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METHODOLOGICAL JOURNAL****MENTAL ENLIGHTENMENT SCIENTIFIC –  
METHODOLOGICAL JOURNAL**<http://mentaljournal-jspu.uz/index.php/mesmj/index>**MONITORING OF THE FUNCTIONAL STATE OF FIGURE SKATERS BASED ON  
THE ANALYSIS OF CARDIORESPIRATORY INDICATORS IN TRAINING  
ACTIVITY CONDITIONS****Svetlana Vyacheslavovna Fedorova**

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**ABOUT ARTICLE**

**Key words:** figure skating, heart rate (HR), heart rate variability (HRV), heart rate zones, functional state, training load.

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**Abstract:** Modern requirements for training figure skaters necessitate objective monitoring of their functional state during the training process. The article presents an analysis of cardiorespiratory indicators based on heart rate (HR), distribution of load across heart rate zones, and heart rate variability (HRV). The study was conducted using a Polar chest heart rate monitor under conditions close to competitive activity. The dynamics of HR, structure of training load, and recovery indicators of highly qualified athletes were analyzed. It was found that the training process is characterized by high variability and predominance of moderate and high-intensity loads. A relationship between an increase in high-intensity load and a decrease in HRV indicators was identified. The results confirm the effectiveness of modern monitoring tools for optimizing the training process.

**Introduction.** The relevance of research in the field of figure skating is driven by current trends in the development of high-performance sports, where a scientifically based approach to athlete preparation plays a key role. Special attention to the development of winter sports in the Republic of Uzbekistan is given at the state level, as confirmed by the Decree of the President

of the Republic of Uzbekistan Sh.M. Mirziyoyev dated February 4, 2020, "On Measures for the Development of Winter Sports," aimed at creating conditions for athlete training and improving sports infrastructure. Under these conditions, the International Skating Union is constantly raising the requirements for technical complexity and quality of element execution, which imposes increased demands on the functional state of figure skaters.

Figure skating, as a complex-coordination sport, is characterized by a combination of high speed of movement, multiple rotations, jumps with multiple revolutions, and the need to maintain stability and precision of movements. Under these conditions, the importance of monitoring athletes' physiological parameters, particularly heart rate (HR), as one of the key indicators of the body's response to load and recovery efficiency, increases.

Despite the active integration of modern monitoring technologies into the training process, including the use of heart rate monitors and motion analysis systems, the scientific literature still notes a lack of comprehensive data on heart rate dynamics in figure skaters under specific competitive and training conditions. Information regarding highly qualified athletes, where the load is as close as possible to competitive conditions, is particularly limited.

The relevance of this study is also determined by the need to optimize the training process through more precise load dosing and timely assessment of athletes' functional state. Analysis of heart rate indicators in combination with assessing the quality of technical element execution allows for the identification of patterns in the body's adaptation to the specific loads of figure skating, as well as determining factors affecting the stability and effectiveness of performances.

The aim of the study was to collect reliable data on heart rate in figure skaters during training sessions, as well as to analyze heart rate dynamics, load distribution, and recovery indicators using a Polar chest strap heart rate monitor.

Research objectives. The study is based on the assumption that the use of a Polar chest strap heart rate monitor will allow obtaining objective data on heart rate directly during the performance of specific physical loads by figure skaters, which will make it possible to more accurately assess their functional state and its relationship with the quality of technical element execution.

The following tasks were set during the study:

1. To determine the optimal conditions for specific dosed physical load, as close as possible to competitive conditions in figure skating.
2. To collect data on heart rate of figure skaters using a Polar chest strap heart rate monitor during the execution of training elements (spins, jumps, step sequences).

3. To analyze heart rate dynamics in various phases of the training session (warm-up, main part, cool-down).
4. To assess load distribution across heart rate zones and athletes' recovery indicators.
5. To identify the relationship between heart rate indicators and the quality of execution of technical elements in figure skating.

**Methodology.** The study involved highly qualified figure skaters from the Republican School of Higher Sports Excellence for Winter and Technically Complex Sports in Tashkent.

In order to determine the functional state of the figure skaters and the characteristics of the cardiovascular system, heart rate was measured using a Polar chest strap heart rate monitor.

Data collection was carried out during a training session that followed the standard structure of a session:

- Preparatory part (warm-up) – exercises for gliding, coordination, and balance;
- Main part – execution of specific figure skating elements (jumps, spins, combinations, step sequences);
- Final part – recovery exercises and load reduction.

The total duration of the training session was 60 minutes. Special attention was paid to selecting physical loads that are as close as possible to the competitive activity of figure skaters, including the execution of elements under conditions of high intensity and coordination complexity.

The Polar chest strap heart rate monitor was attached to the chest area, ensuring accurate recording of the heart's electrical impulses. The obtained data were transmitted to a compatible device (smartwatch or mobile application), allowing heart rate to be monitored in real time.

**Results and discussion.** During the study, data were obtained characterizing the functional state of figure skaters under training process conditions, as well as the characteristics of load distribution across various heart rate zones.

Analysis of the indicators presented in Table 1 shows significant variability in the athletes' functional state and training load level. Specifically, the highest training load value (TRIMP = 202) was recorded in S. Alimova, indicating the performance of high-intensity work. This is also confirmed by the high average heart rate level (87%) and a relatively low heart rate variability (HRV = 7), which may indicate pronounced fatigue and tension in the body's regulatory systems.

**Table 1.****Indicators of the functional state of figure skaters in the training process**

Skater	TRIMP	Avg HR (%)	Min HR (%)	Max HR (%)	Distance (km)	Energy Expenditure (kcal)	Avg Speed (km/h)	HRV (RMSSD)
Tian	108	73	19	112	1.705	225	1.6	25
Galich	121	73	49	98	1.451	349	1.2	14
Alimova	202	87	49	102	1.404	320	1.2	7
Rakhmatullaeva	153	79	27	100	1.730	351	1.4	14

In turn, A. Tian shows a lower level of training load (TRIMP = 108) with an average heart rate of 73% and the highest HRV value (25), which indicates a more favorable functional state and better recovery level. Similar, though less pronounced, indicators are observed in Z. Galich and E. Rakhmatullaeva, whose TRIMP values (121 and 153, respectively) and heart rate indicate a moderately high intensity of load.

The indicators of distance and energy expenditure also reflect the specificity of figure skaters' training activity, characterized by alternating periods of high intensity and relative recovery, which corresponds to the intermittent nature of load in this sport. Additional analysis of the distribution of time across heart rate zones (Table 2) allows for a more detailed characterization of the training load structure.

**Table 2.****Distribution of time across heart rate zones**

Skater	zone 1	zone 2	zone 3	zone 4	zone 5
A.Tian	3:44 (6%)	17:14 (27%)	29:29 (46%)	09:06 (14%)	02:53 (4%)
Z.Galich	00:00 (0%)	20:29 (28%)	31:08 (42%)	13:33 (19%)	02:58 (4%)
S. Alimova	00:00 (0%)	00:33 (1%)	12:42 (18%)	33:48 (48%)	23:39 (33%)
E.Rakhmatullaeva	00:41 (1%)	10:17 (14%)	25:24 (35%)	31:34 (43%)	04:47 (7%)

The majority of female figure skaters predominantly work in zones 3 and 4 (70–89% of maximum heart rate), which corresponds to the aerobic-anaerobic energy supply mode. For instance, A. Tian spends 46% of her time in zone 3 and 14% in zone 4, indicating a predominantly aerobic load focus with elements of high intensity.

Z. Galich shows a similar load distribution structure, where the majority of time is also spent in zones 2 and 3 (28% and 42%, respectively), indicating a more uniform nature of training impact, with a significant share of work in zone 4 (19%), suggesting a combined load character.

The most intense load was recorded in S. Alimova, who spends a significant portion of time (48% and 33%) in zones 4 and 5, respectively. This indicates a predominance of high-intensity work, characteristic of performing complex technical elements (jumps, spins), requiring significant energy expenditure and high mobilization of the body's functional systems.

E. Rakhmatullaeva also shows a significant share of work in zone 4 (43%), but the share of extreme load (zone 5) is substantially lower (7%), which may indicate a more rational distribution of effort during the training session.

The obtained results confirm that training activity in figure skating is predominantly intermittent in nature, with alternating loads of varying intensity. At the same time, the level of functional tension in the body is directly related to the distribution of time across heart rate zones and the magnitude of the training load.

**Conclusion.** Analysis of the relationship between heart rate indicators, TRIMP, and HRV allows us to conclude that an increase in the proportion of work in high-intensity zones (4–5) is accompanied by an increase in training load and a decrease in heart rate variability indicators, indicating the development of fatigue. At the same time, a more even load distribution and a smaller proportion of work in extreme zones contribute to maintaining a higher level of functional state and better recovery.

1. It has been established that the training activity of figure skaters is characterized by high load variability and is predominantly intermittent in nature, with alternating periods of varying intensity, which is determined by the specifics of performing technical elements.

2. Analysis of heart rate indicators showed that the main part of the training load across heart rate zones is individual in nature, with the majority of female skaters working in zones 3–4 (70–89% of maximum heart rate), which corresponds to the aerobic-anaerobic energy supply mode and is optimal for developing special endurance in figure skaters.

3. It was revealed that an increase in the proportion of work in high-intensity zones (4–5) is accompanied by an increase in training load (TRIMP) and a decrease in heart rate variability (HRV) indicators, indicating an increased level of fatigue and tension in the body's functional systems.

4. Individual differences in the level of functional state of athletes were established: higher HRV values under moderate load indicate better recovery, while the combination of high heart rate and low HRV indicates significant functional tension.

5. The effectiveness of using the Polar chest strap heart rate monitor for monitoring the functional state of figure skaters has been demonstrated, allowing for real-time objective data on heart rate, load structure, and recovery processes.

6. The obtained results confirm the feasibility of using data on heart rate, heart rate zones, and HRV to optimize the training process, individualize loads, and improve the quality of execution of technical elements in figure skating.

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