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Original Research

The Cardiorespiratory Response while Nordic Walking vs. Regular Walking Among Middle-Aged to Older Adults

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ABSTRACT

Topics in Exercise Science and Kinesiology Volume 5: Issue 1, Article 6, 2024. Roughly five million deaths worldwide are accounted for by physical inactivity. Furthermore, there is a strong dose-response relationship between physical inactivity and all-cause mortality, cardiovascular health, and metabolic health. Recently, Nordic walking (NW) has been introduced as a mode of exercise where one can increase energy expenditure compared to regular walking (RW) due to increased engagement of upper body musculature using poles while walking. According to established findings, most work has been done in a laboratory which can interrupt natural NW mechanics. Therefore, this study's purpose was to measure the cardiorespiratory and energy expenditure differences in NW and RW in a field setting. Twenty middle-aged and older adults participated in this study. The initial session included Nordic walking familiarization, 10-m gait speed test, and a peak oxygen uptake (VO_2peak) test. The two exercise sessions consisted of either NW or RW on an indoor track for 30-min. All metabolic variables were measured via COSMED K5. A paired-sample *t*-test revealed a significant difference between NW and RW for %VO_2peak values ($p = .008$), kcal · min^{-1} ($p = .005$), and total kcal expenditure ($p = .001$). No significant difference was found for preferred gait speed ($p = .485$) between NW and RW. NW elicited a higher %VO_2peak, kcal · min^{-1}, and total kcal expenditure compared to walking. In turn, this study agrees with previous research and supports the use of NW to increase energy expenditure to potentially improve one's metabolic and cardiovascular health.

KEY WORDS: Nordic poles, aerobic exercise, VO_2peak, energy expenditure, field setting

INTRODUCTION

Hoffman estimated that five chronic diseases accounted for more than two-thirds of all adult-related mortality in the United States: heart disease, cancer, stroke, chronic obstructive pulmonary diseases, and diabetes (7). The U.S. Department of Health and Human Services found that there was a strong dose-response relationship between all-cause mortality, cardiovascular health, and metabolic health with physical activity (15). Therefore, the more doses of physical activity one has, the less likely one is to develop health problems and chronic disease. However, physical inactivity rates in U.S. adults have also increased, a factor that accounts for roughly 5 million deaths worldwide (6). According to the U.S. Department of Health and Human Services, the recommended amount for aerobic physical activity is 30-60-min of moderate intensity exercise per day (15). In fact, walking is one of the most popular forms of physical activity for older adults; however, individuals must walk at a moderate level of effort comparable to their individual fitness level that elicits a noticeable increase in both heart rate and breathing to be classified as moderate intensity (15).

Alternatively, Nordic walking (NW) may be a more appealing form of exercise because one can reach a higher relative intensity due to greater utilization of arms, while walking at a moderate pace. NW is like regular walking (RW), except it has the enhancement of the active use of poles (8). There is a special technique one uses in NW to help propel the body forward, which may increase energy expenditure and positions NW with more health benefits compared to RW. A systematic review done by Tschentscher et al indicated that regarding short- and long-term effects on several factors such as oxygen consumption and quality of life, NW has the same or if not better benefits than brisk walking and is comparable to jogging (14). Despite these dated findings, recent studies by Muollo et al and Terada et al found similar results (9, 12).

However, there is limited research on NW in field settings as most work is done in a laboratory, which can interrupt natural NW mechanics (3). However, two studies were conducted in a field setting and utilized the COSMED K4 portable metabolic analyzer (3, 11). COSMED K4 has been updated to the K5 which has not been used in any recent NW study. Church et al and Schiffer et al both found increases in oxygen consumption but did not account for the cardiorespiratory fitness of the participants. These findings could be controversial as differences in cardiorespiratory fitness may have contributed to the results. Both studies were primarily of a younger age (M = 30.5 years and 44 years, respectively). However, Church et al conducted their walking on an indoor track with a selected distance and Schiffer et al's study performed an incremental field test on an outdoor track.

Due to the paucity of research conducted outside of a laboratory setting, more research in a field setting is needed, especially to promote natural NW mechanics during activity while accounting for cardiorespiratory fitness through a peak oxygen consumption test. Thus, to address this literature gap, the current study's main purpose was to determine differences in cardiorespiratory and energy expenditure responses between NW and RW in a field setting. A second outcome of this study is to measure preferred gait speed between NW and RW. We hypothesized that NW would mimic the laboratory responses of having a higher relative oxygen consumption and energy expenditure within each participant compared to RW at the same speed. We also hypothesize that NW will elicit a higher preferred gait speed due to the extra propulsion forward utilizing poles.

METHODS

Participants

Twenty-five participants (age range: 35 – 75 years) were recruited by word of mouth from a community exercise outreach program offered at the university for this randomized cross-over design study. The descriptive statistics of the participants are displayed in Table 1. Each participant signed an informed consent form along with self-identifying height and sex. Weight was measured using a body impedance analyzer (InBody 770, Seoul, South Korea) and BMI was calculated in usual fashion using height and weight. All participants were physically active, able to engage in ambulatory activity and ranged in familiarity of NW. Each participant signed an informed consent form before participation. The inclusion criteria for participation were participants need to be within an age range of 35-75 years and met the American College of Sports Medicine preparticipation screening process to engage in moderate-intensity activity (15). Participants were excluded from the study if they did not pass the preparticipation screening process. Prior approval to conduct this study was provided by the university's Institutional Review Board.

A priori power analysis was conducted using IBM Statistical Package for Social Sciences (SPSS) software version 28 for sample size estimation based on data from Church et al, which compared NW to RW (3). The effect size in Church et al's study was 0.836, considered to be large using Cohen's *d* criteria. With a significance criterion of $\alpha = 0.05$ and power = 0.95, the minimum sample size needed with this effect size is N = 20. Thus, the obtained sample size of N = 20 is more than adequate to test the study hypothesis.

Table 1. Participant characteristics.

Variable	Combined (n = 20)	Males (n = 10)	Females (n = 10)
Age (years)	60.65 ± 10.90	60.40 ± 12.15	60.90 ± 10.16
Weight (kg)	93.03 ± 19.71	106.01 ± 15.52	80.04 ± 14.31
Height (cm)	171.15 ± 10.22	175.30 ± 10.00	167.00 ± 9.06
BMI ($kg \cdot m^{-2}$)	31.80 ± 6.41	34.68 ± 5.61	28.92 ± 6.06
VO_2peak ($ml \cdot kg^{-1} \cdot min^{-1}$)	28.19 ± 9.31	28.52 ± 5.75	27.86 ± 12.23

Note. Data reported as mean ± SD. BMI = body mass index; VO_2peak = peak oxygen consumption.

Maximal Laboratory Testing Protocol: Every participant went through a peak cardiorespiratory test to obtain their VO_2peak. Peak was chosen over VO_2max due to the targeted population of this study being middle to older adults, which have a higher chance of contraindications making it difficult to reach a plateau in VO_2 with increasing workload (10). Previous research has shown that VO_2peak is a viable measurement for cardiorespiratory fitness and is similar to VO_2max (4). During the test, metabolic gasses and heart rate (HR) were measured using the portable COSMED K5 metabolic analyzer (ParvoMedics CPET, Via dei Piani di Mt. Savello,Italy) and the Polar T31 uncoded heart rate monitor (Bethpage, NY). The COSMED K5 has an intraclass correlation coefficient of 0.76-0.85 and the relationship between devices has a correlation coefficient of r = 0.72-0.82, therefore, the COSMED K5 is ranked good in reliability and validity (5). The K5 was calibrated according to manufacturer recommendations prior to each use and was set at a sampling rate of every 10 seconds. VO_2peak was calculated by averaging the relative VO_2 values of the last minute of the maximal laboratory test.

Regarding protocol, the modified Balke was used, which consisted of 2-min stages with increasing the grade by 2.5% each stage. Speed was maintained the same for the entirety of the test and was selected by the participant in the first stage based on achieving a rating of perceived exertion (RPE) of 11 on the Borg RPE scale. Participants were instructed to walk on the treadmill until they reached maximal effort and the test was terminated at this point. Blood pressure was monitored throughout the test and cool down to ensure no extreme hypertensive or hypotensive responses occurred. Each participant walked at a speed of 1.5 miles per hour at 0% incline after the test until their blood pressure had returned to a normotensive state.

Field Testing Protocol: Each participant went through two field testing days each separated by at least 48-hr to avoid carry over fatigue. Field testing days consisted of the same protocol with the only difference being NW versus RW and was done on a 200-m indoor track. The order in which the participant NW or RW was decided randomly. Every participant was given a NW lesson prior to their NW field test and was given ample time to be deemed as having adequate technique by a researcher. The participants were instructed to exercise for 30-min on the indoor track at their preferred walking pace. Pace was controlled between the NW and RW field test by having two researchers placed on either side of the track instructing the participant to adjust pace if needed. The COSMED K5 (sampling rate = 10 sec) and Polar T31 were used again to measure metabolic gasses and HR continuously. The first 5-min of the exercise sessions were not included in the overall analysis due to participants not being at steady state intensity. The independent variable being controlled for was pace per lap in order to compare NW and RW. The dependent variables measured were %VO_2peak, energy expenditure (total kcals and $kcal \cdot min^{-1}$), steady state HR (SSHR), RPE, and preferred gait speed.

Preferred Gait Speed Test Protocol: A ten-meter gait speed test for NW and RW was used to answer the second outcome of this research. Once the participant developed the correct NW technique, they went through three trials of the 10-m gait speed test. There were two researchers recording the time of the 10-m test and all values were averaged to obtain the preferred gait speed. There were 2-meter markers on either end of the 10 meters for the timers to account for acceleration and deceleration. The same steps were taken to get the preferred gait speed for RW. Participants were instructed for both the RW and NW trials to walk at a preferred pace as if they were taking a leisure walk outdoors.

Statistical Analysis

IBM SPSS software version 28 was used to analyze the data. All data were reported as mean ± SD. A paired sample *t*-test was employed to compare the differences in the dependent variables between NW and RW for the three categories of males, females, and both combined. An alpha level of $p < .05$ was used to determine statistical significance. Cohen's *d* was used to display effect size with 0.2 indicating small, 0.5 indicating medium, and 0.8 indicating large.

The %VO_2peak for NW and RW was calculated by the participant's relative VO_2 averaged during the last 5 minutes of a 30-minute exercise session divided by their VO_2peak and multiplied by 100 to get a percentage. The reason for using %VO_2peak was to account for relative cardiovascular fitness across every participant. The energy expenditure was measured directly by the COSMED K5 and reported in total kcals and kcal · min^{-1}. The preferred gait speed was measured in m · sec^{-1} and was compared across both walking types.

RESULTS

Of the twenty-two participants who volunteered to be a part of this study, two dropped out of the study due to health concerns and personal reasons. As shown in Table 2, the paired sample *t* test indicated that $\%VO_2peak$, caloric expenditure, and total energy expenditure significantly ($p < .05$) increased for the combined and male categories for NW compared to RW (Table 2). Females did not display any main effect comparing NW and RW. (Table 2). Furthermore, no significant ($p > .05$) differences were observed between NW and RW for the 10-m gait speed test, SSHR, RPE values, or pace per lap for all groups. Interestingly, SSHR was on average 6-8 b · min^{-1} higher during NW. Thus, there appeared to be some effect on SSHR due to including more intentional arm movement with NW compared to RW, but the trend was not significant.

Table 2. Physiological Responses to Nordic Walking vs. Regular Walking

Variable	Regular Walking	Nordic Walking	*t* values	*d*	Confidence Interval	
					Low bound	High bound
$\%VO_2peak$ (%)						
Combined	65.67 ± 17.79	72.36 ± 19.30	2.64*	0.59	0.11	1.06
Male	62.25 ± 18.43	70.51 ± 20.40	2.56*	0.81	0.07	1.52
Female	69.10 ± 17.39	74.21 ± 19.05	1.27	0.40	-0.25	1.04
EE (kcal · min^{-1})						
Combined	7.72 ± 2.27	8.31 ± 2.21	2.81*	0.64	0.15	1.11
Male	8.75 ± 2.54	9.50 ± 1.95	2.57*	0.81	0.07	1.52
Female	6.69 ± 1.43	7.71 ± 1.85	1.44	0.46	-0.21	1.10
Total EE (kcal)						
Combined	217.65 ± 62.73	249.75 ± 63.09	3.56*	0.80	0.28	1.29
Male	255.30 ± 19.27	289.40 ± 55.11	3.72*	1.18	0.34	1.98
Female	180.00 ± 38.01	210.10 ± 43.27	1.87	0.59	-0.10	1.25
10-MGT (m · sec^{-1})						
Combined	1.68 ± 0.17	1.68 ± 0.05	-0.04	-0.01	-0.45	0.43
Male	1.67 ± 0.21	1.68 ± 0.25	-0.48	-0.15	-0.77	0.48
Female	1.70 ± 0.12	1.68 ± 0.17	0.42	0.13	-0.49	0.75
SSHR (b · min^{-1})						
Combined	117.45 ± 16.72	124.54 ± 17.11	2.03	0.45	-0.01	0.91
Male	112.74 ± 15.26	120.16 ± 13.47	1.20	0.38	-0.27	1.01
Female	122.16 ± 17.54	128.92 ± 19.85	1.86	0.59	-0.10	1.25
RPE						
Combined	10.81 ± 1.70	11.19 ± 1.82	1.11	0.26	-0.21	0.73
Male	11.06 ± 1.49	11.33 ± 1.12	0.48	0.15	-0.50	0.81
Female	10.56 ± 1.94	11.06 ± 2.40	1.20	0.40	-0.29	1.07
Pace Per Lap (seconds)						
Combined	138.40 ± 16.23	138.85 ± 13.90	0.44	0.10	-0.34	0.54
Male	140.60 ± 17.10	139.90 ± 14.11	-0.42	-0.13	-0.75	0.49
Female	136.20 ± 15.90	137.80 ± 14.36	1.32	0.42	-0.24	1.06

Note. Data reported as mean ± SD. $\%VO_2peak$ = percentage of peak oxygen consumption; Total EE = total energy expenditure; 10-MGT = 10-m gait speed test; SSHR = steady state heart rate; RPE = rating of perceived exertion. $^*p < .05$

DISCUSSION

This study was to determine if differences exist in cardiorespiratory and energy expenditure responses between NW and RW in a field setting. The current study was the first to account for relative differences between NW and RW in peak oxygen consumption determined by peak exercise testing. The primary finding of the current study was that NW resulted in greater $\%VO_2$peak responses, energy expenditure ($kcal \cdot min^{-1}$) and total energy expenditure in middle-aged and older adults. This finding supports the initial hypothesis that NW will be greater to RW regarding these variables. However, a second hypothesis was not supported as NW did not increase preferred gait speed compared to RW.

Similar to the current findings, higher oxygen consumption and energy expenditure for NW compared with RW in the combined category has been reported in other studies (3, 9, 12). However, the current study accounted for cardiorespiratory fitness during exercise by using percentage values of VO_2peak that was measured during peak exercise testing. Church et al and Schiffer et al were the only two studies to have similar field design studies around a track (3, 11). The authors had their participants walk a selected distance; whereas in the current study, participants walked for 30-min (3, 11). This time-based design difference left participants blind to where they would finish while the distance design shows exactly the finishing location. The current study demonstrated how an increase in oxygen consumption would still be observed regardless of time- or distance-based design.

Also, in agreement with Church et al, the current study showed no significant difference in RPE between NW and RW (3). The importance of this finding is that perception of effort was similar between NW and RW at the same pace, but NW led to a greater energy expenditure and $\%VO_2$peak. Practically speaking, if an older adult is limited to walking at a brisk pace, the use of NW could be prescribed to elicit a more effective training response without having to walk faster. Conversely, for an older adult who is already walking at a higher preferred gait speed, the addition of NW poles could produce a greater training response and energy expenditure for reasons of increasing aerobic fitness while meeting other goals such as better weight management and chronic disease prevention. In these scenarios, because perception of effort is similar between both modes of walking, adherence to a higher intensity of exercise (NW) is much more likely leading to longer term health and fitness benefits for the individual. The only difference with RPE, is that participants in the current study reported higher RPE values (10-11 on the 6-20 Borg Scale versus 8-9) when compared to Church et al (3). This finding is likely due to the use of older participants (M = 60.65 versus M = 30.5) who may perceive NW as a harder activity to engage in compared to younger individuals who were likely more aerobically fit.

Additionally, because of the higher relative exercise intensity that accompanies NW, it is also possible to shorten the total time of exercise and achieve similar physiological benefits to RW for a longer period of time. This is also a likely factor impacting exercise adherence as time constraint is a commonly reported barrier to exercise adherence (2, 6, 13). Similar to high-intensity interval training, NW could be introduced to help with exercise adherence to maintain health benefits as it could take less time and possibly be a more enjoyable form of exercise (1).

One major difference between this study and previous literature, is females' had no main effect in oxygen consumption or energy expenditure (2,11). Majority of previous literature analyzed NW groups combining males and females (2, 9, 12) but there are some articles that split the sexes apart (2) or only had female participants (11). Of the published literature that analyzed females alone (2, 11), the sample size was larger compared to this study (n = 11 and 15 versus n = 10). Researchers believe if the sample size (n = 10) were increased, a significant difference would be present in females as it was in previous studies (2, 11). Future research could be warranted in this specific topic.

A review of the current literature showed that the current study was the only one to conduct a 10-m preferred gait speed test with NW and RW. As stated previously, there was no significant difference between preferred gait speed for NW and RW. It was hypothesized that NW would result in faster preferred speeds due to extra propulsion forward while utilizing the poles. Perhaps, a longer distance for the gait speed test would elicit a different result due to more time spent in preferred gait speed. There needs to be more research done on this topic since this is one of the first studies to collect this data.

Limitations and Strengths: The main limitations of the current study were issues with a potential learning effect with NW and use of VO_2peak instead of maximal oxygen consumption (VO_2max). Each participant was familiarized with NW for approximately two to 5-min prior to each session. In the first session, the NW technique was verbally explained and then shown by a researcher. The participant was then asked to practice 1:1 with an undergraduate researcher for at least one lap (200-m) on the track. In either the second or third session, the participant was re-familiarized with NW by repeating the 200-m distance with technique correction as needed. In general, there was high variability in the time needed for participants to attain proper NW technique. Due to time constraints in the data collection periods, some participants had ipsilateral walking patterns or decreased speed and may not have fully mastered proper technique. In future studies, more familiarization with NW for select participants may be warranted. Due to the study's population, the use of VO_2peak was warranted as older adults have a more challenging time reaching true VO_2max criteria due to age and fitness related limitations. Thus, even though VO_2peak may not fully reflect maximal cardiorespiratory fitness, the researchers deemed the use of VO_2peak as a more appropriate reflection of study participants' cardiorespiratory responses to exercise.

The current study also had several strengths, such as using %VO_2peak as a main variable. Using %VO_2peak allows for a more accurate comparison of intensity between the two walking modalities while considering the participants' actual cardiorespiratory fitness levels. Another strength was that exercise was performed on an indoor 200-m track instead of in a laboratory or outdoor setting. This allowed for more control with the measured variables. This study also included older adults along with the more typical middle-aged population. In general, this is the first field study to include older adults in the participant population while collecting expired gas during exercise.

Future Research: For future directions, including the measurement of blood lactate could be employed to study physiological responses to exercise and quantify exercise intensity from a metabolic perspective. This was done in a previous study (11) so would add additional support to those findings. Since the cardiorespiratory responses from NW have been measured using middle-aged and older adults, future studies could be designed to characterize these responses in younger and potentially more aerobically fit adult populations. This would provide more data to compare cardiorespiratory responses to middle-aged and older adult populations.

Conclusion: The main findings of this study were an increase in $\%VO_2$peak and energy expenditure in NW compared to RW at the same pace. Additionally, these responses were observed with no significant differences in RPE values between the walking modalities. Thus, participants had similar perceived levels of exertion despite there being increases in $\%VO_2$peak and energy expenditure. When looking at practical implications of the study, the increased stability provided by the poles may benefit middle-aged and older adults who have limited ambulation. Since it was found that there is no increase in RPE when NW, it is safe to assume individuals can utilize NW poles for assistance when walking. In addition, since NW provides greater caloric expenditure when compared to RW, individuals in a weight management program can burn more calories for a given amount of time.

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