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## Nordic Walking May Safely Increase the Intensity of Exercise Training in Healthy Subjects and in Patients with Chronic Heart Failure

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### Abstract

**Background.** Physical activity in patients with chronic heart failure (HF) improves the exercise capacity and quality of life, and may also reduce mortality and hospitalizations. The greatest benefits are achieved through high-intensity aerobic exercises resulting in a stronger cardiorespiratory response. Nordic walking (NW), a walking technique using two poles and mimicking the movements performed while cross-country skiing, is associated with the involvement of more muscle groups than in the case of classic walking, and should therefore make it possible to increase exercise intensity, resulting in more effective training for patients with HF.

**Objectives.** The aim of the study was to assess the feasibility and safety of the NW technique, and to compare the effort intensity while walking with and without the NW technique in both healthy subjects and in patients with chronic HF.

**Material and Methods.** The study involved 12 healthy individuals (aged  $30 \pm 10$  years, 5 men) and 12 men with stable chronic systolic HF (aged  $63 \pm 11$  years, all categorized in New York Heart Association class II, median LVEF 30%, median peak  $\text{VO}_2$  18.25 mL/kg/min). All the participants completed two randomly assigned submaximal walking tests (one with NW poles and one without) conducted on a level treadmill for 6 min at a constant speed of 5 km/h.

**Results.** Walking with the NW technique was feasible, safe and well tolerated in all subjects. In both the control group and the chronic HF group, walking with the NW technique increased peak  $\text{VO}_2$ , RER, VE, PET  $\text{CO}_2$ , HR and SBP over walking without the poles; and the fatigue grade according to the abridged Borg scale was higher. Dyspnea did not increase significantly with the NW technique.

**Conclusions.** The NW technique can increase the intensity of aerobic training in a safe and well-tolerated way in both healthy individuals and in patients with chronic HF (*Adv Clin Exp Med* 2016, 25, 1, 145–149).

**Key words:** Nordic walking, heart failure, new training concepts, total body workload, high intensity training.

In patients with chronic heart failure (HF), regular physical training improves the exercise capacity and the quality of life, and can reduce mortality and hospitalizations [1–2]. Regular physical effort is therefore a highly recommended standard management in this group of patients.

In accordance with recommendations of scientific associations, all clinically stable patients with heart failure should participate in cardiac rehabilitation programs involving regular physical exercise [1, 3–5]. So far, it has not been determined how to manage physical activities in an optimal

way, how to select the types and forms of physical activity, and how to schedule loads; however, there have been reports indicating that the greatest benefits are achieved with high-intensity aerobic exercises resulting in a more intense cardiorespiratory response [6–8].

In HF patients, regular walking sessions are usually prescribed as an inexpensive, safe and well-tolerated form of exercise. Recently, a new form of aerobic training has been gaining greater popularity – namely Nordic walking (NW), energetic walking supported by two appropriately sized poles [9]. The NW technique mimics the movements performed while cross-country skiing and involves more muscle groups than regular walking performed in a similar way. In NW, in addition to the muscles of the lower extremities and trunk, the muscles of the chest, shoulders and abdomen also take part [10]. The use of the NW technique therefore results in increased effort intensity, and it consequently might be a more effective training method for HF patients than regular walking.

The aim of this study was to assess the feasibility and safety of the NW technique under controlled laboratory conditions and to compare the effort intensity, measured by cardiopulmonary exercise testing, in comparison with standard walking in fit healthy volunteers and in patients with chronic heart failure.

## Material and Methods

The study involved 12 healthy volunteers with high physical performance levels (a mean age of  $30 \pm 10$  years, 5 males) and 12 males with stable systolic chronic heart failure who were being treated at the Outpatient Heart Failure Clinic at the 4<sup>th</sup> Military Hospital in Wrocław, Poland. Table 1 presents the clinical characteristics of the two study groups. All the HF patients were categorized in New York Heart Association (NYHA) class II; their median of peak oxygen consumption (peak  $\text{VO}_2$ ) was 18.25 mL/kg/min. The HF patients in the study were treated in accordance with the recommendations of the European Society of Cardiology [1]. After being enrolled in the study, all the participants were given practical training to familiarize them with the Nordic walking technique.

The Bioethics Committee for Research Studies at the University School of Physical Education in Wrocław approved the study.

All the participants completed two walking tests (one using the NW technique and one involving regular walking) conducted on a mobile treadmill (General Electric, Fairfield, CT, USA) according to a protocol prepared for the purpose

**Table 1.** Clinical characteristics of the healthy controls and the patients with HF

Clinical variable	Healthy controls (n = 12)	HF patients (n = 12)
Age [years]	$30 \pm 10$	$63 \pm 11$
BMI [kg/m <sup>2</sup> ]	$22.3 \pm 1.9$	$27.1 \pm 4.2$
NYHA class II [%]	–	100
Peak $\text{VO}_2$ (mL/kg/mn)	–	18.25
ICD, n	0	11
Ischemic etiology NS, n [%]	–	66
Median LVEF [%]	65	30
Beta-blockers, n [%]	0	100
ACE-I, n [%]	0	95
Statins, n [%]	0	95
ASA, n [%]	0	60
Loop diuretics, n [%]	0	85
Digoxin, n [%]	0	35

**Table 2.** Protocol for treadmill exercise tests

Stages	Protocol for treadmill exercise tests		
	duration (min)	treadmill speed [km/h]	treadmill slope [°]
Rest	5	0	0
Exercise	6	5	0
Recovery	60	0	0

of this study (Table 2). During each walking test a distance of 500 meters was reached. The protocol resembled a 6-min corridor walk test, which is a standard diagnostic tool used in patients with HF, and is usually a well-tolerated form of exercise. During two consecutive cardiopulmonary exercise tests on the mobile treadmill, the following parameters were assessed: ECG (ECG module, General Electric, USA), oxygen consumption ( $\text{VO}_2$ ), carbon dioxide production, respiratory exchange ratio (RER), minute ventilation (VE), partial end-tidal  $\text{CO}_2$  (PET  $\text{CO}_2$ ) (Ultima, Graphics, Medical Graphics Corporation, St Paul, MN, USA) systolic blood arterial pressure (manual sphygmomanometer, Riester, Jungingen, Germany) and heart rate (HR) (Polar heart monitor, Kempele, Finland). The participants' subjective feelings of fatigue and dyspnea related to the task performed were also

assessed, using a simplified 10-point Borg Rating of Perceived Exertion scale. The parameters measured while walking with and without NW poles were compared using the Wilcoxon signed-rank test. A p-value < 0.05 was considered significant.

## Results

All the subjects completed the walking tests with and without NW poles without complications. During and after the tests there were no symptoms of myocardial ischemia, increased effort dyspnea or significant arrhythmia. In the group of patients with HF, walking with the NW technique increased  $\text{VO}_2$ , RER, VE, PET  $\text{CO}_2$ , HR and systolic arterial pressure, in comparison to regular walking, and the fatigue grade according to the abridged Borg scale was higher than after regular walking (Table 3). Similarly, increases in  $\text{VO}_2$ , RER, VE, PET  $\text{CO}_2$ , HR, systolic arterial pressure,

and fatigue level while walking with the NW technique were observed in the healthy subjects. At the same time, dyspnea did not increase significantly in either group.

## Discussion

The results of this study indicate that walking with the NW technique is feasible, safe and well-tolerated both in healthy volunteers and in HF patients. None of study participants exhibited symptoms of increased dyspnea, symptoms of myocardial ischemia, signs of heart failure or significant arrhythmia while walking with the NW poles. Additionally, none of participants complained about discomfort or asked for an earlier end to the test. This is of special importance because aerobic training is effective only if regularly performed for an extended period of time, and with the prescribed effort intensity [11]. Consequently, if any form of physical activity is too burdensome for a patient or is associated with signs or symptoms of significant discomfort, patients will have a negative attitude toward the exercises and will not comply with the recommended training schedule over the long term, which will undoubtedly result in a failure to achieve the expected effects.

Secondly, the results of this study indicate that the NW technique, compared to traditional walking, significantly increases the intensity of effort performed, as expressed by the more intense response of the participants' circulatory and respiratory systems. Although the current European Society of Cardiology recommendations do not establish an optimal form of physical activity that should be implemented as part of cardiac rehabilitation, and many studies in this field recommend continuous training of medium intensity, it seems that training sessions of higher intensity may provide significantly greater benefits [1, 12–14]. There have been reports of significantly better effects on the performance of the circulatory system in the case of high-intensity training than with low- or medium-intensity training, both in healthy volunteers and in patients with ischemic heart disease and HF [7, 8, 15, 16]. Wisloff et al. demonstrated a significant correlation between the type and intensity of aerobic training and achieved therapeutic effects in HF patients [6]. A randomized study with 27 patients with stable systolic HF compared the effects of intense interval training and continuous training of moderate intensity, and demonstrated a greater increase in exercise capacity and greater improvement of vascular endothelial functions and the quality of life in a subgroup of patients subjected to intense training. Beneficial reverse

**Table 3.** Patients with heart failure (#: p < 0.05)

Median change in parameter from baseline to peak during exercise	Walking without poles	Nordic walking
$\text{VO}_2$ [mL/kg/min]	9.2	11.2 <sup>#</sup>
RER	0.04	0.15 <sup>#</sup>
VE [L/min]	22.7	38.5 <sup>#</sup>
PET $\text{CO}_2$	3.6	3.8 <sup>#</sup>
HR [bpm]	41	47 <sup>#</sup>
Systolic BP [mm Hg]	13	23 <sup>#</sup>
Fatigue [Borg scale]	3	5 <sup>#</sup>
Dyspnea [Borg scale]	3	4

**Table 4.** Healthy controls (#: p < 0.05)

Median change in parameter from baseline to peak during exercise	Walking without poles	Nordic walking
$\text{VO}_2$ [mL/kg/min]	9	14.5 <sup>#</sup>
RER	0.03	0.12 <sup>#</sup>
VE [L/min]	14.1	22.4 <sup>#</sup>
PET $\text{CO}_2$ [mm Hg]	2	5 <sup>#</sup>
HR [bpm]	20	49 <sup>#</sup>
Systolic BP [mm Hg]	10	25 <sup>#</sup>
Fatigue [Borg scale]	1	3 <sup>#</sup>
Dyspnea [Borg scale]	1	1

remodeling of the left ventricle was observed only in the group that underwent intense training [6]. This indicates that increasing the intensity of exercises performed as part of a cardiac rehabilitation program may be a good strategy that can increase the beneficial therapeutic effects. The use of the NW technique as part of a cardiac rehabilitation program appears to have specific advantages, as it does not cause any additional load to the muscles of the lower extremities that are usually active while walking, but it involves additional groups of muscles, resulting in more even load distribution on individual muscles, which may translate into good tolerance and safety. This type of physical activity, featuring so-called total body workload and based on the participation of a large number of different muscle groups, can be an optimal way to

achieve higher effort intensity, especially in HF patients who might not tolerate increases in the speed of regular walking, for example.

The Nordic walking technique increased the intensity of aerobic training in a safe and well-tolerated way in both healthy individuals and in patients with chronic heart failure. However the number of patients in the current study was relatively small, and HF subjects were all male, and all in NYHA functional class II. The results of the study should therefore be regarded as preliminary, and need to be confirmed in larger studies comprising more heterogeneous HF populations. Nevertheless, the authors believe that the data presented may contribute important information to current knowledge about cardiac rehabilitation in HF patients.

## References

- [1] **Mc Murray JJV, Adamopoulos S, Anker SD, Auricchio A, Böhm M, Dickstein K, Falk V, Filippatos G, Fonseca C, Gomez-Sanchez MA, Jaarsma T, Køber L, Lip G, Maggioni AP, Parkhomenko A, Pieske BM, Popescu BA, Rønnevik PK, Rutten FH, Schwitter J, Seferovic P, Stepinska J, Trindade PT, Voors AA, Zannad F, Zeiher A:** ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012. *Eur Heart J* 2012, 33, 1787–1847.
- [2] **Ponikowski P, Szelemiej R, Sebzda T:** Skuteczność i bezpieczeństwo rehabilitacji ruchowej u chorych z umiarkowaną i ciężką niewydolnością krążenia. *Kardiologia Polska* 1995, 43, 473–480.
- [3] **Piepoli MF, Conraads V, Corra U, Dickstein K, Francis DP, Jaarsma T, McMurray J, Piotrowicz E, Pieske B, Schmid JP, Anker SD, Solal AC, Filippatos GS, Hoes AW, Gielen S, Giannuzzi P, Ponikowski PP:** Exercise training in heart failure: from theory to practice. A consensus document of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation. *Eur J Heart Fail* 2011, 13, 347–357.
- [4] **Piepoli MF, Corra U, Benzer W, Bjarnason-Wehrens B, Dendale P, Gaita D, McGee H, Mendes M, Niebauer J, Zwisler AD, Schmid JP:** Secondary prevention through cardiac rehabilitation: from knowledge to implementation. A position paper from the Cardiac Rehabilitation Section of the European Association of Cardiovascular Prevention and Rehabilitation. *Eur J Cardiovasc Prev Rehabil* 2010, 17, 1–17.
- [5] **Pina IL, Apstein CS, Balady GJ, Belardinelli R, Chaitman BR, Duscha BD, Fletcher BJ, Fleg JL, Myers JN, Sullivan MJ:** Exercise and heart failure: a statement from the Committee on Exercise, Rehabilitation, and Prevention. *Circulation* 2003, 107, 1210–1225.
- [6] **Wisloff U, Stoylen A, Loennechen JP, Wisloff U, Stoylen A, Loennechen JP, Bruvold M, Rognum O, Haram PM, Tjonna AE, Helgerud J, Slordahl SA, Lee SJ, Videm V, Bye A, Smith GL, Najjar SM, Ellingsen O, Skjaerpe T:** Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study. *Circulation* 2007, 115, 3086–3094.
- [7] **Hambrecht R, Gielen S, Linke A, Fiehn E, Yu J, Walther C, Schoene N, Schuler G:** Effects of exercise training on left ventricular function and peripheral resistance in patients with chronic heart failure: a randomized trial. *JAMA* 2000, 283, 3095–3101.
- [8] **Giannuzzi P, Temporelli PL, Corra U, Tavazzi L:** ELVD-CHF Study Group. Antiremodeling effect of long-term exercise training in patients with stable chronic heart failure: results of the exercise in left ventricular dysfunction and chronic heart failure (ELVD-CHF) trial. *Circulation* 2003, 108, 554–559.
- [9] **Morgulec-Adamowicz N, Marszałek J, Jagustyn P:** Nordic walking – a new form of adapted physical activity (a literature review). *Human Movement* 2011, 12, 124–132.
- [10] **Schiffer T, Knicker A, Montanarella M, Struder HK:** Mechanical and physiological effects of varying pole weights during nordic walking compared to walking. *Eur J Appl Physiol* 2011, 111, 1121–1126.
- [11] **O'Connor CM, Whellan DJ, Lee KL, Keteyian SJ, Cooper LS, Ellis SJ, Leifer ES, Kraus WE, Kitzman DW, Blumenthal JA, Rendall DS, Miller NH, Fleg JL, Schulman KA, McKelvie RS, Zannad F, Pina IL:** Efficacy and safety of exercise training in patients with chronic heart failure: HF-ACTION randomized controlled trial. *JAMA* 2009, 301, 1439–1450.
- [12] **Perk J, De Backer G, Gohlke H, Graham I, Reiner Z, Verschuren M, Albus C, Benlian P, Boysen G, Cifkova R, Deaton C, Ebrahim S, Fisher M, Germano G, Hobbs R, Karadeniz S, Mezzani A, Prescott E, Ryden L, Scherer M, Syvanne M, Sjöström M, Verschuren WJ, Vrints C, Wood D, Zamorano JL, Zannad F:** Europejskie wytyczne dotyczące zapobiegania chorobom serca i naczyń w praktyce klinicznej na 2012 rok. *Kardiologia Polska* 2012, 70, Suppl 1, S1–S100.

- [13] Meyer K, Schwaibold M, Westbrook S, Beneke R, Gornandt L, Lehmann M, Roskamm H: Effects of short-term exercise training and activity restriction on functional capacity in patients with severe chronic congestive heart failure. *Am J Cardiol* 1996, 78, 1017–1022.
- [14] Guiraud T, Nigam A, Gremeaux V, Meyer P, Juneau M, Bosquet L: High-intensity interval training in cardiac rehabilitation. *Sports Med* 2012, 42, 587–605.
- [15] Lee IM, Sesso HD, Oguma T: Relative intensity of physical activity and risk of coronary heart disease. *Circulation* 2003, 107, 1110–1116.
- [16] Rognum O, Hetland E, Helgerud J, Hoff J, Slordahl SA: High intensity aerobic interval exercise is superior to moderate intensity exercise for increasing aerobic capacity in patients with coronary artery disease. *Eur J Cardiovasc Prev Rehabil* 2004, 11, 216–222.

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