Efficacy of Nordic Walking in Obesity Management

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Efficacy of Nordic Walking in Obesity Management

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Key words
- obesity
- Nordic walking
- training
- middle-aged women

Abstract

The effects of a Nordic walking (NW) program compared to those of a walking (W) program on physiological and perceptual variables in obese middle-aged women were investigated. Subjects (n = 12 NW group, n = 11 W group) trained over 12 weeks 3 times.week^{-1}. Body mass, body mass index (BMI), body fat, heart rate (HR), resting blood pressure, peak oxygen consumption ($\dot{V}O_{2peak}$) were measured before and after the training period. Moreover, HR, rating of perceived exertion (RPE) and adherence were recorded during all training sessions. After the training period body mass, body fat and diastolic blood pressure decreased in both groups ($P < 0.05$) whereas $\dot{V}O_{2peak}$ increased in the NW group (+3.7 ml.min^{-1}.kg^{-1}; $P = 0.005$). During the training sessions, mean HR ($P = 0.021$), HR at preferred walking speed ($P = 0.020$) and % of time at high intensity ($P = 0.031$) were higher in NW than in the W group. Finally, RPE was not influenced by the modality of exercise and NW group showed a higher rate of adherence (91 ± 19 % vs. 81 ± 29 %; $P = 0.011$). To conclude, NW activity in obese women allows an increase in exercise intensity and adherence to a training program without increasing the perception of effort leading to enhanced aerobic capacity.

Introduction

Obesity, defined as a body mass index (BMI) greater than 30 kg.m^{-2} [41], is a significant and increasing health problem in industrialized countries. According to the World Health Organization [51], in Europe there are over 130 million obese adults and over 400 million people overweight. Weight reduction is the common goal in the treatment of obesity, and to deal with this issue dietary intervention and combating a sedentary lifestyle seem to be the main proposals. The role of physical exercise in preventing and/or treating obesity has already been well documented (for review see Hill and Wyatt [24]). Results from epidemiological studies have revealed that people who are physically active are less likely to gain weight over time, compared with those who are physically inactive [13, 20, 40, 48]. In the same way, randomized controlled exercise trials in middle-aged overweight subjects have demonstrated a dose-response relationship between the amount of physical activity and the amount of weight change [10, 42]. Thus, in obese subjects the prescription of physical activities in a body weight management strategy seems to be largely justified but is impeded by a significant problem in term of subjects' adherence. Indeed, in overweight adults, a lower rate of adherence to physical activity compared to their normal-weight counterparts has been reported [15]. This might be explained by the activity being experienced as more laborious and less pleasant [15] and by prescribed continuous exercise monotony [12]. Therefore, to limit the phenomenon of poor adherence to a training program, intermittent exercise could represent a viable alternative to continuous exercise. In 2003, Jacobsen et al. [25] examined adherence and attrition in previously sedentary overweight females during 72 weeks of continuous or intermittent exercise. These authors demonstrated that, although attrition did not appear to differ between the 2 modes of training at the end of the experiment, intermittent exercise elicited lower attrition rates during the first 24 weeks of an exercise program compared to continuous exercise. More recently, Coquart et al. [12] reported firstly, that obese women, some of whom had type 2 diabetes, perceived intermittent exercise as being less difficult than continuous exercise; and secondly, that an intermittent exercise program (32 min, 3 days. week^{-1}, during 10 weeks) had beneficial effects

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on glycosylated hemoglobin, body mass, BMI, heart rate and distance limit during a 6-min walking test.

Moreover, to break up the monotony of exercise and to increase adherence to the training program, it is important to propose a physical activity that is not only effective from a physiological standpoint but also innovative and enjoyable from a psychological perspective [3,6,8]. From this point of view, walking with poles, called Nordic walking (NW) could meet these criteria. Indeed, NW is growing in popularity as an endurance activity. NW is widely used in health and leisure time sports [38] and elicits higher metabolic and cardiovascular demands than normal walking [9,16,34,35]. To our knowledge, comparison of the effects of a NW training program to those of a walking training program in obese adult individuals has never been investigated. In light of the foregoing and since it has been demonstrated that overweight adults exhibit better adherence when physical activity is unsupervised and self-determined rather than supervised and prescribed [33], the main aim of this study was to compare the effects of a 12-week NW interval training program to those of a walking (W) interval training program, both performed primarily in non-supervised mode and at preferred walking speeds, on the physical health and exercise capacity of obese middle-aged women.

Methods

Subjects

23 healthy, middle-aged obese women volunteered for this study and went through a medical examination before inclusion. To be eligible for participation, baseline BMI, calculated as weight in kilograms divided by height in meters squared had to be $>30\,kg.m^{-2}$. In addition, all participants were classified at baseline as "sedentary", which was defined as reporting exercising less than 1 $h.week^{-1}$ over the previous 6 months. Participants were excluded if they met any of the following criteria: taking medication known to influence the variables measured and having a medical condition that would limit exercise participation. All participants gave their written informed consent to participate in this study, which was approved by our University ethics committee, in accordance with required ethical standards [22].

Experimental design

The experimental protocol is summarized in **Table 1**.

12 obese subjects trained in Nordic walking (NW) and 11 BMI-matched obese subjects trained in walking (W) volunteered to take part in this study. As we recently showed that in non-expert obese middle-aged women, a learning period of NW technique is needed to enhance the difference in cardiovascular demand between NW and W locomotion [16], subjects from the NW group learned the correct use of NW poles during walking before beginning the study (4 weeks, 3 $sessions.week^{-1}$ and 45 $min.session^{-1}$). According to the International Nordic Walking Federation guidelines, the length of the NW poles (mass 155 g each, Gabel X3, Rosà, Italy) was adjusted specifically for each subject to an appropriate length in which the elbow was at 90° while the pole was held in a vertical position and in contact with the ground.

Over a 12-week period, the subjects performed 3 programmed exercise sessions per week; 1 supervised by the study investigators, and 2 performed individually.

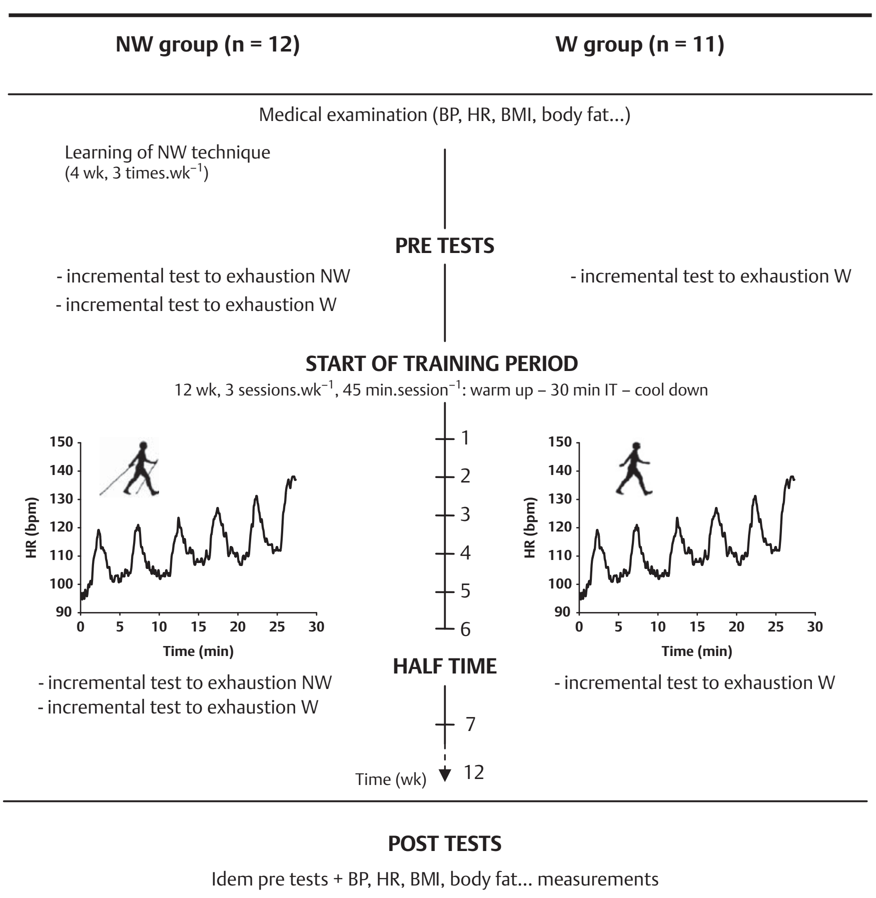

Table 1 Experimental protocol.
NW: Nordic walking; W: Walking; BP: blood pressure; HR: heart rate; BMI: body mass index; IT: interval training.

Training program

All exercise training sessions were performed outdoors and consisted of warm-up (5–10 min), interval training (30 min) and appropriate cool-down (5–10 min). The training program, inspired by the Square Wave Endurance Exercise Test of Gimenez et al. [18] and by its the modified version proposed by Tordi et al. [43], consisted of 6 successive bouts of 5 min each. During each bout, a 4-min period of moderate exercise, corresponding to the individual preferred walking speed (with or without poles according to the group), was followed by a 1-min period of more intense exercise, corresponding to the individual maximal walking speed (with or without poles according to the group). The preferred and maximal walking speeds were explained to the participants by the same investigator using verbal descriptions: the preferred walking speed, corresponding to the speed for each individual that minimizes the amount of energy required to walk a given distance [7], was described as a walk at "comfortable walking pace". The maximal walking speed was described as the maximal speed achieved just before running and bearable during 1 min. During each exercise session, heart rate was continuously recorded (Polar Electro Oy, Kempele, Finland) for a subsequent assessment of exercise intensity (5-s recording interval). Before starting the training program, the exercise instructor gave instructions for the training sessions with advice on warm-up, cool-down and the use of the heart rate monitor. Even though heart rate monitors were worn in all training sessions, the subjects were advised to follow the monitor's display only to check the duration of exercise.

Testing procedure and measurements

All tests and measurements described below were performed before and after the training period. Moreover, an incremental test to exhaustion was repeated half way through the training program (week 6). For subjects included in the NW group, incremental tests were carried out in a counterbalanced order on different days separated by at least 48 h and tests were carried out at the same time of day for each subject. Subjects were instructed to avoid consuming any food, alcohol or smoking tobacco for 2 h before their assessment. Finally, during the study, the participants were advised not to change other lifestyle habits, especially not to lose weight by dieting.

Resting and anthropometric measures

Each subject's physical level was assessed by physical examination performed by a medical doctor. Resting systolic and diastolic blood pressures were determined from the left arm of the seated participant after 5 min of resting using a mercury sphygmamometer (Erka, Bad Tölz, Germany). These values were determined to the nearest millimeter of mercury (mmHg). 3 separate measurements were taken at 1-min intervals, and the mean of these 3 readings was recorded. Resting heart rate represented the minimal value of heart rate measured during the last 30 s after a seated rest period of 5 min. Anthropometric data was also collected during the medical examination. Body mass and height were measured in light clothing without shoes. Body mass was recorded to the nearest 0.1 kg and height was measured to the nearest centimeter. Body mass and height were then used to calculate the BMI. The subject's body fat percentage was predicted by measuring 4 skin-folds using a Holtain skin-fold caliper (Holtain LTD, Croswell, Crymych, UK) and following the Durnin and Womersley method [14]: 4 skin-fold measurements were recorded from the right side of the body with the subject in a standing position.

Exercise intensity

For both types of training (NW and W) percentage of training time spent on exercise of a given intensity was assessed based on recordings from the heart rate monitor, and data on resting and peak heart rate measured during the baseline incremental test to exhaustion. Exercise intensity was subdivided into 5 categories (expressed in percentage of heart rate reserve (HRR)): very low, low, moderate, high and maximal intensities corresponding to 0–19 % HRR, 20–39 % HRR, 40–59 % HRR, 60–84 % HRR and 85–100 % HRR, respectively [29].

Rating of perceived exertion (RPE) and adherence

After each training session subjects were asked to record their RPE using the 6–20 Borg scale [5]. Standardized instructions on how to interpret the scale [4] were explained to all participants by the same investigator. Adherence was calculated as the number of sessions completed divided by the number of sessions set per week and expressed as a percentage.

Incremental test

Maximal time to exhaustion, time at ventilatory threshold and relative and absolute peak oxygen consumption ($\dot{V}O_{2peak}$) were determined for each subject using an incremental test to exhaustion on a motorized treadmill (belt dimensions of 2.5 m × 3.5 m, Rodby, Sodertalje, Sweden). Treadmill speed was held constant (4 km.h^{-1}). After a first step of 3 min at 0 %, inclination was increased by 1 % every 1 min until voluntary exhaustion. At the end of the test, subjects were asked to evaluate their RPE on the 6–20 Borg scale [5]. Subjects from the NW group performed 2 walking tests (with and without poles) in random order, whereas subjects from the W group were evaluated only without poles. Before beginning the test subjects were fully familiarized with walking on treadmill with or without poles and with the use of the safety harness.

During the incremental test to exhaustion, gas exchange and ventilatory parameters were collected breath-by-breath during all trials by means of a portable (mass 800 g) metabolic system (Cosmed K4*b*^{2}, Rome, Italy). Gas analyzers were calibrated before each test with ambient air (O_2 20.93 % and CO_2 0.03 %) and a gas mixture of known composition (O_2 16.00 % and CO_2 5.00 %). The face mask was equipped with a low-resistance, bidirectional digital turbine (diameter 28 mm) that was calibrated before each test with a 3-L syringe (Cosmed, Rome, Italy). Face masks allowed subjects to breathe simultaneously through the mouth and nose, for more comfort. Heart rate was monitored continuously using a wireless Polar monitoring system and was synchronized with the Cosmed system.

Data analysis

$\dot{V}O_{2peak}$ criteria

The attainment of $\dot{V}O_{2peak}$ was confirmed by the achievement of at least 3 of the following criteria: $\dot{V}O_2$ reaching a plateau with increasing work rate, a respiratory exchange ratio above 1.0, heart rate corresponding to 95 % age-predicted maximal values and exhaustion with impossibility to continue despite verbal encouragements.

Ventilatory threshold determination

Two independent and blind reviewers were asked for the individual determination of ventilatory threshold by visual analysis of the breakpoints of ventilator equivalent of carbon dioxide ($\dot{V}_E/\dot{V}CO_2$), ventilator equivalent of oxygen ($\dot{V}_E/\dot{V}CO_2$) and $\dot{V}_E$

changes over time. The first increase of $\dot{V}_E$ with a rapid increase in $\dot{V}_E/\dot{V}CO_2$ and with no concomitant increase in $\dot{V}_E/\dot{V}CO_2$ corresponds to ventilatory threshold [45–47]. The modified V-slope method where $\dot{V}CO_2$ was plotted against $\dot{V}O_2$ was also used to support the estimate of ventilatory threshold by ventilator equivalents [2]. If there was disagreement over the determination of ventilatory threshold, the opinion of a third investigator was obtained.

Statistical analysis

Data for each dependent variable is expressed as mean ± standard deviation. Student's t-tests were used to compare the characteristics of NW and W training sessions. Anthropometric data, resting heart rate, resting blood pressure measurements and parameters obtained during incremental tests to exhaustion were analysed using a 2-way (training modality × time) repeated-measures analysis of variance (ANOVA). For statistically significant analyses of variances, all pairwise comparisons among the groups were tested using Tukey studentized range adjustment. Before using parametric tests, the assumption of normality and sphericity were verified. The alpha level of acceptance for the rate of committing a Type I error was 0.05. Statistical evaluations were carried out with the software package Sigma Stat version 3.5 (St Louis, MO, USA).

Results

▼

All patients enrolled in the study completed the training program, and no adverse events were observed.

Subjects' characteristics

Subjects' characteristics are displayed in **Table 2**. There were no significant differences (P > 0.05) between the NW and W groups for any variables at baseline and end tests. Significant decreases were found among groups at end test for body mass, total skin-fold thickness, body fat and diastolic blood pressure (P value ranging from < 0.001 to 0.045, **Table 2**).

Characteristics of exercise training sessions

Table 3 presents comparisons between NW and W training sessions. Exercise sessions always began and ended with 5–10 min of slow walking. Exercise time (without warm-up and cool-down) averaged 31 ± 7 min and 29 ± 1 min for the NW and W groups, respectively. Mean adherence to the exercise program was significantly higher in the NW group (91 ± 19 %) than in the W group (81 ± 29 %; P = 0.011). Moreover, higher values of mean heart rate (121 ± 10 vs. 107 ± 7 beats per minute for the NW and W groups, respectively; P = 0.021), heart rate at preferred walking speed (120 ± 12 vs. 107 ± 7 beats per minute for NW and W groups, respectively; P = 0.020) and percentage of time spent at high intensity exercise (17 ± 12 vs. 5 ± 3 % for the NW and W groups, respectively; P = 0.031) were observed during NW training sessions compared to W training sessions. Although exercise intensity was higher during NW training sessions than during W training sessions, a trend of a lower RPE during NW training sessions was observed (P = 0.057).

Exercise capacity

Fig. 1 presents the results of the maximal incremental tests performed with and without poles for the NW group and without poles for the W group. Whereas no significant training modality × time interaction was found for Time at ventilatory threshold and absolute $\dot{V}O_{2peak}$ ($L.min^{-1}$), a significant training modality × time interaction was found for maximal time to exhaustion (P = 0.045) and relative $\dot{V}O_{2peak}$ ($ml.min^{-1}.kg^{-1}$) (P = 0.047). For the NW group tested with and without poles and the W group, maximal time to exhaustion reached during halfway and end tests significantly increased compared to maximal time to exhaustion reached during the baseline test (P < 0.05, **Fig. 1a**). Moreover, maximal time to exhaustion during end test in the NW group tested with poles was significantly higher than that of the W group (P = 0.049, **Fig. 1a**). Time at

Variable	Baseline test	End test	Changes NW	P-level	W	P-level
body mass (kg)						
NW	86.1 (15.2)	84.6 (15.3)*	− 1.4	0.036	− 1.8	0.045
W	84.9 (8.32)	83.0 (8.3)*				
BMI (kg/m²)						
NW	34.2 (4.4)	33.7 (4.6)	− 0.5	0.132	− 0.7	0.060
W	32.3 (2.6)	31.6 (2.2)				
total skin-fold thickness (mm)						
NW	95.7 (25.3)	88.6 (18.7)*	− 7.1	0.028	− 8.0	0.020
W	91.4 (17.8)	83.3 (14.2)*				
body fat (%)						
NW	41.5 (3.9)	40.6 (3.1)*	− 0.9	0.039	− 1.2	0.011
W	41.1 (2.8)	39.9 (2.4)*				
heart rate (bpm)						
NW	76 (16)	79 (13)	3	0.428	1	0.428
W	80 (12)	81 (16)				
systolic BP (mmHg)						
NW	139 (15)	136 (12)	− 4	0.085	− 7	0.085
W	136 (13)	129 (12)				
diastolic BP (mmHg)						
NW	86 (9)	79 (8)***	− 7	< 0.001	− 12	< 0.001
W	85 (7)	73 (7)***				

* P < 0.05 and *** P < 0.001, significantly different from the Baseline test

Table 2 Mean (SD) body mass, body mass index (BMI), total skin-fold thickness, percentage body fat, heart rate, systolic and diastolic blood pressure (BP) measurements for the Nordic Walking group (NW) and Walking group (W) at Baseline test and End test.

Table 3 Characteristics of the Nordic Walking (NW) and Walking (W) training sessions.

	NW group	W group	*P-level*
session duration[a] (min), mean (SD)	31 (7)	29 (1)	*0.449*
RPE, mean (SD)	10.98 (1.47)	11.44 (1.78)	*0.057*
adherence[b] (%), mean (SD)	91 (19)*	81 (29)	*0.011*
mean HR (bpm)	121 ± 10*	107 ± 7	*0.021*
HR1'[c] (bpm)	142 ± 7	122 ± 10	*0.267*
HR4'[d] (bpm)	120 ± 12*	107 ± 7	*0.020*
percentage of time at maximal intensity exercise (85–100 % HRR[e])	1	0	*0.089*
percentage of time at high intensity exercise (60–84 % HRR)	17*	5	*0.031*
percentage of time at moderate intensity exercise (40–59 % HRR)	51	44	*0.591*
percentage of time at low intensity exercise (20–39 % HRR)	27	40	*0.197*
percentage of time at very low intensity exercise (0–19 % HRR)	4	11	*0.301*

SD: standard deviation; RPE: rating of perceived exertion; HR: heart rate; bpm: beats per minute; HRR: heart rate reserve; MS: maximal walking speed; PS: preferred walking speed

[a] Without time dedicated to warm-up and cool-down

[b] Adherence to the exercise program was calculated as the number of sessions completed divided by the number of sessions prescribed per week and expressed as a %

[c] Mean heart rate measured during the last 10 s of the 1-min bouts at maximal walking speed

[d] Mean heart rate measured during the 4-min bouts at preferred walking speed

[e] Heart rate reserve calculated from resting heart rate and peak heart rate measured during maximal test to exhaustion

* P < 0.05 significantly different from the Walking group

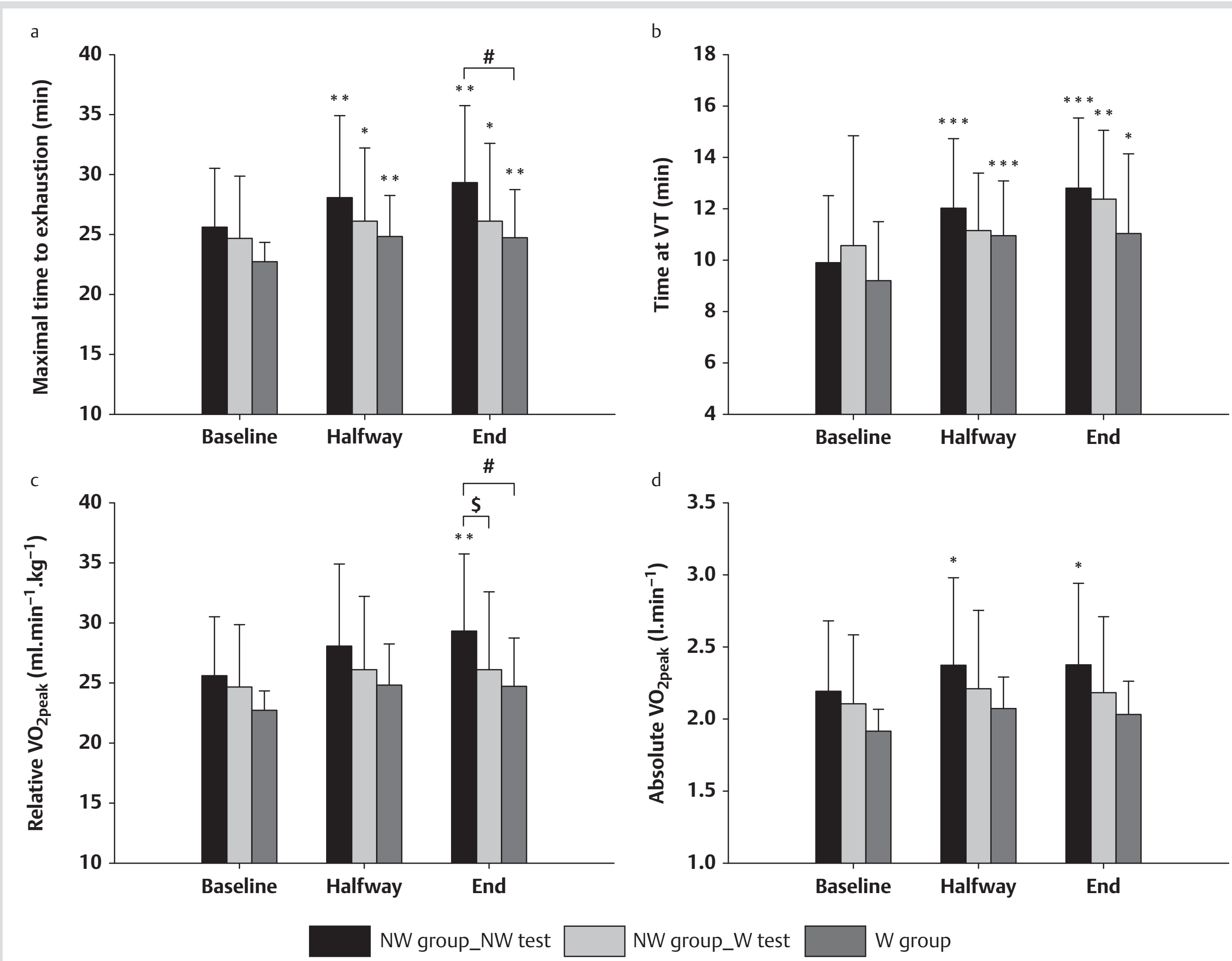

Fig. 1 Maximal time to exhaustion (panel **a**), time at ventilatory threshold (Time at VT, panel **b**) and peak oxygen consumption (relative $\dot{V}O_{2peak}$ (ml.min^{-1}.kg^{-1}) panel **c**; absolute $\dot{V}O_{2peak}$ (L.min^{-1}) panel **d**) measured during incremental test to exhaustion.
* P < 0.05, ** P < 0.01 and *** P < 0.001, significantly different from the baseline test. [#] NW group tested with poles significantly different from the W group at P < 0.05; [$] NW group tested with poles significantly different from the NW group tested without poles at P < 0.05.

ventilatory threshold recorded during halfway and end tests was significantly increased compared to that measured during the baseline test for the NW group tested with poles and the W group ($P<0.05$, ▶ **Fig. 1b**). Time at ventilatory threshold was also increased for NW subjects tested without poles during the end test in comparison with the baseline test ($P<0.01$, ▶ **Fig. 1b**). Relative $\dot{V}O_{2peak}$ ($ml.min^{-1}.kg^{-1}$) significantly increased in the NW group tested with poles between the baseline and end tests (25.8 ± 4.9 vs. $29.5\pm6.4\,ml.min^{-1}.kg^{-1}$, $P=0.005$; ▶ **Fig. 1c**). Furthermore, during the end test, relative $\dot{V}O_{2peak}$ achieved by the NW group tested with poles (29.5 ± 6.4 vs. $24.9\pm4.0\,ml.min^{-1}.kg^{-1}$) was significantly higher than that achieved by the same subjects without poles ($26.27\pm6.5\,ml.min^{-1}.kg^{-1}$, $P=0.048$) and by the W group ($P=0.045$; ▶ **Fig. 1c**). Finally, ▶ **Fig. 1d** shows that absolute $\dot{V}O_{2peak}$ ($L.min^{-1}$) was significantly higher during halfway ($P=0.019$) and end ($P=0.017$) tests in the NW group tested with poles compared to values obtained during the same baseline test.

Discussion

This study was designed to investigate the effects of a NW training program on the physical health and exercise capacity of obese middle-aged women in comparison with a W training program. Our results showed that 12 weeks of 3-weekly either NW or W exercise sessions without dietary intervention elicited an improvement in anthropometric parameters. More interestingly, only the NW training program increased cardiovascular fitness, at the same time significantly increasing adherence rate to the exercise program.

Anthropometric parameters and blood pressure

In the present study, both exercise training modalities (NW and W) caused modest, but significant, decreases in body mass. The effects of physical activity on weight reduction, without a concomitant low-energy diet, are already well-documented (for reviews, see [17,36,37,49]). Our results are in accordance with those described in the meta-analysis of Garrow and Summerbell [17]. Indeed, analysing 28 papers, the authors showed that aerobic exercise without dietary restriction among overweight women elicited a weight loss of 1.4 kg in 12 weeks compared with sedentary controls. The concomitant drop in BMI (not statistically significant in the present study; $-0.5\,kg.m^{-2}$ and $-0.7\,kg.m^{-2}$ for the NW and W groups, respectively), was similar to that described by Wing in 1999 [49]. More recently, Grant et al. [19] reported a significant reduction in body mass (−1.7 kg) and BMI ($-0.6\,kg.m^{-2}$) in overweight middle-aged women after a 12-week exercise program (40 min of aerobic exercises combined with muscular strength, endurance and flexibility exercises, 2 times.week^{-1}). However, in this study, subjects received advice on diet improvement from a practice nurse. Thus, in this case it is difficult to know whether it is really the exercise that produced the weight loss, or whether participants changed their dietary routine, or both.

Additionally, in our study, measurements of body fat using the skin-fold thickness method showed a decreased percentage of body fat in both groups (−0.9% and −1.2% for the NW and W groups, respectively). These findings are in agreement with those of Hagner et al. [21], who demonstrated a significant decrease in total fat mass in postmenopausal obese women after a 12-week, moderate intensity NW program. However, our results must be taken with caution. Indeed, as in the study of Grant et al. [19], we encountered problems with the supra-iliac skin-fold site, such as difficulty in palpating fat-muscle interfaces and in positioning the caliper tips at the appropriate depth. But, despite the existence of limitations in skin-fold caliper use in obese subjects [30] and the presence of more accurate methods of measuring body fat (i.e., hydrostatic weighing), the skin-fold technique was the only method which could be used in our context.

A statistically significant improvement also occurred after the training period in both groups for diastolic blood pressure values (−8% and −12% for the NW and W groups, respectively), whereas no changes were observed for systolic blood pressure. Our findings are in agreement with those of Schjerve et al. [39], who showed that 12 weeks of aerobic endurance training at high (85–95% of maximal heart rate) or moderate intensity (60–70% of maximal heart rate) in healthy obese adults significantly decreased diastolic blood pressure without modifying systolic blood pressure values. Nevertheless and to our knowledge, there is no study dealing with the effect of a NW training program on blood pressure control. Thus, it is important to consider that NW might represent a physical activity able to act on cardiovascular risk factors implicated in metabolic syndrome such as hypertension. However, despite having a significant excess of body weight, subjects included in our experiment were "healthy" at baseline, taking into account the diastolic blood pressure values recorded during the baseline test (< 90 mmHg). Since obesity is usually a condition associated with the development of diastolic dysfunction in the absence of evidence of systolic dysfunction [50], we consider that further investigations are needed to assess the impact of a NW training program in obese hypertensive subjects.

Exercise capacity

Our findings showed that $\dot{V}O_{2peak}$ was significantly higher in the NW group in comparison with the W group after the 12-week training program. The positive effects of a NW exercise program on exercise capacity and fitness have been recently documented but mainly in subjects presenting cardiovascular pathologies (such as peripheral arterial disease) [11,29,32]. To our knowledge, only one study published in 2009 by Hagner et al. [21], has investigated the effect of a 12-week NW training program (three 90-min sessions, heart rate between 100–140 beats per minute) in 53 obese women (62.5 ± 5.43 years). These authors also reported a significant increase in maximal $\dot{V}O_2$ in response to NW administration. The originality of our present work lies in the fact that we compared cardiorespiratory responses to NW training program to those induced by a walking training program. A similar experimental design was conducted by Kukkonen-Harjula et al. in non-obese middle-aged sedentary women [31]. After a 13-week training program, the authors concluded that both training modes (W and NW, four 40-min sessions) similarly improved $\dot{V}O_{2peak}$ values. This discrepancy could be explained by the exercise intensity measured during the training period. In the study of Kukkonen-Harjula et al. [31], in which subjects of both groups were asked to "walk briskly so that breathing is enhanced", the average heart rate was 123 ± 10 beats per minute in the NW group and 120 ± 9 beats per minute in the W group, corresponding to a similar exercise training intensity (54 ± 6% HRR and 52 ± 7% HRR for the NW and W groups, respectively). In our study, all subjects were asked to walk six 4-min + 1-min periods at their individual preferred walking speed and at their individual maximal walking speed, respectively. Mean heart rate reached 51% HRR in our NW group, whereas it reached only 39% HRR in the W group. For a given level of perceived exertion, the increase in cardiopulmonary work when using NW poles in comparison with normal walking is well-documented [16,26–28]. Therefore, we can suppose that the NW technique was not sufficiently mastered by the subjects involved in the study of Kukkonen-Harjula et al. to induce an increase in cardiovascular demand in comparison with normal walking [31]. Indeed, we recently showed that in non-expert, obese middle-aged women, a period spent learning the NW technique, consisting of at least 12 sessions of 45 min each, led to an increase in the difference in cardiovascular demand between NW and W locomotion [16]. In the present study, the increased exercise intensity elicited by NW poles for the same exercise instruction in both groups, could have important clinical implications for obese subjects. Indeed, when following the American College of Sports Medicine recommendations [23], adult subjects should be encouraged to walk briskly for 30 min.day^{-1}, 5 days.week^{-1}. Unfortunately, this aim is often difficult to achieve for obese people, who generally cannot walk far enough or fast enough to provide a sufficient cardiopulmonary exercise stimulus. Moreover, we must underline that the use of NW poles when walking is a beneficial means of enhancing exercise intensity without increasing the sense of exertion. Indeed, RPE values recorded during training sessions were similar in both groups.

Adherence

Although high body weight, BMI and adiposity are currently associated with lower levels of physical activity participation and lower adherence to activity programs [1,44], our findings showed that both training modalities elicited a significant rate of adherence (81 ± 29% and 91 ± 19% for the W and NW groups, respectively). This fact can be explained firstly by the training used. Indeed and as we previously described in the introduction, the efficiency of the interval training program on compliance in overweight or obese subjects has been clearly highlighted [12,25]. Secondly, the elevated rate of adherence observed in our study might be induced by the intensity of the exercise. Since Ekkekakis and Lind [15] demonstrated that obese women (mean age 43 ± 5.4 years) asked to walk at a pace set 10% higher than the pace they would have self-selected themselves reported a significant decline in pleasure, we asked our subjects to walk mainly at their preferred walking speed. The 1-min repetitions at maximal walking speed were certainly imposed but not directly controlled by the investigator, subjects adjusting their walking intensity to achieve a speed that they perceived as "maximal". Finally, it is important to mention that mean adherence rate to the NW program was significantly higher than that observed during the W program. This finding bears evidence of keen interest in a new physical activity never practiced by our subjects before enrolment in the study. After debriefing, subjects verbally declared that NW is clearly tolerable and enjoyable from a psychological perspective. Thereby, in addition to being safe and effective from a physiological standpoint, NW appears to represent a suitable type of exercise for obese people in terms of ensuring long-term adherence.

Conclusion

To conclude, it should be emphasized that the present findings demonstrate that NW could be a useful tool for improving cardiovascular fitness in previously sedentary obese middle-aged women who are usually unable to walk fast enough or long enough for this response to occur. Moreover, to obtain the health benefits of exercise, not only is it important for individuals to initiate a physical activity program, but they must adhere to the program, creating a lifestyle change. In the light of our findings, NW activity clearly seems to meet this criterion.

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