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Determining Factors of Physical Performance in an Exercise Stress Test in Women Practicing Nordic Walking

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Abstract

The goal of this research is the Analyse the influence of age, experience and relative fat mass (RFM) on physical performance in women practising Nordic Walking during maximal treadmill exercise testing. The population was formed of 20 women, who underwent a maximum stress test with continuous electrocardiographic recording. The Bruce protocol on the ramp was modified with progressive increases in speed and incline. In addition, we measured their height, weight, and waist. A study of exhaled gases was carried out. Our population has an average RFM of 39.8±2.9. Experience subjects reach higher levels of intensity during the exercise, with a variable speed of 6.4±0.9 km/h, compared to newcomers at 5.6±0.7 km/h ($p<0.05$). We observe that with higher RFM, higher body mass index (BMI) and waist size index, there is a lower oxygen consumption (VO2) and metabolic equivalent (METS) ($p<0.05$). Likewise, a longer time increases both VO2 and METS ($p<0.05$). The results suggest that the indexes and anthropometric relationships RFM, BMI, and waist-size index (WSI) influence performance in women practising Nordic Walking. In addition, previous experience in this discipline is also an influential factor in the intensity of the exercise.

Keywords: *ergospirometry, nordic walking, aerobic resistance, older women*

Introduction

Nordic Walking (NW) is a relatively new activity, which originated in Finland in 1930; since then, different investigations have been carried out on its characteristics and benefits (Jódar-Reverte, 2019).

This activity consists of walking with canes specifically designed for this activity; it involves working both the upper and lower part of the body, respecting the joint alignment and reducing the impact on the joints (Padulo et al., 2018). Unlike the usual gait, in NW, the gait of an upright position is adopted; the individual is tilted slightly forward, also requiring counter-lateral hand/foot coordination (Pérez-Soriano et al., 2014). Likewise, it involves the active participation of the upper limbs that exert the necessary force to contribute to the displacement, in this way, the movement ranges of the joints are much greater than in conventional walking (Song, Yoo, Choi, & Kim, 2012).

The Spanish Federation of Mountain and Climbing Sports (FEDME) states that it is a dynamic and rhythmic activity that can be suitable for everyone. According to the regulations of the FEDME, competitions are usually made on routes with a length between 10 and 42 km (FEDME, 2019). Thus, due to the type of exercise that is performed, the duration of its sessions and the predominant metabolic characteristics, it can be considered an aerobic endurance sport (Tschentscher, Niederseer, & Niebauer, 2013).

Therefore, the performance of a stress test in laboratory conditions is adequate for the objective assessment of its participants regarding both health and performance (Geevar-Zachariah & Anoop, 2017). This test examines the

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response of the heart to physical exercise; electrocardiographic analysis (Balady et al., 2010) is used for the diagnosis, monitoring and prevention of ischemic heart disease (McSweeney et al., 2016) and monitoring the performance of athletes (Ronconi & Alvero-Cruz, 2011). In addition, by incorporating spirometric analysis, through the study of respiratory gases, these practitioners will obtain information on the adaptation to exercise that can be evaluated regarding the performance and planning of training (Arós et al., 2000). In this manner, the data obtained in performing the ergospirometric test can be modified in order to develop or adapt the training plans to the physical capabilities of each individual (Mezzani, 2017).

In the literature referring to Nordic walking, studies that evaluate the influence of training programmes in NW in order to improve health stand out. These have been performed in specific populations, such as people with diabetes (B. Gram, R. Christensen, C. Christiansen, & J. Gram, 2010), hypertension (Launois et al., 2018), overweight or obesity (Hagner-Derengowska et al., 2015) or Parkinson's disease (Monteiro et al., 2017), among others. Most authors agree that NW is a relatively easy activity and that it can be used to counteract the negative aspects associated with inactivity, thus helping to maintain subjects' optimal performance (Mansour, Gorce, & Rezzoug, 2018). Among the subjects, we do not find references that separate the population according to age, experience (experienced and novices) and relative fat mass that could be useful for adapting different training plans according to the responses of these athletes to exercise.

The purpose of this research is to analyse the influence of age, experience and relative fat mass (RFM) on physical performance in women practising Nordic Walking during maximal treadmill exercise testing.

Methods

Subjects

The population was formed of 20 women with a mean age of 50.6±5.1 years. Participants voluntarily registered through an agreement with the Mountaineering Federation of the Region of Murcia. Women over 40 years were included, excluding those who, due to illness, alteration and/or injury, were unable to perform the stress test. Prior to the data collection, participants were informed of the objectives and procedures of the study, all of them signed the corresponding informed consent document. The study was conducted in accordance with the Declaration of Helsinki and also has the approval of the Research Ethics Commission.

Design

This is an observational, descriptive study. Each participant had the following evaluation. After anthropometric measurements (weight, height and waist and hip contours) and baseline cardiovascular examination (history, auscultation, blood pressure and resting electrocardiogram), each woman underwent a maximum stress test on a Run model treadmill 7411 (Runner®) with the continuous recording of the 12 standard electrocardiogram leads (Cardioline® electrocardiograph, Click ECG model) and blood pressure every two minutes (Metronik BL-6®). The study of exhaled gases, maximum oxygen consumption, respiratory ratio and maximum ventilation was carried out using the Cortex Metalyzer® 3 B gas analyser.

A modified Bruce protocol was used on the ramp; the test began with a speed of 1.9 km/hour, and the slope and/or speed were progressively increased (Will et al., 1999). During this, the heart rate was recorded every minute and the blood pressure every two minutes, and at 1, 3 and 5 minutes of recovery. The test ended when each woman reached the maximum capacity and indicated this by raising her arm; at that time, the recovery period began. Similarly, the reason for the end of the test was noted. To establish the maximality of the test, it is verified that 1.1 is exceeded in the respiratory exchange ratio and 85% of the maximum expected heart rate for the age of the subject.

Statistical analysis

The SPSS version 24 software was used. Quantitative variables are presented using their mean and standard deviation and qualitative variables with their absolute frequencies and percentages. Furthermore, the normality of the distributions with the Shapiro Wilk test was determined, and the Wilcoxon traits test was used to establish the differences between related samples. Likewise, the Mann Whitney U test has been used for two independent samples. The relationship between quantitative variables was made with the Pearson correlation. The analyses were performed with a 95% confidence interval and $p \leq 0.05$. The body mass index (BMI) has been obtained from the classic formula (body mass/squared size), the waist-size index (WSI) (waist circumference/height) and the relative fat mass (RFM) by the procedure of Woolcott and Bergman (2018), from the height and waist circumference, using the equation adjusted according to gender.

Results

The following table shows the general characteristics of the population (Table 1).

Table 1. General characteristics of the population

Age (years)	50.6±5.1
Previous experience in NW (years)	3.25±3.95
Height (cm)	163.87±5.02
Weight (Kg)	67.49±10.19
Waist (cm)	91.12±9.54
Hip (cm)	103.02±7.93
BMI (Kg/m^2)	25.11±3.24
WSI	0.55±0.05
RFM (%)	39.72±3.40

Legend: NW - Nordic Walking; BMI – Body Mass Index; WSI - Waist-Size index; RFM - Relative Fat Mass

Likewise, we divided women according to previous experience in Nordic Walking, considering experienced subjects those who had a year or more of experience. Table 2 shows the anthropometric characteristics according to the level of experience.

Table 2. Anthropometric characteristics according to experience

		Veterans (n=8)	Newcomers (n=12)	p
Age (years)	49.7±6.2	51.1±4.3	0.057	0.057
Height (cm)	162.60±4.33	164.71±5.43	0.369	0.369
Weight (Kg)	67.66±6.71	67.38±12.26	0.954	0.954
Waist (cm)	91.93±6.21	90.58±11.47	0.765	0.765
Hip (cm)	102.68±4.57	103.25±9.75	0.881	0.881
BMI (Kg/m^2)	25.60±2.28	24.79±3.80	0.598	0.598
WSI	0.53±0.04	0.55±0.05	0.254	0.254
RFM (%)	40.48±2.60	39.20±3.85	0.424	0.424

The clinical, electrical, and hemodynamic responses during the stress test were normal in all participants. Likewise, resting electrocardiographic traces showed no alterations. Table 3 details the ergospirometric values obtained in the maximum effort of veteran and novice women. We note that experienced women had slightly higher intensity, yet still show no significant differences.

Table 3. Ergospirometric characteristics according to experience

	Veterans	Newcomers	t	Sig.	U
Speed (Km/h)	6.48±0.93	5.66±0.75	2.11	0.05	75.00
Duration (min)	10.94±2.15	9.18±1.62	2.04	0.057	109.00
VO2 (ml/kg/min)	27.13±2.59	24.91±3.67	1.46	0.163	177.00
METS	9.52±0.87	9.81±1.43	1.68	0.341	103.00

Table 4 shows the correlation between the different anthropometric variables and ergospirometric variables. In this way, we observe a significant relationship between the relative fat mass and the body mass indexes and waist size index, these being higher when the relative fat mass is higher. Likewise, we observe that the higher the relative fat mass, the lower the consumption of oxygen and metabolic index.

Table 4. Anthropometric and ergospirometric data correlation

		Age	BMI	WSI	RFM	Duration	VO2	METS
BMI	Pearson correlation	-0.076	1.000	0.871**	0.847**	-0.088	-0.740**	-0.740**
	p	0.749		0.000	0.000	0.721	0.000	0.000
WSI	Pearson correlation	0.191	0.871**	1.000	0.992**	-0.237	-0.708**	-0.708**
	p	0.420	0.000		0.000	0.329	0.001	0.001
RFM	Pearson correlation	0.232	0.847**	0.992**	1.000	-0.232	-0.697**	-0.697**
	p	0.325	0.000	0.000		0.339	0.001	0.001

Discussion

The objective of this study was to analyse the influence of age, experience and relative fat mass (RFM) on physical performance in women who practice Nordic Walking during the maximum treadmill exercise test. The results indicated that experienced women reached slightly greater intensity during the stress test without showing specific differences. In addition, we observe that the different anthropometric indices affect the performance of the participants.

Previous studies analysed aspects related to Nordic walking on populations similar to ours: middle-aged women (Cebula et al., 2017; Pilch et al., 2018) and with a number of similar or lower subjects (Sprod, Drum, Bentz, Carter, & Schneider, 2005; Strombeck, Theander, & Jacobsson, 2007). In our study, we only consider the participation of those who have the characteristic profile of the Nordic walking practitioner and who are middle-aged women (Martínez-Lemos, 2013).

Regarding the anthropometric characteristics of our population, they correspond to the data obtained from the Spanish population in recent years (Rodríguez-Rodríguez, López-Plaza, López-Sobaler, & Ortega, 2011; Jiménez-Talamantes, Rizk-Hernández, & Quiles-Izquierdo, 2017). In relation to the calculation of relative fat mass, the values provided by their researchers are consistent with those obtained in our population (Woolcott & Bergman, 2018).

We have taken into account previous experience in the practice of Nordic walking by dividing our population into veterans and newcomers; this separation has not been seen in the literature cited referring to the practice of this discipline (Perrey & Fabre, 2008; Grainer et al., 2017). This division has been considered since a previous level of experience may cause changes not to occur or be slight due to the habit of exercising.

Our results show that experienced women reach slightly greater intensity during the stress test, without finding signif-

icant differences, which may be because the stress tests were carried out at the beginning of the season after a period of rest, which could lead to veteran women disabling the exercise. Likewise, they show that various anthropometric indices influence the performance of the participants, reaching lower oxygen consumption and metabolic index when the physical condition is worse.

One of the main limitations of this study lies in the small sample size; however we must consider that we have studied all women who practice Nordic walking in an organized way of the city of Murcia, aged between 40 and 65 years. We consider another limitation to be that the stress tests were carried out at the beginning of the season, which could cause no differences between the two groups.

Regarding practical applicability, we consider that the data provided by this study allow the individual situation of each athlete to be assessed in order to adapt the intensity of the exercise according to their needs. Likewise, if the stress test were repeated at the end of each season, we would obtain information on the effects that this type of long-term training produces.

The results suggest that the indexes and anthropometric relationships RFM, BMI and WSI influence performance in women practising Nordic Walking. In addition, previous experience in this discipline is also an influential factor in the intensity of the exercise.

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Conflict of Interest
The authors declare that there is no conflict of interest.

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References

Arós, F., Boraita, A., Alegría, E., Alonso, Á.M., Bardají, A., Lamiel, R., … Wilke, M. (2000). Guías de práctica clínica de la Sociedad Española de Cardiología en pruebas de esfuerzo. *Rev Esp Cardiol, 53*, 1063-1094.

Balady, G.J., Arena, R., Sietsema, K., Myers, J., Coke, L., Fletcher, G.F., … Milani, R.V. (2010). Clinician's Guide to Cardiopulmonary Exercise Testing in Adults A Scientific Statement From the American Heart Association. *Circulation, 122*, 191-225. https://doi.org/10.1161/CIR.0b013e3181e52e69

Cebula, A., Tyka, A.K., Pilch, W., Szyguła, Z., Pałka, T., Sztafa-Cabała, K., Frączek, B., & Tyka, A. (2017). Effects of 6-week Nordic walking training on body composition and antioxidant status for women > 55 years of age. *International journal of occupational medicine and environmental health*, *30*(3), 445–454. https://doi.org/10.13075/ijomeh.1896.00860.

Federación Española de Deportes de Montaña y Escalada. (2018) Reglamento de competiciones de marcha nórdica. Retrieved 03/11/2019, from www.fedme.es/salaprensa/upfiles/1535_F_es.pdf

Geevar-Zachariah, M.D., & Anoop, G.A. (2017) Exercise for Prevention of Cardiovascular Disease: Evidencebased Recommendations. *J Clin Prev Cardiol*, *6*, 109-14.

Grainer, A., Zerbini, L., Reggiani, C., Marcolin, G., Steele, J., Pavei, G., & Paoli, A. (2017). Physiological and Perceptual Responses to Nordic Walking in a Natural Mountain Environment. *International journal of environmental research and public health*, *14*(10), 1235. https://doi.org/10.3390/ijerph14101235

Gram, B., Christensen, R., Christiansen, C., & Gram, J. (2010). Effects of nordic walking and exercise in type 2 diabetes mellitus: a randomized controlled trial. *Clin J Sport Med, 20*(5), 355-361.

Hagner-Derengowska, M., Kałużny, K., Kochański, B., Hagner, W., Borkowska, A., Czamara, A., & Budzyński, J. (2015). Effects of Nordic Walking and Pilates exercise programs on blood glucose and lipid profile in overweight and obese postmenopausal women in an experimental, nonrandomized, open-label, prospective controlled trial. *Menopause (New York, N.Y.)*, *22*(11), 1215–1223. https://doi.org/10.1097/GME.0000000000000446

Jiménez-Talamantes, R., Rizk-Hernández J., & Quiles-Izquierdo, J. (2017). Diferencias entre la prevalencia de obesidad y exceso de peso estimadas con datos declarados o por medición directa en adultos de la Comunidad Valenciana. *Nutr Hosp, 34*(1), 128-33.

Jódar-Reverte, M. (2019). *Estudio antropométrico y funcional de adultos mayores practicantes de marcha nórdica.* Tesis doctoral no publicada. Murcia. Universidad de Murcia.

Launois, P., Khoudeir, A., Pujol, V., García, N., Fargas, J., Mena, J., Gines, A., Espinel, E., & Gómez-Garrido, A. (2018). Does Nordic walking helps to improve exercise capacity and weight control in patients with resistant hypertension? *Ann Phys Rehabil Med, 61*, 276-83. https://doi.org/10.1016/j.rehab.2018.05.644

Mansour, B., Gorce, P., & Rezzoug, N. (2018). The impact of Nordic walking training on the gait of the elderly. *J Sports Sci, 36*(20), 2368–74.

Martínez-Lemos, R.I. (2013). Análisis del perfil de usuario de un centro Nordic walking que incorpora las nuevas tendencias en el wellness. *Eur J of Hum Mov, 30*, 73-84.

McSweeney, J.C., Rosenfeld, A.G., Chair, V., Abel, W.M., Braun, L.T., Burke, L.E., ... Reckelhoff, J.F. (2016). Preventing and Experiencing Ischemic Heart Disease as a Woman: State of the Science A Scientific Statement From the American Heart Association. *Aha Scientific Statement, 133*, 1302-133. https://doi.org/10.1161/CIR.0000000000000381

Mezzani A. (2017) Cardiopulmonary Exercise Testing: Basics of Methodology and Measurements. *AnnalsATS, 14*(1), 3-11.

Monteiro, E. P., Franzoni, L. T., Cubillos, D. M., de Oliveira Fagundes, A., Carvalho, A. R., Oliveira, H. B., Pantoja, P. D., Schuch, F. B., Rieder, C. R., Martinez, F. G., & Peyré-Tartaruga, L. A. (2017). Effects of Nordic walking training on functional parameters in Parkinson's disease: a randomized controlled clinical trial. *Scandinavian journal of medicine & science in sports*, *27*(3), 351–358. https://doi.org/10.1111/sms.12652

Padulo, J., Luliano, E., Dello Iacono, A., Milić, M., Rizzi, M., & Ardigò, LP. (2018). Nordic walking versus natural walking: an easy approach to comparing metabolic demands. *Int J of Perf Analy in Sport*, *18*(5), 686-692.

Pérez-Soriano, P., Encarnación-Martínez, A., Aparicio-Aparicio, I., Giménez, JV., & Llana-Belloch, S. (2014). Nordic walking: a systematic review. *Eur J Hum Mov, 33*, 26–45.

Perrey, S., & Fabre, N. (2008). Exertion during Uphill, Level and Downhill Walking With and Without Hiking Poles. *J Spots Sci Med, 7*(1), 32-8.

Pilch, W., Tota, L., Piotrowska, A., Śliwicka, E., Czerwińska-Ledwig, O., Zuziak, R., Pilaczyńska-& Szcześniak, L. (2018). Effects of nordic walking on oxidant and antioxidant status: levels of calcidiol and proinflammatory cytokines in middle-aged women. *Oxid Med Cell Longev,* 1–6. doi:10.1155/2018/6468234.

Rodríguez-Rodríguez, E., López-Plaza, B., López-Sobaler, A.M., & Ortega, R.M. (2011). Prevalencia de sobrepeso y obesidad en adultos españoles. *Nutr Hosp, 26*(2), 355-63.

Ronconi, M., & Alvero-Cruz, J.R. (2011). Respuesta de la frecuencia cardíaca y consumo de oxígeno de atletas varones en competiciones de duatlón sprint. *Apunts Med l'Esport, 46*(172), 183–8.

Song, M.S., Yoo, Y.K., Choi, C.H., & Kim, N.C. (2012). Effects of nordic walking on body composition, muscle strength, and lipid profile in elderly women. *Asian Nurs Res, 7*(1), 1–7.

Sprod, L.K., Drum, S.N., Bentz, A.T., Carter, S.D., & Schneider, C.M. (2005). The Effects of Walking Poles on Shoulder Function in Breast Cancer Survivors. *Integr Cancer Ther, 4*(4), 287–93.

Strombeck, B.E., Theander, E., Jacobsson, L.T.H. (2007). Effects of exercise on aerobic capacity and fatigue in women with primary Sjogren's syndrome. *Rheumatology. Oxford University Press, 46*(5), 868–71.

Tschentscher, M., Niederseer, D., & Niebauer, J. (2013). Health benefits of nordic walking: A systematic review. *Am J Prev Med, 44*(1), 76–84.

Woolcott, O.O., & Bergman, R.N. (2018). Relative fat mass (RFM) as a new estimator of whole-body fat percentage - A cross-sectional study in American adult individuals. *Sci Rep, 8*(1), 1–11.