DYNAMICS OF AEROBIC CAPACITY AS A RESULT OF A REGULAR TRAINING PROCESS IN FEMALE DANCERS

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ABSTRACT
Maximal oxygen consumption ($VO2_{max}$) is a key indicator of the body's aerobic capacity, reflecting the efficiency of the cardiovascular and respiratory systems during intense physical activity. Despite the limited number of published studies on $VO2_{max}$ in female dancers, existing research confirms that regular dance sport practice contributes to an increase in functional aerobic capacity and overall health optimization. The aim of this study was to determine changes in maximal oxygen consumption and functional work capacity in female dancers practicing dancesport following a planned four-month training program. The study subjects were ten advanced amateur female dancers from a dancesport club team affiliated with the Bulgarian Dance Sport Club Federation. They conducted two maximal treadmill exercise tests, separated by four months. During the four months, the dancers followed a training regimen consisting of 90-minute sessions with moderate-intensity loads, three times per week. We analyzed the obtained values of maximal oxygen consumption ($VO2_{max}$, $VO2_{max}$/kg), maximal lactate concentration (La_{max}), maximal heart rate (HR_{max}), maximal oxygen pulse ($VO2_{max}/HR_{max}$), and the highest treadmill speed achieved (S_{max}). The results revealed a significant increase in average $VO2_{max}$ (11%), $VO2_{max}$/kg (7.4%), S_{max} (9.4%), and $VO2_{max}/HR_{max}$ (13.3%) during the second test compared to the first one. These improvements were accompanied by a significant decrease in La_{max} (average reduction of 8.9%). Based on the observed significant increases in $VO2_{max}$, $VO2_{max}$/kg, and $VO2_{max}/HR_{max}$, it can be concluded that the implemented training program over the four-month period contributed to a substantial enhancement in the subjects' aerobic capacity.

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INTRODUCTION

Modern dynamic lifestyle in large urban centers motivates many individuals in young and middle adulthood to engage in dancesport activities with the aim of reducing psychoemotional stress levels, maintaining optimal body mass, improving cardiorespiratory fitness, and enhancing overall physical conditioning. In this context, regular participation in dancesport is viewed as an opportunity to engage in health-promoting physical activity and maintain a healthy lifestyle (Tiemens et al., 2023). The increasing interest among young people in improving their quality of life through diversifying their routine physical activity, along with the availability of numerous clubs specializing in organizing dancesport activities, also contributes to the high popularity of this sport. Standard dances (European style) and Latin American dances are the internationally recognized categories within the sport of dancesport (Pilar et al., 2020). Regardless of the specific technical characteristics of the individual dance styles within these categories, experts emphasize that the motor activity performed in dancesport involves a dynamic functional load on the cardiorespiratory system and skeletal musculature (Bria et al., 2011).

The American College of Sports Medicine emphasizes that cardiorespiratory fitness is directly dependent on the efficiency of the respiratory and cardiovascular systems, and is considered a fundamental component of an individual's physical work capacity (Pescatello et al., 2014). It is well established that prolonged moderate-intensity physical activity stimulates respiratory and cardiovascular functions, as well as tissue-level metabolic processes, leading to improved cardiorespiratory functional capacity. From a methodological perspective, it is widely accepted that, due to the dependence of cellular aerobic processes on the available oxygen supply, maximal oxygen consumption ($VO2_{max}$) is a primary quantitative criterion for assessing cardiorespiratory fitness (Kenney et al., 2011; McArdle et al., 2009). In accordance with this methodological approach, McCord et al. (1989) report that regular participation in dancesport leads to a significant improvement in cardiorespiratory fitness, as evidenced by increased levels of dancers' maximal oxygen consumption. In line with this methodological approach, the researchers comment that regular participation in dancesport leads to a significant improvement in cardiorespiratory fitness, resulting in an increase in the recorded values of the dancers' maximal oxygen consumption (Liiv et al., 2013; McCord et al., 1989). In this context, Bria et al. (2011) emphasize that the motor activity involved in competitive dances requires substantial functional engagement of the cardiorespiratory system and skeletal musculature. They conclude that the intense physical exertion characteristic of the dynamic movements in dancesport contributes to improvements in athletes' aerobic capacity and increased maximal oxygen consumption. This finding aligns with Redding and Wyon's (2003) conclusion that the high functional capacity of competitive dancers is a crucial factor for optimal performance in dance sport competitions.

Despite the widespread non-professional practice of various dance styles in modern society, there is a limited number of scientific studies investigating the dynamic changes in the body's functional aerobic capacity resulting from participation in organized dancesport activities. This observation motivated us to conduct the present research, which aims to examine the effect of a structured dance sport training program on the aerobic capacity of advanced amateur female dancers. ***The present research aims*** to investigate changes in maximal oxygen consumption and functional work capacity in female dancers practicing dancesport following a planned four-month training program.

METHODS

The subjects of the study were ten advanced amateur female dancers (mean age, 22.4 ± 2.38 years) from a dance sport club affiliated with the Bulgarian Dance Sport Club Federation. The dancers had a mean training experience of 2.6 ± 1.5 years. All were healthy and injury-free. Prior to participation, all subjects were familiarized with the experimental procedure and informed of the risks associated with performing maximal treadmill exercise tests. All subjects provided written informed consent. The female dancers performed two maximal incremental tests on a treadmill (Quasar 4.0 Med; HP Cosmos, Germany), conducted four months apart. A stepwise exercise protocol was applied, starting at 6.0 km/h and increasing by 1.2 km/h every 90 seconds at a constant elevation of 2.5%, until volitional exhaustion was reached (Iliev, 1974). Respiratory parameters and electrocardiographic characteristics were recorded using a precisely calibrated Oxycon Pro cardio-pulmonary testing device (Erich Jaeger, GmbH & Co., Wuerzburg, Germany). Following the exercise test, capillary blood lactate concentration was measured from earlobe samples using a calibrated HP Cosmos Sirius lactate analyzer. Samples were collected immediately after exercise and at 3, 7, and 10 minutes of recovery to determine the maximal lactate concentration. During the four months between the two tests, each dancer followed a training regimen consisting of 90-minute sessions, three times per week. Training sessions involved both Standard and Latin dances, with a moderate-intensity training load. The subjects reported that in addition to dancesport-specific training, they occasionally (1–2 times per month) engaged in moderate-intensity aerobic activities such as jogging or hiking during weekends.

We analyzed the obtained values of maximal oxygen consumption ($VO2_{max}$), maximal lactate concentration (La_{max}), maximal heart rate (HR_{max}), maximal oxygen pulse ($VO2_{max}/HR_{max}$), and the highest treadmill speed achieved (S_{max}). Relative values for maximal oxygen consumption ($VO2_{max}$/kg) were also calculated, expressed as the ratio of absolute values to each dancer's body weight. Student's t-test was performed to analyze the values of S_{max}, $VO2_{max}$, $VO2_{max}$/kg, La_{max}, HR_{max}, and $VO2_{max}/HR_{max}$ recorded during the two exercise tests. The normality of the data distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Differences between dependent variables were analyzed using paired Student's t-tests at a standard significance level ($p < .05$) to determine statistically significant differences between two related sets of values, such as measurements taken from the same participants at different time points (Stehlik-Barry & Babinec, 2017). Mean values and standard deviations were calculated, and significance levels were determined to assess the statistical significance of the observed differences. All analyses were performed using SPSS Statistics version 17.0 and GraphPad Prism 5.0.

RESULTS

It was established that the measured $HR_{max\ (real)}$ values did not differ significantly from the theoretically estimated HR_{max} (HR_{max}(theoretical) = 208 – (0.7 × age)) (Tanaka et al. 2001). Furthermore, high maximal lactate values (La_{max} (first test) = 12.4 mmol/L; La_{max} (second test) = 11.3

mmol/L) were recorded in both tests. Therefore, all examined female dancers performed an objectively verified maximal effort, and maximal oxygen consumption was reached. The assessment of the distribution of differences between dependent variables using the Kolmogorov-Smirnov and Shapiro-Wilk tests confirmed normality. Accordingly, the paired Student's *t*-test was applied to evaluate these differences. The conducted Student's *t*-test for dependent variables revealed a significant increase in the mean values of Smax, VO_2max, VO_2max/kg, and VO_2max/HRmax, and a significant decrease in the mean values of Lamax during the second test compared to the first (Table 1).

Table 1. *Mean values of key anthropometric and functional parameters during the two exercise tests (n = 10).*

Parameter	*Mean values recorded during the first exercise test (Mean ± SD)*	*Mean values recorded during the second exercise test (Mean ± SD)*	*Difference between mean values of the recorded parameters during the two tests*
Height (cm)	159.6 ± 4.12	160.7 ± 4.26	1.1 (0.7%)
Weight (kg)	50.28 ± 9.15	52.01± 9.43	1.7 (3.4%)
S max (km/h)	12.8 ± 1.4	14.0 ± 1.1	1.2* (9.4%)
VO_2max (ml/min)	2449.0 ± 317.0	2718.0 ± 443.0	269.0* (10.9%)
VO_2max/kg(ml/kg/min)	48.71 ± 5.29	52.26 ± 5.91	3.6* (7.4%)
VO_2max/HRmax (ml/	12.86 ± 0.85	14.57 ± 1.11	1.71* (13.3%)
La max (mmol/L)	12.4 ± 2.1	11.3 ± 1.8	-1.1* (8.9%)

(– indicates a statistically significant difference)*

A significant increase in both the absolute and relative mean values of the recorded maximal oxygen consumption was observed during the second test (VO_2max (first test) – VO_2max (second test) = 269.0 ml/min (p < .05); VO_2max/kg (first test) – VO_2max/kg (second test) = 3.6 ml/kg/min (p < .05)) (Figure 1).

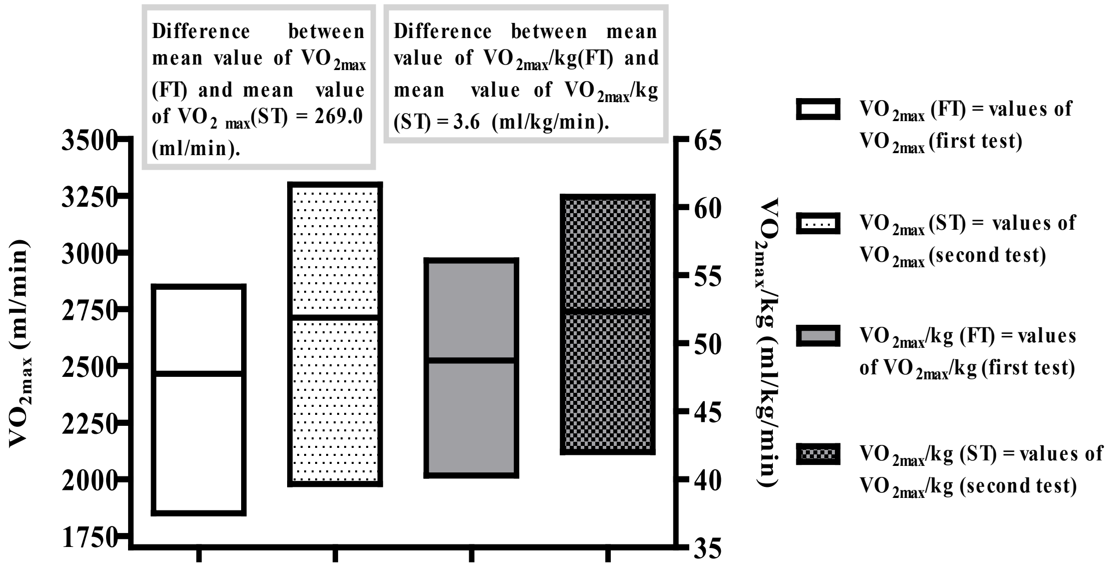

Figure 1. *Values of $VO2_{max}$ and $VO2_{max}$/kg registered during the two exercise tests.*

The positive changes in S_{max} and $VO2_{max}/HR_{max}$ provide additional evidence that during the second test, the subjects had significantly higher functional work capacity. It can be reasonably assumed that the observed increase in VO_2max and VO_2max/kg represents a key functional prerequisite for the improvement in maximal physical work capacity, demonstrated by the higher treadmill speed (Smax (first test) – Smax (second test) = 1.2 km/h (p < .05)) (Figure 2).

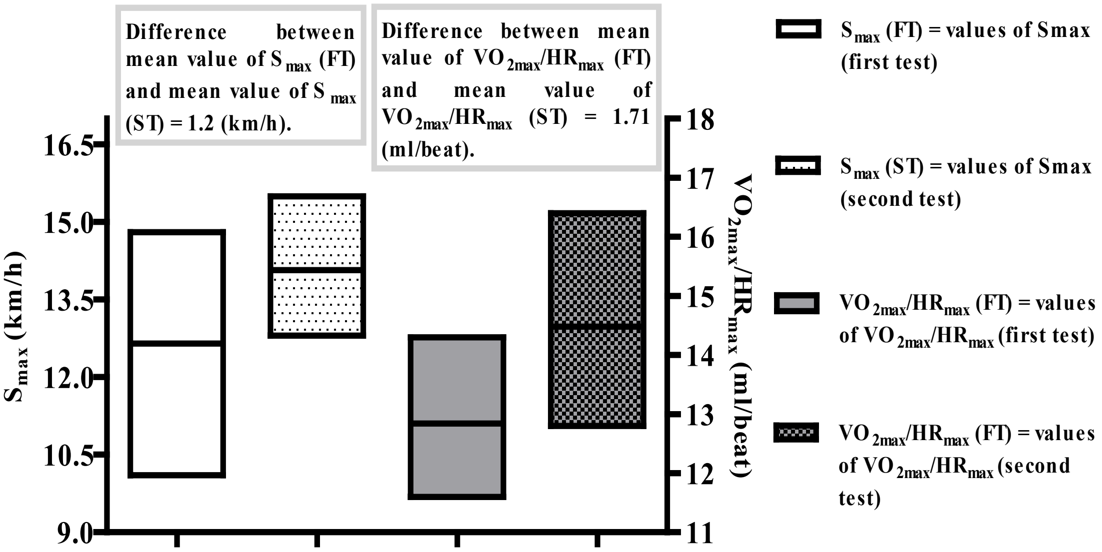

Figure 2. *Values of Smax and $VO_2max/HRmax$ registered during the two exercise tests.*

Further support for this conclusion comes from the increased mean values of maximal oxygen pulse ($VO_2max/HRmax$ (first test) – VO_2max/HR-max (second test) = 1.71 ml/beat ($p < .05$)) and the decreased mean Lamax values (Lamax (first test) – La max (second test) = -1.1 mmol/L ($p < .05$)) recorded during the second test (Figure 2, Table 1). Moreover, a Cohen's d effect size analysis was also performed to assess the magnitude of changes in the examined parameters (VO_2max, VO_2max/kg, Smax, $VO_2max/HRmax$, and Lamax). VO_2max showed a moderate effect (Cohen's $d = 0.48$), VO_2-max/kg a moderate-to-large effect ($d = 0.61$), and Smax the largest change, with a large effect ($d = 0.85$). $VO_2max/HRmax$ and Lamax showed moderate ($d = 0.56$) and small-to-moderate effects ($d = 0.43$), respectively. Overall, all examined parameters demonstrated meaningful improvements, with the most pronounced effect observed for Smax.

DISCUSSION

A comparative analysis of VO_2max/kg values (VO_2max/kg (first test) = 48.71 ± 5.29 ml/kg/min; VO_2max/kg (second test) = 52.26 ± 5.91 ml/kg/min) indicates that the tested subjects demonstrated considerably higher relative maximal oxygen consumption compared to values recorded in women of similar age (20–29 years; mean values of VO_2max/kg = 38–41 ml/kg/min) from the general population (Pescatello et al., 2014). Notably, the relative VO_2max/kg values established in the present study exceed even the mean VO_2max/kg values (VO_2max/kg = 45–50 ml/kg/min) typically observed in males aged 20–29 years from the general population (Pescatello et al., 2014).

Based on the presented data and in accordance with the specific dynamic motor demands of dancesport, the female dancers in our study can be characterized by an aerobic capacity that exceeds that of both females and males of comparable age in the general population. The view that individuals who regularly practice dancesport possess relatively higher aerobic capacity is further supported by Novak et al. (1978). The authors note that the motor activity involved in dancesport is characterized by significant volume and intensity, which, when practiced regularly, contributes to substantial improvement in aerobic capacity. Novak et al. (1978) conclude that dancesport sessions strongly stimulate muscle metabolism and function of the cardiorespiratory system, resulting in increased maximal oxygen consumption. In this context, Blanskby and Reidy (1988) emphasize that dancing is a vigorous physical activity that imposes substantial functional stress on the cardiovascular system. In their study of Australian competitive dancers, they report heart rates ranging from 146 to 196 beats per minute during dance performance, which evidences the significant cardiovascular strain.

Consistent with the findings of Blanskby and Reidy (1988) and Novak et al. (1978), our study also identified a statistically significant increase in maximal oxygen pulse (13.3%) following the four-month training program, indicating improved cardiorespiratory system function in the tested female dancers. From a physiological perspective, this improvement in the cardiovascular system contributes to the statistically significant increase in VO_2max/kg (7.4%). In agreement with Kenney et al. (2011) and McArdle et al. (2009), enhanced cardiorespiratory function and elevated maximal oxygen consumption determine the statistically significant increase in the maximum physical work capacity (treadmill speed achieved) (9.4%) of the tested subjects recorded during the second maximal incremental test.

From a comparative standpoint, the mean VO_2max/kg values (VO_2max/kg (first test) = 48.71 ± 5.29 ml/kg/min; VO_2max/kg (second test) = 52.26 ± 5.91 ml/kg/min) obtained in the present study are consistent with those reported in international level Estonian female dancers (mean age 25.3 years, VO_2max/kg = 51.8 ml/kg/min) specializing in Standard dances (Liiv et al., 2014). The observation that our subjects exhibited high aerobic capacity is further supported by the fact that, despite the similarity in VO_2max/kg values, the participants in the study by Liiv et al. (2014) were elite-level athletes (many of the athletes were listed in the world rankings) with longer training experience (3.9 ± 2.8 years). It is worth noting that Liiv et al. (2014) also included qualified female dancers (mean age, 21.1 years) in their study, who primarily specialized in Latin American dances. In this context, the VO_2max/kg values (53.6 ml/kg/min) registered in the Latin dance group were higher than those observed in our research. According to Bria et al. (2011) and Liiv et al. (2014), the higher VO_2max/kg values in Latin dancers are likely attributable to the more expressive and dynamic motor activity involved in Latin dances, which features greater movement variability and is associated with higher heart rate values during dance performance. These biomechanical and physiological characteristics of Latin dances probably contribute to a more pronounced overall training stimulus on the functional capacity of Latin dance athletes.

CONCLUSION

Based on the data presented in this paper, it can be concluded that the intense physical workload associated with the dynamic motor activity performed in dancesport exerts a positive effect on cardiorespiratory fitness, contributing to improvements in maximal oxygen consumption and functional work capacity. The findings provide a strong rationale to support the conclusion that regular participation in dancesport represents an effective and realistic approach to engaging in health-promoting physical activity and can contribute to improved health outcomes in young and middle-aged individuals.

REFERENCES

Blanskby, B., & Reidy, P. (1988). Heart rate and estimated energy expenditure during ballroom dancing. *British Journal of Sports Medicine*, *22*(2), 57–60. https://doi.org/10.1136/bjsm.22.2.57

Bria, S., Bianco, M., Galvani, C., Palmieri, V., Zeppilli, P., & Faina, M. (2011). Physiological characteristics of elite sport-dancers. *Journal of Sports Medicine and Physical Fitness*, 51(2), 194–203.

Iliev, I. (1974). *Metodika za kompleksno izsledvane na sportisti ot visoka klasa* [Methodology for comprehensive examination of high-level athletes]. Balgarski sayuz za fizicheska kultura i sport, Sofia [Bulgarian Union for Physical Culture and Sport, Sofia]. Kenney, L., Wilmore, J., & Costill, D. (2011). *Physiology of sport and exercise (5th ed.).* Human Kinetics Press, Champaign.

Liiv, H., Wyon, M. A., Jürimäe, T., Saar, M., Mäestu, J., & Jürimäe, J. (2013). Anthropometry, somatotypes, and aerobic power in ballet, contemporary dance, and dancesport. *Medical Problems of Performing Artists*, *28*(4), 207–211. https://doi.org/10.21091/mppa.2013.4041

Liiv, H., Jürimäe, T., Mäestu, J., Purge, P., Hannus, A. & Jürimäe, J. (2014). Physiological characteristics of elite dancers of different dance styles. *European Journal of Sport Science, 14*(Suppl. 1), S429–S436. https://doi.org/10.1080/17461391.2012.711861

McArdle, W., Katch, F., & Katch, V. (2009). *Exercise Physiology: Energy, Nutrition and Human Performance (7th ed.*). Williams & Wilkins, Philadelphia.

McCord, P., Nichols, J., & Patterson, P. (1989). The effect of low impact dance training on aerobic capacity, submaximal heart rates and body composition of college-aged females. *Journal of Sports Medicine and Physical Fitness*, *29*(2), 184–188.

Novak, L. P., Magill, L. A., & Schutte, J. E. (1978). Maximal oxygen intake and body composition of female dancers. *European Journal of Applied Physiology and Occupational Physiology, 39*(4), 277–282. https://doi.org/10.1007/BF00421451

Pescatello, L. S., Arena, R., Riebe, D., & Thompson, P. D. (2014). *ASCM's Guideline for Exercise testing and Prescription (9th ed.).* Lippincott

Williams & Wilkins, Baltimore.

Pilar, L., Borges dos santos, K., Rodacki, A., & Lara, J. (2020). Biomechanic of ballroom dance: corporate adaptations with different footwear. *Journal of Physical Education*, *31*(1), 1–10. https://doi.org/10.4025/jphyseduc.v31i1.3126

Redding, E., & Wyon, M. (2003). Strengths and weaknesses of current methods for evaluating the aerobic power of dancers. *Journal of Dance Medicine and Science*, 7(1), 10–16. https://doi.org/10.1177/1089313X0300700102

Stehlik-Barry, K., Babinec, A. J. (2017). *Data Analysis with IBM SPSS Statistics*. Packt, Birmingham.

Tanaka, H., Monahan, K. D., & Seals, D. R. (2001). Age-predicted maximal heart rate revisited. *Journal of the American College of Cardiology, 37*(1), 153–156.
https://doi.org/10.1016/S0735-1097(00)01054-8

Tiemens, A., van Rijn, R. M., Koes, B. W., & Stubbe, J. H. (2023). A systematic review of cardiorespiratory fitness tests used in dance. *Journal of Dance Medicine and Science*, *27*(1), 27–40. https://doi.org/10.1177/1089313X231176608

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