Regulation and control of young football players’ training loads

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Summary
Currently, according to the conception of children and youth football development in Kazakhstan, there has been a harmonious system formed to train young football players. The trainings are implemented by football departments of children and youth sport schools and specialized children and youth sport schools of Olympic Reserve. Recently, specialized football classes are getting widely expanded as a compulsory part of general education in many countries. However, there have not been designed sufficient methodical recommendations for teachers and coaches about the organization of training processes and rationalizing work load in specialized football classes up to now, in order junior football players to progress in specialized classes, it is necessary to draw the daily regulations properly and to define the content of physical training curriculum for different age groups. However, there are considerably scarce data available on this issue. Moreover, fluctuation of physiological functions in physical activities performed by young football players in learning conditions in specialized classes have not been sufficiently studied yet.

The purpose of this study is to determine the pulse rate of physical exercises and technical trainings fulfilled by young football players in learning conditions in specialized classes. The research study involved 25 young footballers of age 15-16 from specialized classes of secondary schools in Almaty, Kazakhstan. Those young football players’ cardiovascular system reaction was defined via radio telemetry device Sports Tester that recorded average heart rate (HR), its minimum and maximum values, the sum of heartbeat during training and game, and its allocation within different physical activities. Aerobic capacities were determined using indirect method when doing physical load for 5 minutes on a veloergometer Kettler with power of 150W. The maximum oxygen consumption (VO2 max) was estimated by the Astrand (1960) test. In accordance with the age of subjects, the results were correlated with the coefficient \(r=1,1\). The data was analyzed using methods of mathematic statistics.

The results of the research study showed that determining the pulse rate of cardiovascular system activities performed by young football players measured via radio telemetry device which helped to observe the reaction of athletes’ organism to different physical loads during whole physical training classes. It is significant to mention that higher reaction of cardiovascular system in physical activities are noted in carrying out repeated game exercises within technical trainings at a quarter of the pitch without the goal areas with 2 x 2 players, also 6 x 6 players. Among physical activities of young football players, the most intensive work of cardiovascular system requires launch acceleration for 2 minutes, running jumps and outdoor games. The conducted analysis using radio telemetry registered players’ heart rate (HR), defined the pulse rate of separated parts of training and competitive activities. Received data allows coaches to classify training loads in intensity zones which help them correlate training curriculum of young football players. Thus, present research data as well as other authors’ works fills the gap in the area where physical loads of young football players’ functional systems are of studies matter.

Keywords: young football players, physical activities, physical load, heart rate, pulse rate, exercising.

Introduction
Training of young football players is widely studied in scientific literature. The main features of motor skills, criteria of general and special qualifications, training curriculum, and activity of functional systems were discovered in different research works (Janssens et al., 1998; Franks et al., 1999; Reilly et al., 2000, 2005; Galasewski, Wieczorek, 2001; Chamari et al., 2004; Mc Garry, 2005; Wein, 2007). Nowadays, the coherent system in training young football players in Kazakhstan has been established in accordance with the conception of junior football development. The trainings are implemented by football departments of junior sport schools and specialized children and youth sports schools of Olympic Reserve (Adambekov, 2010; Yurievich, Musataev, 2013). The main objective of sport schools is to train comprehensively developed young football players. Specialized football classes in general secondary schools are widely spread in many countries (Nistratov, 2000). Due to those types of classes, new system of instructional training activities with young football players is connected with the organization of physical
activities regularly two times per day. However, methodical recommendations for teachers and coaches about the organization of physical activities and rationalizing work load in specialized football classes are not sufficiently designed yet (Akpayev, Adambekov, 2001; Christensen, Sorensen, 2009).

It is obvious that breakthrough of specialized classes was acquired a distinctive insistence on the preparation of young football players (Musatayev, 2013). In order to implement this in practice, it is possible only in secondary school settings (Fraser-Thomas et al., 2005; Adambekov, 2013). Special classes create opportunities for young football players to combine general school education with physical activities.

Main objectives of specialized football classes are:

- implementation of trainings to prepare comprehensively-developed young athletes with high qualifications, who can successfully combine general education with physical activities;
- preparation of sports reserve for national teams of the republic, regions, masters of sports, athletes of first sports category;
- trainings among public instructors and sports judges;
- being a methodological centre for junior sport to progress, to prepare Olympic reserves based on wide development of current types of sport;
- assisting in organization of extracurricular mass sport activities and taking presidential tests in secondary schools with specialized classes.

For further progress of young football players in specialized classes it is necessary to create a mode of the proper day and to identify the content of physical activities curriculum in different age groups (Williams, 2003; Popov, 2014). However, there is scarce literature available on the current issue. Also, the fluctuation of physiological functions in young football players’ exercising activities during the study in specialized classes have not been studied enough (Nistratov, 2000). The purpose of this study is to determine the pulse rate during the physical exercises and technical trainings fulfilled by young footballers in learning conditions in specialized classes.

**Material and methods**

This research study involved 25 young football players of 15-16 of specialized classes of secondary schools in Almaty, Kazakhstan. The subjects’ physical activities during the training process covered on average 3 hours per day, 18 hours per week, and respectively 2, 5 and 15 hours during competition period. Coaches from children and youth sports schools conducted training sessions. Those young football players’ cardiovascular system reaction was defined via radio telemetry device Sports Tester that recorded average heart rate (HR), its minimum and maximum values, and the sum of heartbeats during a training and a game, and its allocation in different physical activities. The subjects’ cardiovascular system reaction was defined in preparatory, main, and final parts of training. The physical values of fulfilling physical and technical training exercises were outlined as well as in separate parts of trainings with game activities. Aerobic capacities were determined using indirect method, exercising stress for 5 minutes on a veloergometer Kettler with power of 150W where the maximum oxygen consumption (VO2 max) was estimated by the Astrand (1960) test. In accordance to the age of subjects, results were correlated with the coefficient 1,1. The data was analyzed using methods of mathematical statistics.

**Results**

Analysis of chronometric observations and heart rate (HR) research during the study showed that, for the period of separate physical exercises, the maximum heart rate (HR) of young football players can reach 200 beats per minute. Herewith, these conditions presented significantly higher heart rates: 8-15 beats during 15-20 seconds; this characterizes young football players’ high instability of their autonomic functions. Cardiovascular system reaction to the changes of performed exercises intensively demonstrates a self-regulation of the organism, which adjusts to the required level of efficiency. Consequently, average level of heart rate in separate exercises indicates the character and intensive performance.

Our research studies pointed out these preparatory exercises of young football players of age 15-16 to characterize next heart rate indicators:

1. construction, report, goals – 1 minute – 90 beats per minute;
2. heel-and-toe walk – 1 minute – 110 beats per minute;
3. jogging – 2 minutes – 160 beats per minute;
4. sprinting – 5 minutes – 175 beats per minute;
5. gymnastic exercise – 6 minutes – 140 beats per minute.

Thus, the average indicator of pulse rate in preparatory part contained: (90+110+160+140+175):5=135 beats per minute.

The average result of young football players’ heart rate in fulfilling main types of exercises in physical preparation has its distinctions and characterizes next indicators of HR (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Types of exercises</th>
<th>Duration (min.)</th>
<th>Pulse rate (beats/minutes)</th>
<th>Amount of repetition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>average</td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Free heel-and-toe walking</td>
<td>2</td>
<td>105-113</td>
<td>84</td>
</tr>
<tr>
<td>Free running (jogging) in circles</td>
<td>3</td>
<td>129-141</td>
<td>121</td>
</tr>
<tr>
<td>Sprinting in turns</td>
<td>2</td>
<td>153-161</td>
<td>138</td>
</tr>
<tr>
<td>Gymnastic exercises on the site</td>
<td>3</td>
<td>115-121</td>
<td>95</td>
</tr>
<tr>
<td>Gymnastic exercises in motion</td>
<td>5</td>
<td>120-135</td>
<td>110</td>
</tr>
<tr>
<td>Outdoor games</td>
<td>10</td>
<td>151-159</td>
<td>135</td>
</tr>
<tr>
<td>Running jumps</td>
<td>3</td>
<td>151-159</td>
<td>135</td>
</tr>
<tr>
<td>Launch acceleration</td>
<td>2</td>
<td>152-170</td>
<td>150</td>
</tr>
</tbody>
</table>

4. sprinting – 5 minutes – 175 beats per minute;
5. gymnastic exercise – 6 minutes – 140 beats per minute.

Thus, the average indicator of pulse rate in preparatory part contained: (90+110+160+140+175):5=135 beats per minute.

The average result of young football players’ heart rate in fulfilling main types of exercises in physical preparation has its distinctions and characterizes next indicators of HR (Table 1).

The results of the Table 1 describe that, when carrying out gymnastic exercises on the site, heart rate contained 115-121 beats per minute, gymnastic exercises in motion – 120-135 beats per minute, in conducting outdoor games – 151-159 beats per minute. Doing free heel-and-toe walking on average contained 105-113 beats per minute. When conducting launch acceleration, higher heart rate which fluctuated from 152 to 170 beats per minute was observed.

Young football players’ pulse rate in different game activities and technical elements is presented in Table 2. The data discovered that higher heart rate indicators (171-185 beats per minute) were noted while conducting game activities at quarter part of a pitch without the goal areas with 2х2 players. Next higher level of heart rate (164-172 beats per minute) was recorded in a small-sided game which field size covered 35x18 meters, number of participants was 7x7 or 6x6 and one time prolonged 10 minutes. Further, dribbling bypass with four posts at a distance of 20 meters with following beat to goal (157-164 beats per minute). The least level of heart rate was noted when the players practiced hitting the stationary ball off the ground with a short hop (113-125 beats per minute).

Structure of lessons was one of the most important issues in terms of the allocation of classes and training loads; for instance, a coach designed a plan for each individual training drill. Having pulse characteristics of individual physical drills, a coach could choose exercises more rationally and vary the loads while constructing educational training plan. Based on the study of heart rate using

Table 2

<table>
<thead>
<tr>
<th>Type of drills</th>
<th>Duration of performance (min.)</th>
<th>Repetition</th>
<th>Pulse rate (beats/minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>average</td>
<td>min</td>
<td>max</td>
</tr>
<tr>
<td>Tapping the stationary ball with a running start at a distance of 10-12 meters</td>
<td>5</td>
<td>15-20</td>
<td>113-125</td>
</tr>
<tr>
<td>Tapping the moving ball with a hop to the goal area</td>
<td>5</td>
<td>10-15</td>
<td>140-145</td>
</tr>
<tr>
<td>Dribbling in a circle</td>
<td>5</td>
<td>-</td>
<td>127-151</td>
</tr>
<tr>
<td>Juggling</td>
<td>5</td>
<td>-</td>
<td>112-114</td>
</tr>
<tr>
<td>Passing the ball in motion in pairs</td>
<td>5</td>
<td>20-25</td>
<td>114-150</td>
</tr>
<tr>
<td>Dribbling posts and kick accuracy (20 m)</td>
<td>5</td>
<td>4-6</td>
<td>157-164</td>
</tr>
<tr>
<td>Football game ¾ of a pitch without the goal area with 2x2 players 5 series through 3 min., break between series – 3 minutes</td>
<td>20</td>
<td>5</td>
<td>171-185</td>
</tr>
<tr>
<td>A small-sided game with field size 35x18 m, with 6x6 players</td>
<td>10</td>
<td>-</td>
<td>164-172</td>
</tr>
<tr>
<td>Two-sided game 11x11 or 9x9</td>
<td>40</td>
<td>-</td>
<td>156-160</td>
</tr>
</tbody>
</table>
radio telemetry, chronometry of training drills, and games performed by young football players, we explored next pulse rate in separate parts of trainings (Table 3).

### Table 3

<table>
<thead>
<tr>
<th>Parts of training classes</th>
<th>Pulse rate (beats)</th>
<th>Average indicator (beats/minutes)</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary</td>
<td>2400-2800</td>
<td>120-140</td>
<td>20</td>
</tr>
<tr>
<td>Main</td>
<td>9800-9900</td>
<td>155-165</td>
<td>60</td>
</tr>
<tr>
<td>Final</td>
<td>1300-1500</td>
<td>130-145</td>
<td>10</td>
</tr>
<tr>
<td>For training</td>
<td>13500-14200</td>
<td>135-150</td>
<td>90</td>
</tr>
</tbody>
</table>

This conducted research study gave an opportunity to identify more typical structure of training classes for young football players of age 15-16 years, whose pulse rate reached 17.7-19.7% in the preliminary part, 69.7-72.6% in the main part, and 9.6-10.5% in the final part out of total pulse rate of training activities.

Moreover, a slightly different ratio of load upon the indicators of pulse rate can be noticed in training activities where main part is two-sided game. This game starts with warm-up activities and pulse rate involves 20% of the total training class, and the game comprises 63.4-64.1% of pulse rate in 20 minutes. Accordingly, the average level of heart rate during the two-sided game should be in range of 160-175 beats per minute. Therefore, the pulse rate in such training activity includes 9700-10520 beats (Table 4).

### Table 4

<table>
<thead>
<tr>
<th>Parts of training classes</th>
<th>Pulse rate</th>
<th>Average level (beats/minutes)</th>
<th>Duration (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up</td>
<td>1860-2140</td>
<td>124-142</td>
<td>15</td>
</tr>
<tr>
<td>Game (two halves per 20 minutes)</td>
<td>6215-6670</td>
<td>160-175</td>
<td>40</td>
</tr>
<tr>
<td>Break</td>
<td>950-1010</td>
<td>95-110</td>
<td>10</td>
</tr>
<tr>
<td>Final</td>
<td>675-700</td>
<td>120-135</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>9700-10520</td>
<td>138-150</td>
<td>70</td>
</tr>
</tbody>
</table>

**Discussion**

The results of our research study determined the regimes of young football players’ heart rate at the age of 15-16 years throughout different training activities with different intensity in physical and technical preparations likewise the research studies by following authors Drust, Reilly (1997), and Stratton et al. (2004).

It was noticed that higher heart rate was reached while carrying out initial shoots by young footballers for 1-2 minutes. Kotzamanidis et al. (2005) and Stolen et al. (2005) mentions that higher heart rate is reached while conducting intense running and jumping exercises. According to present study, young footballers HR in preparatory parts is within the limits of 120-140 beats per minute, however, under average indicator, it is 135 beats per minute.

As stated by Armstrong and McManus (2011), research subjects’ pulse rate reached 150-160 beats per minute while conducting the preparatory part of high sport abilities.

The results of this study, in terms of physiological regime, indicate the effect of organism in the main part of training drills to be matching with the data by Bunc and Psotta (2001), who give evidence that the performance of physiological effect is sufficient, however, it still does not reach the high level of footballers’ tournament standard, for instance, as Reilly et al. (2000) showed the results of HR to reache 170-190 beats per minute.

The suggested structure of training classes gives opportunity to allocate the load taking into account the availability of adjustment period within optimal work capacity and reduced productivity against the background of increasing fatigue.

Depending on the pulse rate, average level of HR, and motor concentration, young footballers’ classes should be divided into three loads as low, middle and high.

Consequently, in order to determine the motor concentration in training activities, the method of chronometry can be used as a dimension. Time intervals spent by young football players to fulfil physical and technical exercises during the training classes are registered by stopwatch in a special time card. The ratio of these time intervals in the total duration of trainings in percentage characterizes its motor density. The higher motor activity is, the higher physiological effect, which means the lung ventilation and oxygen consumption (VO₂) gets increased. Using this method, we developed the assessment criteria of training loads to apply in preparation classes of young football players. The pulse rate of low intensity exercises for 90 minutes
contain 7000–7500 beats, oxygen consumption (VO2) – 1.5–2.0 litres per minute, motor density – 30–35%, average physical loads – 8500–9000 beats, VO2 – 2.0–2.5 litres per minute and 40–50% respectively, whereas the pulse rate of high intensity exercises comprise 9500–10000 beats, VO2 respectively, whereas the pulse rate of high intensity exercises comprise 9500–10000 beats, VO2

Therefore, the results of this study, as well as other researchers (Stolen et al., 2005; Liitle, Williams, 2006; Rampinini et al., 2007; Mosey, 2009) fill in gaps in this area where physical loads of young football players’ functional systems are of studies matter.

Conclusions
1. Determining the pulse rate of cardiovascular system, activities performed by young football players using radio telemetry device help to observe organism reaction to different physical loads during whole physical training classes.
2. Higher reaction of cardiovascular system in physical activities are noted in carrying out repeated game exercises within technical trainings at a quarter part of the pitch without goal areas with 2×2 players and also with 6x6 players.
3. Among young football players’ physical activities the most intensive work of cardiovascular system requires launch acceleration for 2 minutes, running jumps, and outdoor games.
4. Radio telemetry analysis registered players’ heart rate (HR), defined the pulse rate of separated parts of training and competitive activities. Received data allow coaches to classify training loads in intensity zones that help them correlate the training curriculum of young football players.

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Kazachstano nacionalinis Abajaus pedagoginis universitetas

SANTRAUKA


KIEMIŲ KRŪVIŲ REGULIAVIMAS IR KONTROLĖ


Raktažodžiai: jaunieji futbolininkai, fizinis krūvis, pulso dažnis, pratybos.