

DETERMINATION THE STATE OF THE CARDIOVASCULAR SYSTEM IN PROFESSIONAL FOLK DANCERS

DETERMINAÇÃO DO ESTADO DO SISTEMA CARDIOVASCULAR EM DANÇARINOS FOLCLÓRICOS PROFISSIONAIS

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ABSTRACT

Bulgarian folk dances are one of the most recognizable symbols of Bulgarian culture. Behind the beauty of dance are intensive rehearsals that demand high physical endurance, strongly dependent on the cardiovascular system. Specialized training programs can support dancers' performance and health. The purpose of this study was to assess cardiovascular function before and after a specialized training program in professional folk dancers. Sixteen dancers (mean age 21 years) from the Student Folklore Ensemble at South-West University "Neofit Rilski" participated. Cardiovascular function was evaluated using the Ruffier and Master's two-step tests, applied before and six weeks after the program. Heart rate, blood pressure, and calculated indices (Ruffier and Ruffier-Dickson) were analyzed. Improvements were observed in all measured cardiovascular parameters after the program, with significant reductions in heart rate and blood pressure, as well as better recovery indices. The application of simple, low-cost, and accessible field tests such as the Ruffier and Master's two-step tests provides an adequate assessment of cardiovascular function in dancers. Their ease of use makes them valuable for coaches, medical professionals, and sport specialists, particularly when advanced technology is not available.

Keywords: Ruffier test, Master's two-step test, Cardiovascular system, Training program, Dancers

RESUMO

As danças folclóricas búlgaras são um dos símbolos mais reconhecíveis da cultura da Bulgária. Por trás da beleza da dança estão ensaios intensos que exigem alta resistência física, fortemente dependente do sistema cardiovascular. Programas de treinamento especializados podem contribuir para o desempenho e a saúde dos dançarinos. O objetivo deste estudo foi avaliar a função cardiovascular antes e depois de um programa de treinamento especializado em dançarinos folclóricos profissionais. Participaram dezesseis dançarinos (idade média de 21 anos) do Conjunto Folclórico Estudantil da Universidade do Sudoeste "Neofit Rilski". A função cardiovascular foi avaliada por meio dos testes de Ruffier e de dois degraus de Master, aplicados antes e seis semanas após o programa. Foram analisadas a frequência cardíaca, a pressão arterial e os índices calculados (Ruffier e Ruffier-Dickson). Observou-se melhora em todos os parâmetros cardiovasculares avaliados após o programa, com reduções significativas na frequência cardíaca e na pressão arterial, além de melhores índices de recuperação. A aplicação de testes de campo simples, de baixo custo e acessíveis, como os testes de Ruffier e de dois degraus de Master, oferece uma avaliação adequada da função cardiovascular em dançarinos. Sua facilidade de aplicação os torna ferramentas valiosas para treinadores, profissionais de saúde e especialistas em esportes, especialmente quando tecnologias avançadas não estão disponíveis.

Palavras-chave: teste de Ruffier; teste de dois degraus de Master; sistema cardiovascular; programa de treinamento; dançarinos.

Introduction

By the term "Bulgarian folk dances" today we mean the choreographic art of folklore. It began its professional development in the middle of the last century with the creation of the State Ensemble for Folk Songs and Dances, today named after its creator Filip Koutev. Over the years, the choreographic art, created on the basis of traditional Bulgarian folklore, has evolved toward more complex dance language, forms, and structures. Nowadays, this art is one of the main emblems of Bulgaria, through which the world recognizes Bulgarian culture. The choreographic art of folklore is of great importance for the identity of the Bulgarian, which is one of the main reasons for its continuing popularity.

Learning elaborate choreographies is associated with long rehearsals. This requires dancers to have significant endurance, which depends on the proper functioning of the cardiovascular system. Megova et al.¹ reported that the positive effect of cardio training is

improved functioning of the respiratory and cardiovascular systems, which promotes good blood circulation and enhances endurance directly linked to better quality of life and physical condition¹. Long training sessions require both cardiovascular endurance and musculoskeletal strength. The physical exertion performed during them increases the anaerobic capacity of the performers². The term cardiorespiratory fitness refers to the ability of the respiratory and cardiovascular systems to deliver the necessary amount of oxygen and nutrients during physical activity, and it is a direct reflection of the individual's physical condition³.

Regular physical exercise has a beneficial effect on the cardiovascular system. However, intense training can cause adverse reactions such as chest tightness, dizziness, and palpitations, which may indicate disturbances in the functioning of the cardiorespiratory system or the presence of latent cardiac disease⁴. Such problems may be evidenced by sudden changes in blood pressure and heart rate, as well as easy fatigue and shortness of breath during endurance tests with maximal and submaximal effort. Submaximal tests are often preferred by physiotherapists due to their wider applicability in clinical practice⁵. These include walking, squatting, and step tests. Squat tests have been known for many years and are considered a powerful tool for orthostatic loading, with good baroreflex homeostasis ensuring that changes in blood pressure and heart rate do not provoke symptoms⁶. Step tests are widely used to assess cardiorespiratory endurance and physical activity levels, being an integral part of the health and fitness assessments. Their application in sports practice contributes to the development of individualized training programs⁷. Examining the physiological foundations of step tests, Glushkova et al.⁸ classify them as those that assess anaerobic power, with approximately 30% of the energy required being provided by the aerobic system⁸.

Professional folk dancers are exposed to prolonged rehearsals, frequent performances, and physically demanding choreographies that combine rapid tempo changes, jumps, and complex step patterns. Although such activity provides natural physical conditioning, it does not always guarantee optimal cardiovascular adaptation. Standard warm-up and rehearsal routines in ensembles often emphasize technical mastery and synchronization, but not necessarily structured cardiorespiratory training aimed at developing endurance. At the same time, dancers are expected to sustain high-intensity choreographies and recover quickly between consecutive performances, which further highlights the importance of targeted cardiovascular preparation. Due to the frequency of rehearsals, insufficient warm-up routines, and the frequent omission of cool-down phases, the risk of musculoskeletal injuries among dancers increases.

These challenges necessitated the implementation of a specialized training program with the conventional structure in three parts: warm-up, main phase, and cool-down. Our primary role was to design and apply an appropriate warm-up routine that, beyond injury prevention, also focused on improving cardiovascular endurance and post-exercise recovery. Given that the participants were professional folk dancers, the program incorporated elements typical of folk dance, particularly movements with a "high knee lift." The training consisted of alternating periods of high-knee lift exercises and rest, with gradually increasing workload and intensity over time, to simulate the demands of intensive choreographies. In addition, we monitored the cool-down (stretching) to ensure it was performed consistently by all participants, as it is often neglected in practice. The main part of the rehearsals remained under the direction of the ensemble's choreographers, depending on the repertoire and upcoming performances.

To determine the functioning of the cardiovascular system and evaluate the effectiveness of the program, we applied two standardized submaximal tests - the Ruffier test and the Master's two-step test. From our review of the literature, we did not find previous

studies reporting the results of these tests in folk dancers. This highlights the novelty of our work and its potential interest for professionals in the field of dance and sports medicine.

Our aim was to determine the state of the cardiovascular system through the changes in the indicators obtained by applying the Ruffier test and the Master test in professional dancers before and after the introduction of a specialized training program.

Methods

Subjects

This study was approved by the Research Ethics Committee of the South-West University “Neofit Rilski”, Blagoevgrad. Sixteen professional folk dancers (4 men, 12 women) from the Student Folklore Ensemble of South-West University “Neofit Rilski” participated in the study. Written informed consent was obtained from each participant after explanation of the nature and purpose of the research.

Procedures

All participants were assessed for cardiovascular reactivity using the Ruffier test and the Master’s two-step test. Both tests were administered at the beginning and end of the summer semester of the 2023/2024 academic year. Based on the initial results, a six-week specialized training program was developed and implemented in the regular exercise routine of the ensemble. After the intervention, the dancers were retested using the same protocols.

Measurements and Equipment

Heart rate (HR) was measured with a pulse oximeter (Medisana, Germany), and blood pressure (BP) was measured with a digital sphygmomanometer (Medisana, Germany). Measurements were performed according to standardized procedures, following both Bulgarian methodological sources⁹ and international recommendations¹⁰.

Ruffier test

Resting HR (P1) was measured after a five-minute rest in a supine position, as recommended by Bulgarian authors⁹. Participants then performed 30 squats in 45 seconds, with knees flexed to 90°, trunk upright, and arms extended forward¹⁰. Immediately after the exercise, participants returned to the supine position. HR was then recorded during the first 15 seconds (P2) and last 15 seconds (P3) of the first minute of recovery¹¹. To facilitate reproducibility, some authors recommend avoiding full squatting in this protocol¹².

The Ruffier test assesses cardiovascular adaptation to exercise by calculating the Ruffier index, also known as the “post-exercise recovery index.” It evaluates the efficiency of the circulatory system during submaximal exercise¹³. The Ruffier index was calculated as follows¹⁴:

$$RI = \frac{(P_1 + P_2 + P_3) - 200}{10}$$

Adaptive capacity to effort can also be assessed through the Ruffier-Dickson index, calculated as^{12,15}.

$$RDI = \frac{(P_1 - 70) + 2(P_2 - P_0)}{10}$$

The Master two-step test

The Master’s test, introduced in 1929 by Master and Oppenheimer, and expanded in 1942 with electrocardiogram monitoring¹⁶, involves climbing two 23 cm steps in 90 seconds.

The number of climbs is determined based on age and weight. HR and BP were measured at rest and two minutes after completion of the test.¹⁷

The test is used to assess the overall function of the cardiovascular system and in particular myocardial performance. In addition to monitoring HR and BP responses, the test allows for the calculation of exercise tolerance and efficiency percentage, providing further insight into cardiovascular endurance. Exercise tolerance was calculated by multiplying the participant's body weight by the number of steps climbed. Efficiency percentage was determined by dividing the actual number of climbs by the theoretical standard for age and weight¹⁸.

Specialized Training Program

Testing athletes is extremely important for monitoring their physical and technical development, providing feedback on the need to adjust training¹⁹.

Based on the baseline test results, a six-week specialized program was implemented, four times per week, and integrated into the regular rehearsals of the Student Folklore Ensemble. The program followed the conventional structure of warm-up, main part, and cool-down. Our role was focused on designing and supervising the warm-up (based on folk dance elements, particularly movements with a “high knee lift”) and ensuring that the cool-down (stretching) was performed systematically by all participants, as it is often neglected in practice. The main part of the rehearsals (dance compositions) remained under the direction of the ensemble’s choreographers according to the repertoire and upcoming performances.

The specialized warm-up program consisted of a sequence of folk dance-based exercises, performed in cycles of alternating effort and rest, with a gradual increase in intensity and duration over the six-week period. Movements with a high knee lift were emphasized as a specific element relevant to folk dance technique. Detailed structure of the exercises, musical rhythm, duration, and methodological instructions are presented in Chart 1. The exercises were adapted from Dzhenev and Haralampiev²⁰.

No	Name	Duration	Musical measures	Tempo	Methodological instructions
1	“Kontcheta” (jumps)	30 s	2/4	Moderately fast	Based on the Shops folk dance “Shopsko”, 6 phrases x 8 bars
2	Rest	30 s	2/4		Toe push-ups x 4 in the direction for right and left leg
3	“Rachenitsa”	60 s	7/8	Moderately fast	2 phrases x 8 bars “Rachenitsa” and “Krstosana Rachenitsa”
4	Rest	30 s	2/4	Moderate	Exercise “Squat” from I, II, III and VI position x 4 bars
5	“Daychovo”	90 s	9/8 with 4 th extended part	Moderately fast	4 phrases x 8 bars alternate “Daychovo” with 4 phrases “Spusak”; 10
6	“Rest”	30 s	2/4	Moderate	Performed with left and right foot
7	“Pajdushko”	120 s	5/8	Moderate	6 phrases x 8 bars “jump-skip”, 4 phrases “Golemi hlopki”, 3 phrases “Jump-skip”, 5 phrases “Pajdushka-jump” and 5 phrases x 10 bars the choro “Pajdushka” three
8	“Rest” - the exercise “Bending”	30 s	2/4	Moderate	The movements are performed forward, backward, right and left
9	“Koncheta” (jumps)	150 s	2/4	Moderately fast	Based on the Shops horo “Selskoto”. 6 phrases x 8 bars “Koncheta”, 2 phrases x 8 bars “Jumps” (VI position), 1 phrase “Koncheta”, 1 phrase jumps with feet back, 1 phrase “Scissors”, 1 phrase and jumps with feet back, 4 phrases “Koncheta”, 1 phrase jumps with feet back, 4 phrases “Koncheta”. 10 phrases x 8 bars alternation of the described movements x 2 phrases. The last 2 phrases – “Koncheta”

10	"Rachenitsa"	180s	7/8 with an extended third section	Moderately fast	4 phrases x 8 bars "Rachenitsa", 3 phrases "Vrabchova" with left and right foot, 3 phrases "Rachenitsa", 4 phrases "Krstosana Rachenitsa", 3 phrases "Vrabchova", 3 phrases "Shopsko natrisane", 4 phrases "Rachenitsa", 3 phrases "Scissors", 2 phrases "Vrabchova" and 1 phrase "Rachenitsa" alternate
11	"Rest"	30 s			Half thumbs up with deep inhalation and exhalation
12	Melodic motifs from the Shops choro "Selskoto"	120s	2/4	Moderately fast	4 phrases x 8 bars "Koncheta", 1 phrase jumps with feet backwards, 1 phrase "Scissors", 1 phrase jumps with feet backwards, 1 phrase "Scissors", 2 phrases "Koncheta", 1 phrase jumps with feet backwards, 4 phrases "Koncheta", 2 phrases jumps with feet backwards, 2 phrases "Scissors", 2 phrases "Natrisane", 2 phrases "Koncheta", 2 phrases jumps with feet backwards, 2 phrases "Scissors", 2 phrases "Natrisane", 3 phrases "Koncheta", 2 phrases jumps with feet backwards, 1 phrase "Scissors"
13	"Rest" – the "Bending" exercise	30 s	2/4	Moderate	Performed forward, backward, right and left
14	"Pajdushko"	60 s	5/8	Moderate	3 phrases x 8 bars "Jump-jump", 4 phrases "Pajdushka-jump", 3 "pajdushki" and a jump to the left (total 4 bars); the same to the right. Repeated 2 times (16 bars). Then alternate 2 phrases x 8 bars triple pajdushki in left and right, 2 phrases "Golemi hlopi", 2 phrases "Jump-skip", 2 phrases "Pajdushka-jump"

Chart 1. Specialized training program of the participants from the Student Folklore Ensemble

Note: The exercises are adapted from Dzhenev and Haralampiev²⁰

Source: The authors

Statistical analysis

All data were processed using GraphPad Prism 3.0 (GraphPad Software, San Diego, CA, USA). Normality of distribution was verified for each variable using the Kolmogorov–Smirnov test. Since most of the studied indicators showed a normal distribution, results are presented as mean $\pm$ standard deviation (SD). To assess differences before and after the introduction of the specialized training program, the Wilcoxon signed-rank test was applied for paired comparisons. For variables with more than two related measurements (e.g., heart rate at rest, during the first 15 s, and during the last 15 s of the Ruffier test), the Friedman ANOVA was used to analyze the dynamics across conditions, followed by pairwise Wilcoxon tests when appropriate. Statistical significance was set at $p < 0.05$.

All values are presented as mean $\pm$ SD. In accordance with standard reporting practice, heart rate, blood pressure, and age are rounded to whole numbers, while indices (e.g., Ruffier and Ruffier–Dickson) are reported with one decimal place.

Results

The study included 16 professional dancers from the Student Folklore Ensemble at the South-West University "Neofit Rilski", Blagoevgrad. There were 12 women and 4 men, with a mean age of 21 years. Anthropometric characteristics indicated that the participants had normal body height, body mass, and BMI values.

Result-Ruffier test

When analyzing the Ruffier test results, statistically significant improvements were observed in all measured parameters after the specialized training program. Resting heart rate decreased significantly ($p = 0.0005$), and heart rate values in both the first and last 15 seconds of recovery were lower after the intervention ($p = 0.0118$ and $p = 0.0005$, respectively). The Ruffier index ($p = 0.0006$) and Ruffier-Dickson index ($p = 0.0020$) also showed a significant reduction, reflecting better cardiovascular adaptation to submaximal effort.

Overall, these results indicate that the dancers demonstrated enhanced recovery capacity and improved efficiency of the cardiovascular system following the six-week program (Table 1). Further details of within-test dynamics are presented in Table 2 and illustrated in Figure 1

Table 1. Results from the Ruffier test conducted among participants from the Student Folklore Ensemble (n = 16)

Measurements	Before ($\bar{x} \pm SD$)	After ($\bar{x} \pm SD$)	p- value
<i>HR at rest (bpm)</i>	85 $\pm$ 13	73 $\pm$ 11	0.0005
<i>HR in the first 15 s</i>	125 $\pm$ 20	110 $\pm$ 13	0.0118
<i>HR in the last 15s</i>	105 $\pm$ 13	84 $\pm$ 12	0.0005
<i>Ruffier index</i>	11.61 $\pm$ 4.11	6.61 $\pm$ 3.12	0.0006
<i>Ruffier- Dickson index</i>	9.48 $\pm$ 3.04	6.10 $\pm$ 2.44	0.0020

Note: *HR – Heart rate

Source: The authors

Table 2. Results of Friedman test and Dunn's post-hoc comparisons for heart rate values in the Ruffier test before and after the specialized training program

Comparison	Before program (p- value)	Significance	After program (p - value)	Significance
<i>Rest vs. First 15 s</i>	p<0.001	***	p<0.001	***
<i>Rest vs. Last 15 s</i>	p<0.01	**	n.s.	-
<i>First 15 s vs. Last 15 s</i>	n.s.	-	p<0.01	**

Note: * Friedman test: before p<0.0001, after p<0.0001. n.s.- not significant

Source: The authors

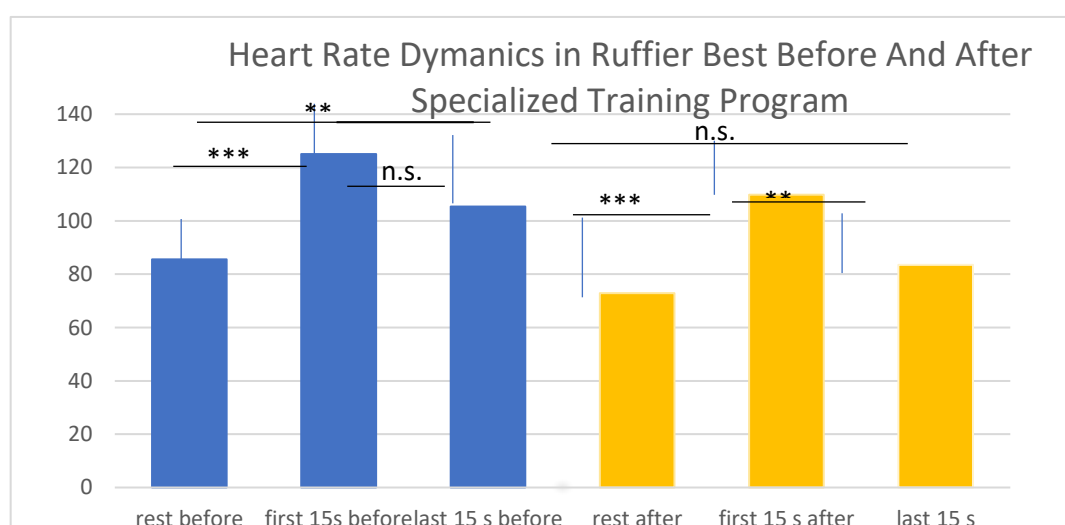


Figure 1. Heart rate dynamics during Ruffier test before and after the specialized training program (mean $\pm$ SD). Dunn's multiple comparison test: ***p < 0.001, **p < 0.01, n.s. - not significant

Source: The authors

Result- Master's two step tests

When analyzing the two-step Master test, improvements were observed in both cardiovascular parameters and exercise tolerance after the specialized training program. Heart rate two minutes after the test decreased significantly ($p = 0.0256$), indicating enhanced recovery capacity. Resting and post-exercise systolic and diastolic blood pressure values were also significantly lower after the intervention (SBP at rest: $p = 0.0194$; SBP 2 min after: $p = 0.0037$; DBP at rest: $p = 0.0016$; DBP 2 min after: $p = 0.0001$). These findings reflect better vascular regulation and reduced load on the cardiovascular system.

Exercise tolerance and percent efficiency improved, with participants showing higher efficiency after the program ($p = 0.0001$).

The detailed values are presented in Table 3.

Table 3. Mean values ($\bar{x} \pm SD$) from the two-step Master test before and after the specialized training program ($n = 16$)

Measurements	Before ($\bar{x} \pm SD$)	After ($\bar{x} \pm SD$)	p- value
HR at rest (bpm)	79 ± 17	74 ± 12	0.2719
HR 2 min after test (bpm)	83 ± 19	71 ± 9	0.0256*
SBP at rest (mmHg)	123 ± 8	120 ± 13	0,0194*
SBP 2 min after test (mmHg)	137 ± 13	124 ± 11	0,0037**
DBP at rest (mmHg)	74 ± 8	65 ± 6	0,0016**
DBP 2 min after test (mmHg)	75 ± 6	66 ± 5	<0.0001***
Tolerance to load (kgm)	1976 ± 455.8	2121 ± 588.8	0.1250
% Efficiency	1.254 ± 0.13	1.407 ± 0.20	<0.0001***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, HR- heart rate; SBP- systolic blood pressure; DBP- diastolic blood pressure

Source: Authors

Discussion

The present study demonstrated significant improvements in cardiovascular function among professional dancers after the implementation of a six-week specialized training program. Both the Ruffier and the two-step Master test revealed lower heart rate values, faster recovery, and better tolerance to submaximal physical exertion. These findings highlight the beneficial effect of structured and targeted training on the adaptive capacity of the cardiovascular system.

Our results from the Ruffier test showed a significant reduction in resting heart rate, as well as in the heart rate recorded during the first and last 15 seconds of recovery. Consequently, both the Ruffier and Ruffier–Dickson indices improved, indicating enhanced cardiovascular adaptation to exercise. These changes are consistent with previous reports emphasizing the sensitivity of the Ruffier index in detecting functional adaptations in athletes¹⁴, while the Ruffier–Dickson index, often considered more suitable for women and non-athletes, also confirmed the positive effect of the program³.

The results from the Master test further supported these observations. After the program, participants showed lower heart rate and blood pressure values at rest and two minutes after exertion, together with improved exercise tolerance and percent efficiency. Such responses reflect improved myocardial function and recovery, in agreement with earlier studies describing the diagnostic and functional relevance of the Master test^{18,21}.

From a physiological perspective, these improvements can be explained by enhanced parasympathetic activity, better vascular regulation, and increased efficiency of oxygen

utilization. Similar mechanisms have been reported in studies on athletes, where structured training leads to reduced cardiac workload and faster post-exercise recovery^{22,23}.

Taken together, our findings indicate that a specialized training program can optimize cardiovascular responses in professional dancers. This is particularly important considering the high physical and emotional demands of intensive rehearsals and performances. Improved adaptation and recovery not only support better endurance but may also reduce the risk of overtraining and cardiovascular strain.

Nevertheless, the study has some limitations, including the relatively small sample size and the lack of a control group. Future research with larger cohorts and longitudinal monitoring is needed to confirm these observations and to explore the long-term effects of specialized training programs on dancers' cardiovascular health.

Conclusion

The application of the Ruffier and Master's two-step tests, although often overlooked in contemporary research, provides a reliable and accessible method for assessing cardiovascular function. Their simplicity and ease of implementation make them suitable not only for sports medicine but also for specialists in dance and performing arts. The results of our study demonstrate that even in artistic disciplines, structured physical training is essential for maintaining endurance, supporting rapid recovery, and ensuring optimal functional capacity. Therefore, integrating such functional assessments can contribute to both improved performance and better health monitoring of professional dancers.

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