patients with asthma, due to its accessibility, transportation constraints, or disruption of established routines [8].

In this context, Nordic walking (NW) may represent a feasible alternative to conventional centre-based PR, offering a more accessible and easily implemented form of structured exercise [9]. NW involves walking with natural gait biomechanics using two poles to enhance propulsion [10]. This exercise modality has been studied in patients with chronic obstructive pulmonary disease [11], a condition with signs and symptoms similar to asthma, where it improved PA, functional exercise capacity, mood status and HRQoL [11]. More recently, randomised clinical trials (RCTs) have investigated NW in adults with asthma, particularly within the Indian population [12,13], reporting improvements in functional capacity [12,13], daily symptoms and HRQoL [12].

Despite these promising results, aspects necessary for the broader implementation of NW in asthma management remain unclear. Previous studies did not standardise the exercise intensity, did not formally assess the safety, nor explored acceptability and participant experience with this novel modality. Additionally, a Cochrane review highlighted the need for further research in PR in asthma, incorporating qualitative methods to explore participants' perspectives on novel interventions [14].

Thus, we conducted a pilot RCT with a mixed-methods approach to evaluate the safety and effect of a NW programme in patients with asthma, focusing primarily on functional exercise capacity and physical activity; and also exploring participants' experience with this training modality.

2. Methods

2.1. Study design

A mixed-methods, two-arm pilot superiority RCT was conducted to assess the safety and effects of a NW programme compared to usual care and education alone in adults with asthma. A qualitative methodology was incorporated to explore the experiences of participants in the NW group (NWG). The study was conducted between July 2021 and May 2025, extended beyond the original schedule due to recruitment challenges. Details of the RCT design have been published [15] and registered on ClinicalTrials.gov (NCT05482620). The trial was reported according to the Consolidated Standards of Reporting Trials [16], Consolidated Criteria for Reporting Qualitative Research statements [17] and the Standards for Mixed Methods Reporting in Rehabilitation Health Sciences Research [18]. The trial was approved by the Clinical Research Ethics Committee of A Coruña-Ferrol (2019/574). All participants provided written informed consent prior to enrolment.

2.2. Participants

Participants aged ≥18 years with physician-confirmed diagnosis of asthma were recruited from the A Coruña health area between July 2021 and September 2024. Exclusion criteria included smoking, other respiratory diseases, recent exacerbation (<4 weeks), cardiovascular contraindications, pregnancy or lactation, and participation in structured exercise or PR within the previous 3 months [15].

Physicians from both primary and secondary care invited eligible patients to participate. Due to a low recruitment rate, additional outreach was performed through social media to facilitate self-selection. Eligibility was verified by the investigator responsible for the interventions, who provided additional information and addressed participants' questions.

A target sample size of 114 participants (57 per group) was calculated using the minimum clinically important difference for the Six-Minute Walk test (6MWT) in patients with asthma (26 m – m [19]), the standard deviation (SD) from a previous feasibility study (45.49 m [20]); considering a power of 80%, a significance level of 0.05, and 15% anticipated dropout rate. The Clinic Epidemiologic and Biostatistics software, from A Coruña University Hospital Complex, was employed [21]. Due to recruitment difficulties, the target sample size was not achieved and the study is reported as a pilot.

2.3. Randomization

Participants were randomly allocated in a 1:1 ratio by a researcher with no clinical involvement in the trial (A.L.P.), using blocks of 4-10 based on participant availability, using randomly generated numbers (http://randomization.com/). Although blocks of six were planned, block sizes of 4, 6 or 10 were used to facilitate grouping of participants and address recruitment challenges. Allocation occurred after baseline assessment and completion of the three health education sessions, ensuring blinding of the physiotherapist who conducted the educational sessions (M.V.P.). After the education period, the allocation sequence was emailed to the intervention coordinator (M.V.P.), who then informed participants of their group assignment. This ensured that all participants received the identical health education programme.

2.4. Intervention

Following baseline assessment (T0), all participants were invited to attend three in-person, group-based educational sessions held within the same week. Each session lasted 1 h and was facilitated by a physiotherapist. Details of the educational programme are available in Supplementary material 1. Participants in the NWG additionally completed an 8-week NW training, three times a week (24 sessions), conducted in blue and green spaces of A Coruña and its surroundings. Routes used are available in Supplementary material 2. A minimum attendance of 70% of the NW sessions was required for completion [22]. Each session included 30 min of NW at 70-85% of the theoretical maximum heart rate (HR_{max}) ($HR_{max} = 206.9 - (0.7 \times age)$ [23]). All NW sessions were supervised by the same physiotherapist responsible for the educational component (M.V.P.), with six years of clinical experience and trained in NW in Finland. A typical NW session is detailed in Supplementary material 3. Both groups maintained usual care (medication and at least an annual physician visit) and were asked to complete a participant diary.

2.5. Data collection

All assessments for NWG and control group (CG) were performed by independent, blinded physiotherapists (M.B.F., I.L.G., V.G.F.) with expertise in respiratory physiotherapy, who were not involved in delivering the intervention. Demographic (sex, age), anthropometric characteristics, resting heart rate, allergy history, prior tobacco use, current asthma medication, and respiratory muscle strength were

recorded at T0 to characterise the sample. Primary and secondary outcomes were collected at baseline (T0); after intervention, nine weeks after T0 (T1); and 22 and 35 weeks after T0 as first (T2) and second (T3) follow-up assessments. All outcomes were assessed in a single session. Study design diagram and assessment timepoints are provided in Supplementary material 4.

Qualitative data on NWG participants' perspectives regarding the intervention were collected through individual interviews, using a semi-structured guide with open-ended questions (Supplementary material 5). Focus groups, initially planned [15], were replaced by individual interviews due to their greater simplicity, lower logistical demands, and reduced risk of peer influence, facilitating the participation of more reserved individuals [24]. Interviews were conducted either in person at the Faculty of Physiotherapy from the University of A Coruña, or online via videoconference, depending on participant availability. All interviews took place after completion of follow-up (T3) and were conducted by the same researcher (M.V.P.), a female physiotherapist trained by a researcher experienced in qualitative methodologies (C.J.). Participants were familiar with the interviewer from previous interventions, and no other individuals were present. Each participant was interviewed once. No notes were taken to avoid interrupting the flow of conversation. On average, interviews lasted 13 min (min–max: 6–24). Data saturation was not formally assessed, as all 15 completers were interviewed. Interviews were audio-recorded and transcribed verbatim. Transcripts were not returned to participants for review, to preserve spontaneous narratives.

2.6. Outcomes

The primary outcome was functional exercise capacity, evaluated by distance covered in the 6MWT. At baseline, the test was conducted twice to account for the learning effect. Adverse events were recorded non-systematically, based on spontaneous reports during NW sessions and follow-up visits. Secondary outcomes included 1) functional exercise capacity measured by the number of repetitions in the 1-min sit-to-stand test (1STST); 2) PA assessed using accelerometry (McRoberts, The Hague, the Netherlands) and the International Physical Activity Questionnaire, short version (IPAQ); 3) asthma-related symptoms and asthma control evaluated with Control of Allergic Rhinitis and Asthma Test (CARAT); 4) adherence to inhalers with the Test of Adherence to Inhalers (TAI); 5) dyspnoea measured using the modified Medical Research Council (mMRC), 6) lung function assessed by spirometry, 7) handgrip strength measured using a dynamometer, 8) HRQoL evaluated with the EuroQol 5-dimensions 5-levels (EQ-5D-5L) and the mini Asthma Quality of Life Questionnaire (mAQLQ), 9) quality of sleep with the Pittsburgh Quality of Sleep Index (PQSI), and 10) adherence of NWG to programmed NW sessions. A comprehensive description of the selected outcomes is available in the published protocol [15] and in Supplementary material 6.

2.7. Statistical analyses

The statistical analysis was adapted from the original protocol [15] to accommodate the final sample size. Data were analysed using an intention-to-treat approach. Missing data were imputed via random forest methods [25]. A per-protocol analysis was also conducted (Supplementary material 7). Between- and within-group comparisons were conducted using parametric (paired and unpaired T tests) or non-parametric tests (Wilcoxon signed rank and Mann Whitney U tests) as appropriate after assessing normality with Shapiro Wilk test. McNemar's and Fisher's exact tests were used for binary categorical variables. Effect sizes, with Cohen's d (values of 0.2, 0.5, and 0.8 correspond to small, medium, and large effect sizes, respectively) [26], *r* statistic (0.1, 0.3, and 0.5 indicate small, medium, and large effect sizes, respectively) [27] or risk ratio were calculated. 95% confidence intervals for mean or median differences, or risk ratios, were also calculated. Asthma severity was classified according to medication used [28], and asthma control according to CARAT score (≥24 indicating well-controlled asthma) [29]. Exercise functional capacity was compared against reference values adjusted for participants' sociodemographic characteristics [30, 31]. A post-hoc, descriptive, participant-level analysis examined changes in PA variables and self-reported activities in the NWG during follow-up, based on individual interviews. Analyses were performed using SPSS (version 26.00, IBM Corp., Armonk, NY, USA) and R (version 4.1.3, R Foundation for Statistical Computing, 2022) [32]. No interim analyses or formal stopping guidelines were applied. Further statistical details are provided in Supplementary Material 8. Qualitative data were thematically analysed independently by two researchers (M.V.*P. and* A.L.P.). A third researcher (C.J.) was involved to critically discuss the analysis process [33].

3. Results

3.1. Participants

A total of 34 participants were recruited, of whom 28 completed all assessments (Fig. 1). Mean age was 45.4 ± 11.4 years, and 82.4% were female. Baseline characteristics for both groups are presented in Table 1.

3.2. NW intervention

Sixteen of 17 participants (94.1%) completed the NW intervention. Adherence to the NW programme was 80.1 ± 16.1%, and no intervention-related adverse effects were reported.

3.3. Primary outcome

At T1, both groups showed comparable 6-min walking distance (6MWD), with a between-group difference of 43.4 ± 22.8 m ($P = .067$, Cohen's d = 0.7, 95% CI 0 to 1.3); and similar trends at follow-up (Table 2). Post-intervention, NWG increased 6MWD by 12.1 ± 30.4 m ($P = .119$), whereas CG decreased by 13.6 ± 41.3 m ($P = .193$). Over 75% of participants in both groups exceeded 100% of their predicted 6MWD at T0, a pattern maintained across subsequent assessments. Fig. 9.1. of supplementary material 9 show graphically the change in 6MWD over time in both groups, compared with the change in number of steps.

3.4. Secondary outcomes

3.4.1. Functional exercise capacity (1STST)

For the 1STST, no significant differences were found between or within groups at any time point, except for NWG, which significantly increased repetitions post-intervention (median difference (IQR) 3 (0–7.5) repetitions, $P = .005$) (Table 3). Over 60% of participants in both groups exceeded 100% of their predicted value at T0, with a similar patterns observed in subsequent assessments (Table 3).

3.4.2. Physical activity

Accelerometry showed higher vigorous PA (VPA) in NWG compared to CG at T1 ($P = .016$, $r = 0.4$, 95% CI 0.8 to 52.4) and T2 ($P = .005$, $r = 0.5$, 95% CI 5.9 to 48.4). At T2, NWG also had higher daily PA metabolic expenditure (MET-min/week) ($P = .012$, $r = 0.4$, 95% CI 12.5 to 568.5). Both groups decreased inactive time at T3 compared to T0 (NWG: median difference (IQR) −61 (−92.8–12.2) min, $P = .025$; CG: −29.8 (−82.8–2.1) min, $P = .015$) (Table 3) (Fig. 9.1. of supplementary material 9). Supplementary material 10 shows most NWG participants who increased PA adopted new activities post-intervention. IPAQ results showed no between-group differences.

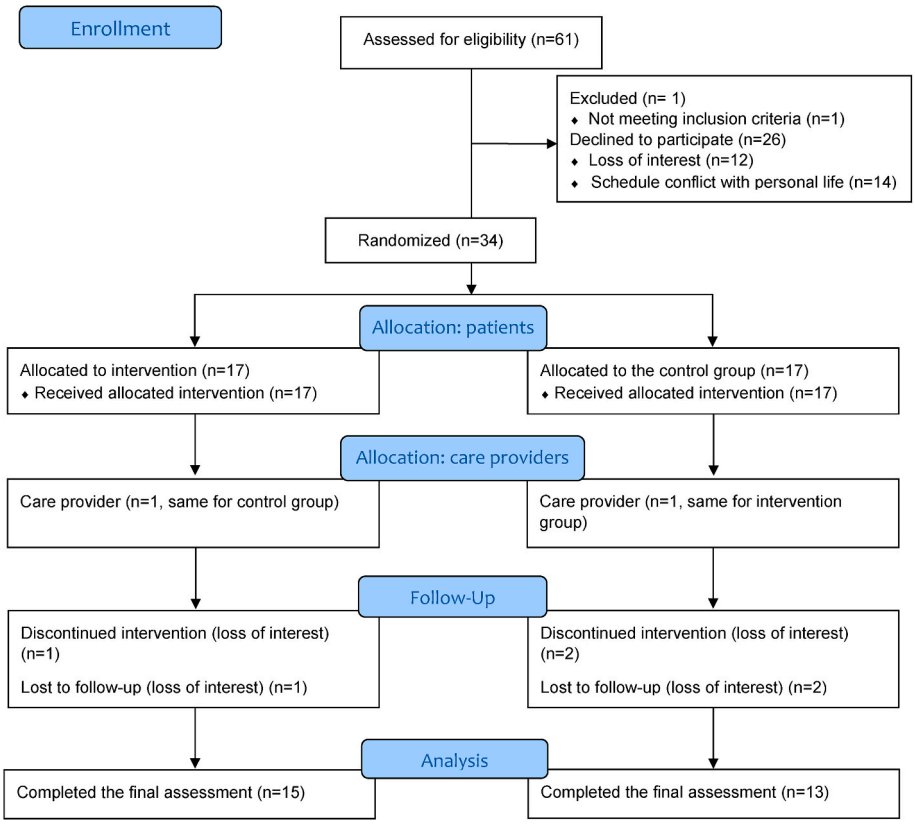

Fig. 1. CONSORT flow diagram.

3.5. Other secondary outcomes

For CARAT and TAI, no between-group differences were detected at any time point. Within-group, both groups increased CARAT score at T3 versus T0 (NWG: median difference (IQR) 15 (9.5–18), $P = .03$); CG: 15 (11.5–17.5), $P = .036$); while only CG improved TAI at T3 versus T0 (median difference (IQR) 1 (0–6), $P = .023$). Only CG decreased within-group mMRC at T1 (median difference (IQR) 0 (0–1), $P = .02$).

In lung function, forced expiratory volume in the first second (FEV_1) was higher in NWG than in CG at T1, T2 and T3. Additionally, in NWG, forced vital capacity (FVC) was higher at T1, FEV_1/FVC at T2 and reference value of peak expiratory flow (PEF) at T1 and T3.

For EQ-5D-5L, the only difference between groups was at T2, with fewer NWG participants reporting no problems in the daily activities' subdomains ($P = .003$, RR (95% CI) 0.5 (0.3 to 0.8)). For mAQLQ, within-group, NWG improved at T1 (median difference (IQR) 0.4 (0.3–1.1), $P = .003$) and both groups improved at T3 versus T0 (NWG: median difference (IQR) 0.4 (0.2–1), $P = .006$; CG: 0.2 (−0.1–0.7), $P = .014$). CG reported a better score in PQSI than NWG at T3 ($P = .038$, $r = 0.4$, 95% CI −1 to 6). No other significant between- or within-group differences were observed (Table 3).

3.6. Experience with NW

Participants' experiences with NW, including perceived benefits and barriers, are summarised in Table 4. Of the 15 participants interviewed (as 2 dropped NWG and declined the interview), 80% had previously engaged in some form of PA or exercise, but for all participants (100%) this was their first experience with NW. About a third (33.3%) continued practising NW after the intervention, and all participants (100%) stated they would recommend NW to others.

Participants consistently reported a range of positive experiences, encompassing improvements in physical health, emotional well-being, and respiratory outcomes, alongside practical advantages related to the intervention, which was considered manageable, comfortable, and easy to implement. In contrast, only a few isolated barriers such as discomfort from keeping the poles attached to the hands, arm soreness or interference with family obligations were reported, each mentioned by a single participant. A word cloud depicting the most frequently mentioned words or concepts from the interviews is available in Supplementary material 11.

4. Discussion

This pilot RCT showed the safety and the preliminary effects of NW in adults with asthma. Although between-group differences were not significant with the exception of PA, NW participants showed moderate improvements in exercise functional capacity, physical activity, and HRQoL. Moreover, participants perceived NW as an acceptable, enjoyable and feasible training modality.

Functional exercise capacity assessed via 6MWT showed no significant differences, likely due to a ceiling effect, as most participants in both groups already exceeded their predicted distances at baseline [30, 34]. While the NWG showed a slight increase, suggesting a possible protective effect preventing decline in the outcome; CG had a slight decrease in 6MWD. However, neither change was statistically nor clinically significant [19], despite the moderate effect size [26], suggesting potential clinical relevance. This ceiling effect may be attributable either to eligibility criteria for asthma stability, which potentially excluded participants with more severe disease, or to physicians referring healthier patients due to uncertainty about the exercise modality's safety. Once NW safety has been established, future studies should determine NW intensity based on both symptoms' perception (dyspnoea and fatigue) and HR. No between-group differences were found in functional exercise capacity measured with 1STST, however the NWG showed a significant within-group improvement post-intervention,

Table 1
Participants baseline characteristics.

	NWG (n = 17)	CG (n = 17)
Females (%)	15(88.2)	13(76.5)
Age (y)	45.4 ± 10.2	45.5 ± 12.7
BMI, kg/m^2	28.7 ± 4.9	29.4 ± 5.8
HR rest, bpm	85.9 ± 12.2	83 ± 17.5
Allergy (%)	13(76.5)	13(76.5)
Prior tobacco history (%)	5(29.4)	8(47.1)
Asthma medication		
ICS + LABA (%)	7(41.2)	12(70.6)
Only SABA (%)	5(29.4)	2(11.8)
ICS (%)	2(11.8)	1(5.9)
ICS + LABA + LRTA (%)	1(5.9)	0(0)
ICS + LAMA (%)	1(5.9)	0(0)
LRTA (%)	0(0)	1(5.9)
SAMA (%)	0(0)	1(5.9)
mAbs + LAMA (%)	1(5.9)	0(0)
Asthma classification		
Intermittent	5(29.4)	3(17.6)
Mild persistent	2(11.8)	2(11.8)
Moderate to severe persistent	10(58.8)	12(70.6)
Controlled Asthma (CARAT[a])	5(29.4)	2(11.8)
Lung function		
FEV_1, %ref. val	99.5 (86.8–106.4)	86.6 (76.5–89.8)
FVC, %ref. val	96 (84.2–100.5)	84 (79–94)
FEV_1/FVC, %	81.1 (75.9–84.5)	78.2 (73.2–79.8)
PEF, L/s	6.5 ± 1.9	6 ± 1.4
PEF, %ref.val	96.3 (86.9–114.5)	84.5 (76.7–102.8)
Respiratory muscle strength		
PImax, cmH_20	105.1 ± 23.8	102.8 ± 25.5
PEmax, cmH_2O	137.4 ± 30.6	146.3 ± 43

%ref.val: reference value; bpm: beats per minute; cm: centimetres; cmH_2O: centimetres of water; CG: control group; FEV_1: forced expiratory volume during first second; FVC: forced vital capacity; HR: heart rate; ICS: inhaled corticosteroids; kg: kilograms; L: litres; LABA: long-acting beta$_2$-agonist; LAMA: long-acting muscarinic antagonist; LRTA: antileukotriene receptor therapy; m^2: squared metres; mAbs: monoclonal antibodies; NWG: Nordic walking group; PEF: peak expiratory flow; PEmax: maximum expiratory pressure; PImax: maximum inspiratory pressure; s: seconds; SABA: short-acting beta$_2$-agonist SAMA: short-acting muscarinic antagonist; y: years old.
Data are expressed as mean ± standard deviation (SD) for normally distributed variables; as median (First quartile, Q1 – Third quartile, Q3) for non-normally distributed variables; or as absolute frequencies (n) and percentages (%).
[a] Following cut off points of Fonseca et al. (2012), considering ≥24 as well-controlled asthma.

reaching a clinically meaningful change [35]. Compared with reference values [31], both groups presented relatively high baseline performance, yet the NWG showed greater potential for improvement.

Increase of PA in both groups became more evident during follow-up. Interviews of NWG participants showed that most adopted new activities, possibly due to habit formation fostered by the education sessions, consistent with evidence that PA habit develops over weeks [36]. Per-protocol analysis confirmed this trend, ruling out imputation effects. Nevertheless, as improvements in PA after education are not always sustained in asthma [37], further research on long-term maintenance is needed [38]. IPAQ results were similar to the general Spanish population [39], but diverged from accelerometry, likely due to recall bias [40] and social desirability [41]. IPAQ's poor agreement with objective measures in asthma is known [42], though it reflects participants' perception.

Between groups differences in lung function are not meaningful due to baseline imbalances. Lung function was normal in both groups [43], and no changes were expected given the limited impact of exercise on pulmonary parameters [44]. Remaining changes were comparable across groups and may be attributable to the educational component [45].

Session adherence was high, even including a participant who dropped out, consistent with classification reported in other studies [46]. Qualitative data collected at follow-up explored feasibility, acceptability, and perceived benefits. This mixed-method approach provided a comprehensive evaluation of NW's clinical impact and potential integration into practise. Despite NW being new to all participants, satisfaction was high and all expressed willingness to recommend it.

Regarding the qualitative part, two main themes emerged from the interviews: benefits and barriers of NW. The most frequently mentioned benefit was improved physical and emotional health, consistent with quantitative findings of non-significant increase in 6MWD, significant gain in lower limb strength, and improved HRQoL. Participants also reported better respiratory health and reduced use of relief medication, possibly linked to CARAT improvements, suggesting treatment reduction [47]. NW was perceived less demanding, yet more complete than conventional walking due to upper body involvement, supported by the greater upper body muscle activation [48], energy expenditure, and oxygen consumption [49], without raising perceived exertion [50–52]. Its accessibility, affordability, and adaptability to daily life encouraged recommendations for others, including those with limitations or for use in uneven terrain, consistent with previous evidence [53–55]. Participants also reported postural improvements, supported by studies showing enhanced postural parameters with NW [56]. Exercising in natural environments was also highlighted as beneficial, consistent with evidence linking it to improved well-being and reduced stress [57]. A

Table 2
Results for primary outcome: functional exercise capacity measured by 6-min walking test.

	NWG (n = 17)				CG (n = 17)				Effect size (95% CI of central tendency differences)		
	T0	T1	T2	T3	T0	T1	T2	T3	T1	T2	T3
6MWD, m	650 ± 53.8	662.1 ± 62.2	659.7 ± 72.4	661.9 ± 59.1	632.4 ± 58.1	618.8 ± 70.7	619.1 ± 72.4	628.5 ± 70.4	0.7 (0 to 1.3)	0.6 (−0.1 to 1.2)	0.5 (−0.2 to 1.2)
Participants achieving ≥100% ref. val.[a] in 6MWT, %	13 (76.5)	14 (82.4)	14 (82.4)	15 (88.2)	13 (76.5)	10 (58.8)	11 (64.7)	13 (76.5)	0.7 (0.5 to 1.1)	0.8 (0.5 to 1.2)	0.9 (0.6 to 1.2)

%ref.value: reference value; 6MWD: Six-minute walking distance during 6-min walking test; 6MWT: 6-min walking test; CG: control group; CI: confidence intervals; m: meters; NWG: Nordic walking group; T0: baseline assessment; T1: postintervention assessment; T2: first follow-up assessment; T3: second follow-up assessment.
Data are expressed as mean ± standard deviation (SD) for normally distributed variables; and as absolute frequencies (n) and percentages (%) for categorical variables. Effect sizes between groups are reported as Cohen's d for parametric data; and risk ratio for binary categorical variables. 95% confidence intervals (CI) of differences between groups are calculated for the mean for normal distribution; for binary categorical variables, CIs are calculated for risk ratios.
[a] : following equations published by Gimeno-Santos et al. (2025);[‡]: $P < .05$ within groups using Wilcoxon's test comparing that time point with the previous measurement;[#]: $P < .05$between groups using Mann-Whitney's Test.

Table 3
Results for secondary outcomes.

	NWG (n = 17)				CG (n = 17)				Effect size (95% CI of central tendency differences)		
	T0	T1	T2	T3	T0	T1	T2	T3	T1	T2	T3
STST result, reps	34 (29–47)	39 (29.5–56.5)[‡]	47 (32.5–51)	39 (33–47.5)	37 (34–48)	39 (31.5–52)	34 (31–49)	33 (32.5–51)	0.1 (−12 to 15.5)	0.2 (−4 to 17.5)	0.1 (−10 to 13)
Participants achieving ≥100% ref. val.[a] in STST (%)	11 (64.7)	12 (70.6)	14 (82.4)	13 (76.5)	13 (76.5)	13 (76.5)	10 (58.8)	12 (70.6)	1.1 (0.7 to 1.6)	0.7 (0.4 to 1.2)	0.9 (0.6 to 1.4)
MET[a]min/wk (IPAQ)	1588 (986.3–2218.5)	1925.1 (1222.5–3006)	1731 (873–2308.8)	1963 (947–2457)	1297 (953.5–2732)	2066 (1162.3–3483)[‡]	1686 (1248.5–2892)	1668 (1164–2483)	0 (−1373.6 to 860)	0.1 (−1265 to 642.8)	0 (−762 to 862)
Category (IPAQ)	2 (2–2)	2 (2–2.5)	2 (1–2)	2 (1.5–2)	2 (2–2.5)	2 (2–3)	2 (2–2)	2 (2–2)	0.1 (−1 to 0)	0.1 (−1 to 0)	0.3 (0 to 0)
Sitting time (IPAQ)	480 (225–630)	480 (300–630)	300 (135–630)	540 (300–690)	600 (300–690)	450 (255–570)	480 (330–630)	420 (270–630)	0.1 (−180 to 270)	0.3 (−390 to 90)	0.1 (−180 to 360)
IT (Accel.), min	596.4 (539.7–725.5)	616.5 (492.1–741.7)	583.4 (556.8–672.2)	578.4 (499.8–619.3)[¶]	661 (593.6–681.3)	615.7 (572.7–708)	618.1 (586.6–679.6)	567 (516.5–667.4)[¶]	0.1 (−102.7 to 117.2)	0.2 (−114.4 to −21.8)	0.1 (−110.4 to 52.3)
LPA (Accel.), min	765 (697.1–828.4)	777.2 (707.01–822.6)	738.8 (690–797.4)[‡]	739.4 (708.4–774.6)	782.8 (765.8–799.1)	788.5 (750.1–820.7)	778.9 (738.7–800.9)	769.3 (716.2–803.8)	0.1 (−87.4 to 47)	0.3 (−87.2 to 17)	0.3 (−47.9 to 40.8)
MPA (Accel.), min	103.2 (64.8–144.8)	97.9 (59.8–139.9)	86.3 (67.8–169.5)	94.7 (75.6–132.4)	84.7 (74.1–108.6)	87.4 (57.1–105)	93.8 (58.9–116.1)	124 (70.1–137.3)[‡]	0.4 (−0.3 to 1.1)	0.6 (−0.1 to 1.3)	0 (−0.7 to 0.7)
VPA (Accel.), min	30.4 (22.4–59.1)	42.2 (28.2–83.5)[#]	55.4 (32.8–84.6)[#]	44.7 (25.7–80.7)	38.2 (30–43.4)	23.6 (16.2–36)[‡#]	28.8 (23.3–39.9)[#]	36.2 (18.9–88)	0.4 (0.8 to 52.4)	0.5 (5.9 to 48.4)	0.1 (−27 to 39.4)
MET[a]min (Accel.)	94.2 (24.5–469.7)	157.3 (50.4–482.4)	319.1 (91.5–693.1)[#]	267.1 (103.1–490.5)	146.4 (86.6–255)	117.7 (37.9–166.8)[‡]	102.7 (76.4–289.2)[#]	213.3 (81.1–464.7)[‡]	0.3 (−48.2 to 348.9)	0.4 (12.5 to 568.5)	0.1 (−197.6 to 284.2)
Steps (Accel.)	7295.2 (4075.2–12971.5)	7142.8 (4371.3–12278)	7914.3 (5321.5–15279.9)	8718.5 (6533.8–12299.9)	6944.2 (5778.3–9668.1)	5895.5 (3756.1–6578)	6274.8 (4457.5–9351.4)	6988.3 (5570–11598.4)[‡]	0.2 (−1307.2 to 6122.2)	0.2 (−1992.9 to 6845.6)	0.1 (−2618.3 to 4168.6)
Walking time (Accel.), min	78.9 (44.6–131.2)	82.9 (47.3–137.9)	89.1 (54.9–145)	93.1 (73.6–138.7)	73.3 (58.5–93.3)	66.9 (48.7–82.3)	72.2 (50.8–89.8)	72.7 (61.5–126.8)[‡]	0.1 (−20.2 to 66)	0.3 (−14.6 to 76.4)	0.1 (−34.3 to 55.6)
CARAT	15 (11.5–24.5)	22 (16.5–26)	20 (15.5–22)	22 (15–26)[¶]	17 (16–18.5)	19 (15.5–23.5)	19 (15.5–20)	20 (17–22)[¶]	0.1 (−4.5 to 7)	0.1 (−2 to 5)	0.1 (−5 to 6)
TAI	48 (40.5–50)	50 (45–50)	49 (40–50)	49 (40–50)	47 (40–49.5)	49 (43–50)	48 (45–50)	49 (46–50)[¶]	0.1 (−3 to 7)	0 (−7 to 4)	0.1 (−7 to 4)
mMRC	1 (0–2)	1 (0–1.5)	0 (0–1)	1 (0–1.5)	1 (1–2)	1 (0–1)[‡]	0 (0–2)	1 (0–1.5)	0 (−1 to 1)	0 (−1.5 to 1)	0.1 (−1 to 0.5)
FEV_1, %ref. val.	99.5 (86.8–106.4)	100 (86.4–106.5)[#]	96 (83.03–106)[#]	98 (79.6–104.7)[#]	86.6 (76.5–89.8)	82 (72.5–89.2)[#]	83 (70–91)[#]	77 (75.3–95)[#]	0.5 (−7 to 25.1)	0.4 (1 to 27.7)	0.4 (1 to 27)
FVC, %ref. val.	96 (84.2–100.5)	98 (86.5–102.7)[‡#]	97.8 (79.3–102)[‡]	96 (85.7–106.5)[‡]	84 (79–94)	87 (79.6–97.5)[#]	84 (82–100.5)	83 (82.5–96.1)	0.4 (−4 to 20)	0.1 (−11 to 17.4)	0.3 (−5.2 to 19)
FEV_1/FVC, %	81.1 (75.9–84.5)	78 (76.6–83.1)	80.9 (77.9–83.8)[#]	78.3 (75.1–83.2)	78.2 (73.2–79.8)	78 (71.7–80.7)	76.7 (74–81.1)[#]	78 (70.1–81.9)	0.2 (−2.5 to 6.9)	0.4 (0.2 to 7.1)	0.1 (−3.3 to 8.4)
PEF, L/s	6.5 ± 1.9	7.1 ± 1.2	6.4 ± 1.1	7.3 ± 1.5[†‖]	6 ± 1.4	6.6 ± 1.4	6.2 ± 1.9	6.9 ± 1.4[†‖]	0.4 (−0.3 to 1.1)	0.2 (−0.5 to 0.8)	0.3 (−0.4 to 0.9)
PEF, %ref.val.	96.3 (86.9–114.5)	104.5 (95.9–115.1)[#]	97.3 (87.8-115.1)	105.5 (99.2–117.1)[†#]	84.5 (76.7–102.8)	89.1 (82.6–100.5)[#]	87.7 (70.7–102.8)	92.4 (83.8–112.4)[†‖#]	0.5 (3 to 37.5)	0.3 (−7 to 34)	0.3 (−5 to 23)
Left hand strength, kg	24 (22.5–29.5)	25 (22–29)	26 (21.5–29.5)	25 (21.5–29)	24 (21–30)	23 (20–28)	21 (20–30)	26 (21–31)	0.1 (−3 to 6)	0.2 (−4 to 7.5)	0.1 (−6 to 4)
Right hand strength, kg	27 (25–32)	28 (22.5–31)	27 (22–32)	29 (23.5–31.5)	24 (22–32)	26 (21.5–30)	26 (23.5–30.5)	25 (22–30.5)	0.1 (−3.5 to 7.5)	0.1 (−3 to 5.5)	0.1 (−3.5 to 7)

(*continued on next page*)

Table 3 (*continued*)

	NWG (n = 17)				CG (n = 17)				Effect size (95% CI of central tendency differences)		
	T0	T1	T2	T3	T0	T1	T2	T3	T1	T2	T3
Mob. (EQ-5D-5L), %L1	12 (70.6)	14 (82.4)	15 (88.2)	14 (82.4)	17 (100)	15 (88.2)	14 (82.4)	14 (82.4)	0.9 (0.7 to 1.2)	1.1 (0.8 to 1.4)	1 (0.7 to 1.4)
SC (EQ-5D-5L), %L1	16 (94.1)	17 (100)	17 (100)	16 (94.1)	17 (100)	17 (100)	17 (100)	17 (100)	1 (N/A)	1 (N/A)	0.9 (0.8 to 1.1)
DA (EQ-5D-5L), %L1	10 (58.8)	14 (82.4)	9 (52.9)[§]	13 (76.5)	15 (88.2)	16 (94.1)	17 (100)[§]	17 (100)	0.9 (0.7 to 1.1)	0.5 (0.3 to 0.8)	0.8 (0.6 to 1)
Pain (EQ-5D-5L), %L1	3 (17.6)	5 (29.4)	6 (35.3)	7 (41.2)	12 (70.6)	10 (58.8)	11 (64.7)	10 (58.8)	0.5 (0.2 to 1.2)	0.5 (0.3 to 1.1)	0.7 (0.4 to 1.4)
AD (EQ-5D-5L), %L1	7 (41.2)	7 (41.2)	7 (41.2)	7 (41.2)	9 (52.9)	8 (47.1)	9 (52.9)	5 (29.1)	0.9 (0.4 to 1.9)	0.8 (0.4 to 1.6)	1.4 (0.6 to 3.5)
EQ-5D-5L Index	0.8 (0.7–0.9)	0.8 (0.8–1)	0.9 (0.8–0.9)	0.8 (0.7–1)	0.9 (0.9–1)	0.9 (0.8–1)	0.9 (0.8–1)	0.9 (0.8–1)	0.2 (−0.2 to 0)	0.2 (−0.2 to 0)	0.2 (−0.2 to 0.1)
mAQLQ	6.1 (4.8–6.5)	6.5 (6–6.8)[‡]	6.2 (5.4–6.7)	6.4 (4.9–6.9)[¶]	6.1 (5.3–6.6)	6.2 (5.9–6.7)	6.3 (5.7–6.6)	6.3 (6.1–6.7)[¶]	0.2 (−0.5 to 0.7)	0 (−0.9 to 0.6)	0 (−1.3 to 0.6)
PQSI	7 (6–11.5)	7 (5–10)	8 (4–12.5)	8 (6–11)[#]	6 (4–10.5)	7 (5–8)	6 (5.5–8)	7 (3.5–8.5)[#]	0.1 (−2 to 3)	0 (−2.5 to 5)	0.4 (−1 to 6)

%L1: percentage of participants rating as no problem in the subdomain; %ref. val.: reference value; Accel.: Accelerometry; AD: Anxiety and depression subdomain; CARAT: Control of Allergic Rhinitis and Asthma Test; CG: control group; CI: confidence intervals; DA: daily activities subdomain; EQ-5D-5L: EuroQol 5 dimensions 5 levels; FEV_1: forced expiratory volume during first second; FVC: forced vital capacity; IPAQ: International Physical Activity Questionnaire, short form; IT: Inactive time; Kg: kilograms; L: litres; LPA: light physical activity; mAQLQ: mini Asthma Quality of Life Questionnaire; MET: Metabolic Equivalent of Task; min: minutes; mMRC: modified Medical Research Council; Mob: mobility subdomain; MPA: moderate physical activity; N/A: not applicable; NWG: Nordic walking group; PEF: peak expiratory flow; PQSI: Pittsburgh Quality of Sleep Index; reps: repetitions; s: seconds; SC: selfcare subdomain; STST: Sit-to-stand test; T0: baseline assessment; T1: postintervention assessment; T2: first follow-up assessment; T3: second follow-up assessment; TAI: test of adherence to inhalers; VPA: vigorous physical activity; wk: week.

Data are expressed as mean ± standard deviation (SD) for normally distributed variables; as median (First quartile, Q1 – Third quartile, Q3) for non-normally distributed variables; and as absolute frequencies (n) and percentages (%) for categorical variables. Effect sizes between groups are reported as Cohen's d for parametric data, as correlation coefficient (r) for non-parametric data, and risk ratio for binary categorical variables. 95% confidence intervals (CI) of differences between groups are calculated for the mean or the median (via bootstrapping) depending on whether the distribution is normal or non-normal, respectively; for binary categorical variables, CIs are calculated for risk ratios.

[†]: $P < .05$ within group using Student's paired *t*-test comparing that time point with previous measurement; [‖]: $P < .05$ within group using Student's paired *t*-test comparing that time point with baseline; [‡]: $P < .05$ within groups using Wilcoxon's test comparing that time point with the previous measurement; [¶]: $P < .05$ within groups using Wilcoxon's test comparing that time point with the baseline measurement; [#]: $P < .05$ between groups using Mann-Whitney's Test; [§]: $P < .05$exact Fisher's test.

[a] : following equations published by Vilarinho et al. (2024).

Table 4
Themes, subthemes and description arising from individual interviews.

Theme	Subtheme	Description and quotes
Positive aspects of NW	Physical Health	Participants reported improved physical fitness, agility, and overall conditioning. - *"I did notice that, like, you had less fatigue, you could walk faster."* (ID 16) - *"When it came to exercising, yeah, I think so. I mean, obviously, the first week was incredibly hard. But then it started to get a bit easier."* (ID 28) - *"I walk more, I'm more—quite a bit more—agile, lighter. And then, it's also really good for my mind."* (ID 7) - *"Like what happened to me, afterwards I felt so good that I actually felt like doing the race (a popular race), and I did it without any difficulty. That was because I'd been doing NW. If I hadn't been doing NW, I wouldn't have been able to do the whole race."* (ID 30)
	Emotional Wellbeing	Participants described feelings of empowerment, greater satisfaction and relaxation after NW sessions. - *"Not just in terms of feeling physically better, but mentally it really helped me to say: 'Wow, I actually can do this.' (…) 'Alright then, I'm going to support this not just with exercise, but with other things too.' So, it really helped me both physically and mentally."* (ID 20) - *"But I feel so much better. More at ease. I even enjoy things more."* (ID 22) - *"Yeah, but overall, it was good—I'd go to work feeling more satisfied, more relaxed too."* (ID 6) - *"Well, overall, it was good. (…) And, yeah, I found it a really enjoyable time. It distracted me a lot—going out for a walk—and, well, I think I felt more relaxed afterwards."* (ID 12)
	Respiratory Health	Some participants noted improvements in asthma symptoms and reduced use of maintenance medication that is associated with their enrolment in the NW sessions. - *"The only thing I expected was to improve my asthma. And well, honestly, this summer was fantastic in that regard."* (ID 22) - *"I didn't have any expectations, but everything really helped me a lot. In fact, two weeks ago I was discharged from pulmonology because my asthma is well controlled now."* (ID 30) - *"The benefit you get at the asthma and bronchial level, that. I noticed it a lot, the improvement."* (ID 7) - *"Well, maybe I needed less medication, and usually when I have a crisis or something, I'm kind of full of phlegm, but this time, I was better. I was breathing better too."* (ID 12)
Positive aspects of NW	Comfortable Pace	Although recognising the physical effort required, participants felt less fatigue, breathlessness and tiredness compared to other more intense activities. - *"I compare it to when I used to run. When I ran, I'd feel fatigued after a minute, then I'd stop and walk. But with walking, no. I don't know where you get the strength from, but with walking you say, 'Come on, it's almost over,' and you keep going. Maybe it's because you don't feel that breathlessness and fatigue you get when you run."* (ID 19) - *"It just happened that it was perfect timing for me because of the training. The activity didn't tire me at all. I could keep going even if I was a bit fatigued."* (ID 30) - *"There's nothing negative. It's a sport … it's easy, right? At the end of the day, when you have a day off and think, I want to do some sport. I hate running, plus, it makes me really tired. But going out for a walk feels even relaxing. It's cardio. It seems to have a lot of good things. And practically no bad."* (ID 31)
	Easy to Practice	Participants found the technique easy to learn and execute. - *"You can do it alone. You can do it with others. You can do it with your dog—I've already tried that. So, it's really easy."* (ID 20) - *"It's very simple, you don't need a big investment or fancy equipment, and if they don't like running—which is a bit more intense than walking—but it's not as extreme as running."* (ID 11) - *"Simple, anyone can do it, and besides that, it's a new way to live life. It's a programme—you go every day, or twice a week—and it's something new."* (ID 1) - *"I think for people like me, who tend to be sedentary, who find it a drag to do sports like running or signing up [for activities] … it's a super simple activity."* (ID 30)
Positive aspects of NW	Physically Accessible	Related with two previous subthemes, NW was perceived as suitable even for those experiencing minor pain or discomfort, and was considered appropriate for individuals with mobility limitations or for use on uneven terrain. - *"In July I felt bad, really bad all over. Neck pain, tiredness, it was hard to climb hills … But with the poles, no. With the poles, I climbed them much more easily."* (ID 22) - *"Honestly, I loved the experience, I really, really liked it. And I do see it as an activity that … that … that's very doable regardless of having little aches, you know?"* (ID 20) - *"It should be a more well-known alternative. I think there are a lot of people who could go out walking with poles. It can help a lot of people who might have mobility problems or who are more afraid. It's a really easy thing to do."* (ID 11) - *"It gives you a boost when you go to other areas, like instead of a seaside promenade, places with obstacles, mountains, trails, whatever … I don't know … "* (ID 6)
	Social Activity	Group participation enhanced enjoyment and adherence. - *"But it really helped me to have to meet up with the group."* (ID 19) - *"Besides just going with you all. That also helped me, it worked in my favour. It was something positive, you know? Otherwise, I wouldn't have gone. But yes, for me it was positive in many ways."* (ID 28) - *"You socialise, you don't feel alone, you're not stuck in your own bubble, and you find that there are more people there. I would recommend it to everyone."* (ID 1) - *"When we went together, I loved it for the social part too, because in the end it was exercising in a group. Then when I did it alone, I did find it hard to leave the house intentionally, just for that."* (ID 31)
	General Health	Participants reported overall health improvements following the NW intervention. - *"But now, I think I'm going to keep getting better. I feel more motivated to do NW and other things, not just NW."* (ID 22) - *"What did I think? Well, good. I mean, it's something positive. It gives you your own perspective. It's true that, health-wise … I noticed it. I mean, health-wise, I could feel myself improving day by day, actually. For me, it was positive."* (ID 28) - *"It was very beneficial for my health; I met new people. Socialising is also important. But*

(*continued on next page*)

Table 4 (*continued*)

Theme	Subtheme	Description and quotes
		above all, for health. I would recommend it to anyone, whether they have asthma or not. Because it's a very healthy exercise." (ID 7)
Positive aspects of NW	Use of Relief Medication	Several participants noticed a decrease in the frequency of using rescue medication, including during exercise. - *"Since I started NW, except for one time, and I think it was due to something specific I touched … I don't know if it was some plants or something that caused a strong allergy, I did feel the need to use my inhaler … but I think it was only that one time. Never again, honestly."* (ID 20) - *"When I used to go running, I did take rescue medication. I would take Ventolin before going out for a run every day. (…) Now, with NW, I'm not taking anything. (…). In fact, right now, I'm still not taking anything. I haven't had an asthma attack since we started doing it, and I still haven't."* (ID 19)
	Economically Accessible	NW was considered cost-effective, requiring minimal equipment (only walking poles) and low investment - *"It's very affordable because you don't need expensive gear. I mean, with some sweatpants and a sweatshirt, and some poles—I bought the cheapest ones—you can already do a very complete workout."* (ID 20) - *"Also, the opportunity to do it for free. It didn't cost me anything. Nothing. And on top of that, it's for your own benefit."* (ID 27) - *"You only need sportswear and the poles. You don't need a facility, nor is it particularly expensive."* (ID 11)
	Postural Improvements	Participants felt they had better posture and increased body awareness, which transferred to walking without poles. - *"I noticed the benefits of walking more upright. Now, when I walk without poles, I do try to straighten up more, because, well, I don't think I walk hunched over, but it's true that with the poles you notice you're walking more upright and probably breathing much better."* (ID 27) - *"But yes, I think that, posture-wise, I became much more aware of my body. I mean, now sometimes when I'm walking fast, my arms make the motion of holding the poles, and I straighten up more. That's something I'm very conscious of."* (ID 31)
Positive aspects of NW	Adaptable to Daily Life	The activity's schedule and location were seen as easy to integrate into daily routines. - *"The schedule was great because it adapted to my schedule, to our lives."* (ID 28) - *"I see it feasible to incorporate into your daily life. I see it as possible. I see that you don't have to travel anywhere."* (ID 8)
	Routine	Establishing a routine with the group was viewed as an important factor supporting adherence - *"First, you establish a routine. You know that every day you've set, you have to be there at that time and on those days, at those hours. You establish a routine like for other things."* (ID 7) - *"Yes, turning it into a routine, and well, it's a routine that's for your health. No one tells you anything, you have to do it all yourself, and you're doing it for your health, something for yourself."* (ID 1)
	Complete Exercise	The involvement of the upper body contributed to a perception of NW as a more comprehensive workout - *"Well, that's it, it's very complete because you're really exercising your whole body."* (ID 20)
		- *"Yes. That, I think … and also, the thing about exercising is the upper body. Because otherwise … even now I realise that when I walk without the poles, I try to move my arms like this (makes arm movement), even though I'm not carrying the poles. I don't know, maybe it's just a habit, but I like it. I'm working a bit more on top of that."* (ID 27)
	Nature	Participants appreciated the opportunity to exercise in natural environments - *"Well, I really liked that a lot — being outdoors, in nature, you know? If I can say that too … it's like, of course … in the end, that's part of it too."* (ID 6)
Barriers of NW		Reported barriers included discomfort from keeping the poles attached to the hands (necessary for correct technique), arm soreness (uncommon with regular walking), self-consciousness from being observed while using poles, exercise intensity, family obligations interfering with participation, and challenging terrain such as hills. Each barrier was mentioned by only one participant - *"The poles. Having them tied to my hands. And I still use them, with the gloves. But it bothers me, I don't know, it's something I find uncomfortable."* (ID 19) - *"No… I think once I had … the first day I had really bad soreness in my triceps"* (ID 6) - *"Well, it's true that when I'm in town — not in Coruña — but when I'm in the village or so, it feels like people stare at you for walking so fast with the poles. I have felt a bit self-conscious. Not in Coruña because there are a lot of people. But in the village, yes."* (ID 31) - *"Nothing else. The only thing is that sometimes when our heart rate went up and we were pushing harder … that was harder for me and sometimes I was like, 'ah, I'm going to die.' But I think that's just about consistency. I think if I were consistent, I would gradually get better at controlling that. (…) Maybe pace is what's hardest for me."* (ID 20) - *"Well, there was one time because I had a sick family member, as you know, and because of that circumstance, I thought maybe I'd have to stop. But other than that, it was always my own choice."* (ID 12) - *"There were moments, especially with hills. Some hills … that … made me feel a bit bad, honestly. It was difficult. The hills and then it took me quite a while to recover. It wasn't like i was having an asthma attack, but I did feel a bit worse."* (ID 29)

ID: Identity number; NW: Nordic walking.

prior sociological study also identified physical health, well-being, accessibility, and social belonging as key motivators for choosing NW in healthy people [58]. Reported barriers were minimal and appeared to reflect individual rather than shared perceptions.

Taken together, these findings suggest that clinicians may consider Nordic walking a safe, feasible, and well-accepted form of exercise for adults with asthma. It may help maintain or modestly improve functional exercise capacity, physical activity levels, and HRQoL, while providing a practical and accessible alternative to centre-based PR.

The primary limitation is the high initial functional status of the participants, which may have reduced the scope for measurable improvement. Another limitation is the small sample size, which led us to report the study as a pilot; this was due to recruitment challenges related to participants' personal and professional commitments. Therefore, results should be interpreted with caution when extrapolated to the

adult asthma population, and larger studies are needed. Furthermore, due to the nature of the intervention, neither participants nor intervention providers could be blinded. Although outcome assessors were blinded, some questionnaires were self-administered. Additionally, familiarity between participants and the interviewer may have influenced responses. Finally, interviews took place at the end of the follow-up, requiring retrospective recall. Despite these limitations, this study has several strengths. It is the first to examine the safety and effects of NW in people with asthma in our context, and the first to use a mixed-method approach, enabling a richer and more comprehensive interpretation of the quantitative results through personal interviews within the NWG. Analyses followed intention-to-treat principles [59], and missing data were handled using random forest imputation [25]. Moreover, while participants' familiarity with the physiotherapist could influence responses, it likely facilitated engagement and openness. Lastly, priority was given to safety, suggesting that future research should include larger, multicentre RCTs, adopt more ambitious interventions, and define optimal training intensity across different asthma phenotypes and fitness levels to confirm efficacy. Overall, NW emerges as a safe and viable alternative to conventional centre-based PR, demonstrating benefits in an open setting, being positively valued by participants, and promoting adherence.

5. Conclusions

This pilot RCT showed the safety and the preliminary effects of NW in adults with asthma. Although between-group differences were not significant with the exception of PA, NW participants showed moderate improvements in exercise functional capacity, physical activity, and HRQoL. NW is therefore a feasible and well-accepted exercise modality for people with asthma, constituting a viable alternative to conventional PR programmes. Future studies are needed to explore NW in adult patients with lower levels of baseline physical functioning, more daily symptoms, and different fitness and levels of asthma control, tailoring intensity to optimise benefits for all participants.

RCT registration

ClinicalTrials.gov (NCT05482620)), registered on 2022-06-29.

Protocol and statistical analysis plan

ClinicalTrials.gov (NCT05482620) and in Vilanova-Pereira M, Jácome C, Prado MJR, Barral-Fernández M, Aparicio MB, García-Boente LF et al. Effectiveness of Nordic walking in patients with asthma: A study protocol of a randomized controlled trial. PLoS One. 2023; 18(3): e0281007 (10.1371/journal.pone.0281007).

Data sharing

Data can be requested from the corresponding author.

Use of artificial intelligence

Artificial intelligence (AI) tools have been used to correct grammatically the text. No AI generative tools have been used.

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CRediT authorship contribution statement

María Vilanova-Pereira: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Cristina Jácome:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Margarita Barral-Fernández:** Investigation, Validation, Visualization, Writing – review & editing. **Verónica Guerra-Fandiño:** Investigation, Validation, Visualization, Writing – review & editing. **Lore Zumeta-Olaskoaga:** Data curation, Formal analysis, Software, Validation, Visualization, Writing – review & editing. **Manuel Jorge Rial-Prado:** Validation, Visualization, Writing – review & editing. **Marina Blanco-Aparicio:** Validation, Visualization, Writing – review & editing. **David Garrido-Victorino:** Validation, Visualization, Writing – review & editing. **Iria Losada-García:** Investigation, Validation, Visualization, Writing – review & editing. **Ane Arbillaga-Etxarri:** Conceptualization, Validation, Visualization, Writing – review & editing. **Lara Fontán García-Boente:** Validation, Visualization, Writing – review & editing. **Anouk W. Vaes:** Supervision, Validation, Visualization, Writing – review & editing. **Qichen Deng:** Validation, Visualization, Writing – review & editing. **Martijn A. Spruit:** Supervision, Validation, Visualization, Writing – review & editing. **Ana Lista-Paz:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

A.A.E.: This statement serves to disclose a potential or actual conflict of interest regarding the public outreach presentation delivered as speaker at the scientific event called MLN (Multiperspective lecture on clinical Allergi Management) organized by Allergy Therapeutics on 14/11/2025. The presentation content focused solely on the general, evidence-based benefits of physical exercise for health and well-being. The speaker received financial compensation (honorarium/speaker fee) from the event organizer, Allergy Therapeutics, for preparing and delivering this lecture. The speaker confirms that the content was developed independently, was not influenced by the funding source, and did not include any promotion or endorsement of Allergy Therapeutics' products, services, or specific research findings. All efforts were made to ensure the presentation was impartial and scientifically objective.

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The remaining authors have declared that no conflict of interest exists.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rmed.2026.108817.

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