

The inner reaction dynamics of 13-14 year-old girls to physical load in the process of Harvard step test performance

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Abstract:

Problem statement. In order to define the differentiated physical loads for girls of a secondary school age we need to take into account the levels of their adaptive reaction. According to the results of our research the significant differences in the heart rate reaction to physical load while performing the Harvard step test by 13-14 year-old girls determine the necessity of their differentiation into relatively homogeneous groups at physical training lessons. *The purpose of the research:* to determine the inner reaction dynamics of 13-14 year-old girls to physical load while performing the Harvard step test. *Results.* In the process of Harvard step test performance we defined three types of heart rate reaction of 13-14 year-old girls to physical load. In particular, we revealed three groups of girls with high (94 stad.unit.), average (68.5 stad.unit.) and low (53 stad.unit.) levels of Harvard step test index. After differentiation of 13-14 year-old girls by this index we have investigated their heart rate reaction to physical load while performing the Harvard step test. The article presents the heart rate indicators of 13-14 year-old girls of high, average and low levels of physical endurance while performing the Harvard step test. *Conclusions:* the dynamics of the inner reaction of 13-14 year-old girls on physical load was defined in the process of Harvard step test performance (4 min) in terms of the heart rate indicators at their registering every 10 seconds, which allowed identifying three groups of pupils with low, average and high levels of adaptability. *Key words:* heart rate reaction, physical load, Harvard step test, physical endurance, 13-14 year-old girls.

Introduction

Harvard step test, according to the researchers (Krutsevich, 2012), allows drawing a conclusion about the state of the cardiovascular system and endurance of an organism. In the process of developing a differentiated approach to the planning of the means and methods of physical training at physical training lessons in football for girls of a secondary school age, we consider that the maximum heart rate is an important additional parameter for the individual dosage of physical load, since the individual data of the maximum heart rate, and heart rate loading and rest allow you to evaluate the intensity of physical load (Sergiyenko, 2014).

Taking into consideration the fact that there observed a great inconsistency in restoring individual functions of teenagers [Ivashchenko & Bezkopylny, 2005; Adeniran & Toriola, 2008], the recovery duration after the performance of exercises depends on the volume and nature of the load. As a result of improper planning of the recovery processes for teenage girls their fitness is greatly reduced. When training impacts are significantly below the potential abilities, increase in fitness is not observed.

Material & methods

For the heart rate measurement at the load we used the device Polar s610i, which is a multi-functional device for determining the heart rate. The device consists of a wrist monitor where the heart rate data are displayed, and the breast belt. Its work is based on the wireless connection between the components. During the pilot study the function SEMPLES was used, that allows to record the heart rate data every 5, 15 or 60 seconds. By the pulsometry results we constructed the graphs of the heart rates of 13-14 year-old girls in the process of Harvard step test performance. The essence of the test is to rise up a step of 40 cm high (for girls of a secondary school age) with a frequency of 30 times per minute [Krutsevych]. Each rise was performed by the girls while counting four to the metronome: 1 – one foot up the step; 2 – another foot; 3-one foot on the floor; 4 – another foot. The duration of the test was 4 minutes.

The heart rate of each girl after performing the exercise in the sitting position was measured with the interval of 1 min – 1 min 30 sec, 2 min – 2 min 30 sec and 3 min – 3 min 30 sec of a recovery period. By the duration of the work performed in seconds and the heart rate in the recovery period the Harvard step test index was calculated. Index value was estimated as low (bad), if it was less than 55, below average – 56 – 64, average – 65-79, above average (good) – 80 – 89, excellent – more than 90.

The study was carried out on the basis of the laboratory of functional studies of athletes' rehabilitation center at Sumy State University (Sumy). The girls of 13-14 years old 155 in number took part in the study from the comprehensive educational institutions (ascertaining stage of the experiment). In the framework of the forming experiment 58 girls took part – 28 schoolgirls of a control group, 30 – an experimental group. The number of football classes in both groups was the same. The lessons were held three times a week. The duration of each lesson was 45 min.

Results

By the results of Harvard step test the differentiated graphs were constructed depending on the dynamics of the heart rate indicators of girls with low, average and high levels of physical endurance, which enabled to standardize the physical loads for the girls in the process of studying the technical and tactical methods at physical training lessons in football.

In the process of study we identified three groups of 13-14 year-old girls– with high, average and low levels of Harvard step test index.

For the girls with a high level of Harvard step test index the indicator was 94 stad.unit. (the heart rate during the first 30 sec after the recovery was 43.0 beats, during the second 30 sec – 42.4 beats, and during the third 30 sec – 42.1 beats). For the girls with an average level of Harvard step test index the indicator was 68.5 stad.unit. (indicators P1, P2 and P3 respectively accounted for 59.1 beats, 58.7 beats, and 57.4 beats). For the girls with a low Harvard step test index the indicator was 53 stad.unit. (indicators P1, P2 and P3 respectively accounted for 75.0 beats, 75.2 beats and 75.8 beats).

After the differentiation of 13-14 year-old girls according to the Harvard step test index we have investigated their heart rate reaction to physical load in the process of its performance.

When testing the 13-14 year-old girls we observed that the girls with a high level of physical endurance started the step test with the heart rate of 90.1 bpm⁻¹. In the process of the test performance the average heart rate of the girls was 124.2 bpm⁻¹, and the maximum heart rate of the girls was 140 bpm⁻¹ (fig. 1). It is worth noting that during the first minute of the test performance the pulse of the girls was at the level of from 90.1 bpm⁻¹ to 116.8 bpm⁻¹, during the second minute – from 120.1 bpm⁻¹ to 127.8 bpm⁻¹, during a third – from 129.8 bpm⁻¹ and 140 bpm⁻¹, and during the fourth was on the mark of 140 bpm⁻¹.

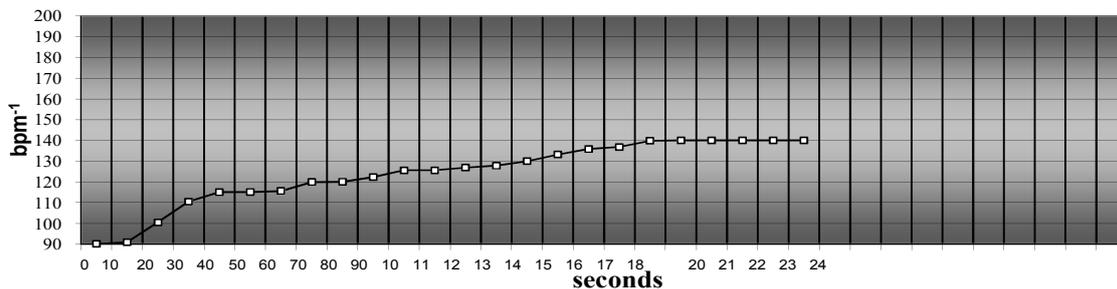


Fig. 1. Indicators of the heart rate of 13-14 year-old girls (n=52) with a high level of physical endurance in the process of Harvard step test performance, bpm⁻¹

For the girls with an average level of physical endurance we observe some other indicators of the heart rate during the Harvard step test performance (fig. 2). In particular, the girls started the step test with the heart rate from 90.5 bpm⁻¹. In the process of the test performance the average heart rate of the girls was 130.6 bpm⁻¹, and the maximum heart rate of the girls was 150.1 bpm⁻¹.

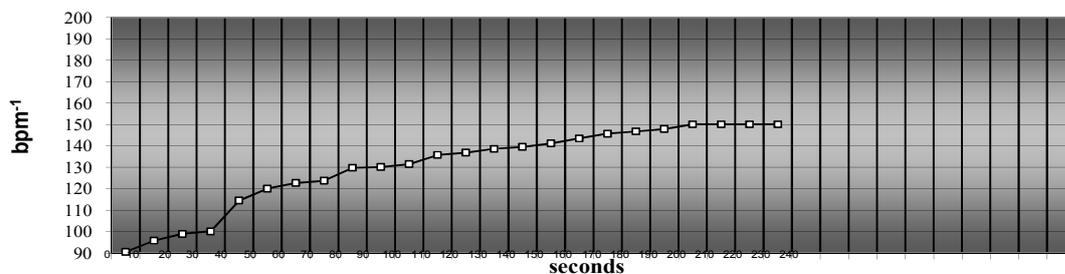


Fig. 2. Indicators of the heart rate of 13-14 year-old girls (n=48) with an average level of physical endurance in the process of Harvard step test performance, bpm⁻¹

It is worth noting that during the first minute of the test performance the pulse of the girls was at the level from 90.5 bpm⁻¹ to 120.1 bpm⁻¹, during the second minute – from 122.7 bpm⁻¹ to 135.8 bpm⁻¹, during the third minute – from 136.9 bpm⁻¹ to 145.8 bpm⁻¹ and during the fourth – on the mark from 146.8 bpm⁻¹ to 150.1 bpm⁻¹.

The girls with a low physical endurance started the step test with the heart rate of 90.9 bpm⁻¹. In the process of the test performance the average heart rate of the girls was 137.0 bpm⁻¹, and the maximum heart rate of the girls was 160.2 bpm⁻¹ (fig. 3).

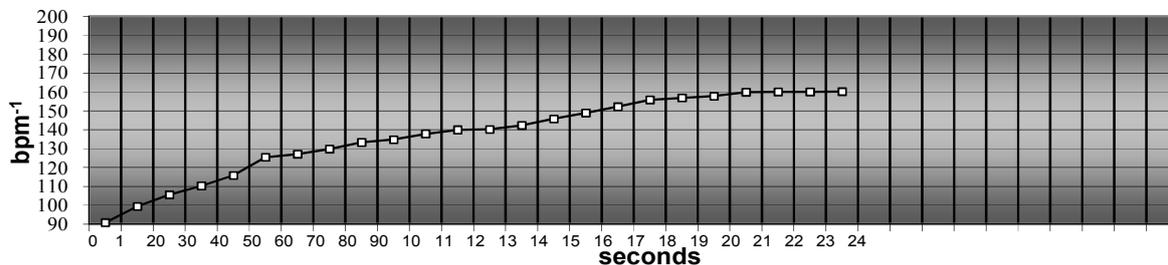


Fig. 3. Indicators of the heart rate of 13-14 year-old girls (n=55) with a low level of physical endurance in the process of Harvard step test performance, bpm⁻¹

It is worth noting that during the first minute of the test performance the pulse of the girls was at the level of 90.9 bpm⁻¹ to 125.5 bpm⁻¹, during the second minute – from 127.1 bpm⁻¹ to 139.8 bpm⁻¹, during the third – from 140.2 bpm⁻¹ to 155.8 bpm⁻¹, and during the fourth – on the mark from 156.9 bpm⁻¹ to 160.2 bpm⁻¹.

Discussion

In the course of our study we determined the inner reaction of the 13-14 year-old girls to physical load at physical training lessons in football.

Pupils with a low level of physical endurance after each exercise on the endurance development had a 60 sec rest, after a series of exercises – 3-4 min. at the heart rate of 130 – 140 bpm⁻¹, with an average level of physical endurance – the rest lasted 30-40 sec, and after a series of exercises – 3 min., at the heart rate of 140-150 bpm⁻¹. Pupils with a high level of physical endurance were given a short rest lasting 20-30 sec, and after a series of exercises – 2 min. at the heart rate of 150 – 160 bpm⁻¹.

To develop speed for the pupils at football lessons as the main means of training we have chosen a short run, and other running exercises (in particular with a ball). Pupils performed dribble at high speed.

Duration of running exercises for the schoolgirls with a low level of physical endurance was no more than 6-10 sec, for the girls with an average level of physical endurance – 10 – 15 sec, for the pupils with a high level of physical endurance – 20 – 30 sec, and the intervals between them provided the physical endurance recovery of the schoolgirls.

Before performing the exercises on flexibility the pupils were offered to "warm up" the organism to avoid injury. The following dosage of load was chosen: for the girls with a low level of physical endurance the most optimal were 3 series of 5–10 reps, for the girls with an average level of physical endurance – 4 series of 10–15 reps, for the schoolgirls with a high level of physical endurance – 4–5 series of 15–20 reps each.

The pupils filled the intervals between the series with the exercises on relaxation of muscles. The amplitude of movements was recommended to increase gradually. The most effective for the independent flexibility development of pupils was an integrated approach, under which 40% of the time, allotted for stretching, is spent for active and passive exercises, and 20% – for static ones.

The exercise duration for the girls with a high level of physical endurance could also range from 15-20 sec to a few minutes.

At that one should remember that it's possible to achieve the maximum (for a specific condition of pupils) amplitude only after 10 – 15 sec after the exercise start. Over the next 15-30 sec it is kept, and then, as a result of fatigue, decreases.

To avoid the monotony and unwanted fatigue for children and teenagers such exercises are given by series (3–5 series) with 10 – 20 reps each (Adeniran & Toriola, 2008).

It is also taken into account in the process of developing the differentiated dosage of physical loads for the development of basic physical qualities (endurance, speed and flexibility) and the approach to the planning of the means and methods of physical education for girls of a secondary school age at football lessons.

At the end of the study we determined the dynamics of change in the indicators of Harvard step test index of 13-14 year-old girls during the experiment (table 1).

Table 1. Dynamics of change in the indicators of Harvard step test index of 13-14 year-old girls during the experiment

Characteristics	Stages of research							
	initial		final		initial		final	
	\bar{x}	S	\bar{x}	S	\bar{x}	S	\bar{x}	S
	CG (n=28)				EG (n=30)			
Harvard step-test index, stad.unit.	57	3,5	60	3,3	58	2,5	77*	2,1

Remark: * – the validity of the difference between the metrics before and after the experiment with $p < 0,05$.

On the basis the received data we see a significant improvement of the indicator of Harvard step test index of the girls from the experimental group compared with the control one. This affirms the correct distribution of physical loads for the girls with low, average and high levels of physical endurance.

Conclusions

At the initial stage of the experiment we defined the heart rate reaction of 13-14 year-old girls to physical load in the process of Harvard step test performance. After that, the girls were divided into three groups with low, average and high levels of physical endurance. Taking into account the received data in the training process of football lessons the optimal physical loads were selected for each group of girls. According to the results of the final stage of the experiment in the control group of girls we note a slight tendency of Harvard step test index increase – from 57 ± 3.5 stad.unit. up to 60 ± 3.3 stad.unit., while as for the girls of the experimental group, on the contrary, there is its significant improvement from 58 ± 2.5 stad.unit. at the beginning of the experiment to 77 ± 2.1 stad.unit. in the end. Thus, in the process of planning of physical training lessons for teenage girls it is important to consider the heart rate reaction to physical loads in order to improve the effect of their fitness.

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