Article

Sustainable Innovation in Football Referee Training in Czech Republic

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Abstract: Professional football has been recently characterized by an increase in game speed and complexity. From this, it follows that football referees also need to improve their skills to keep up with players and adequately respond in various disputed situations. The purpose of this work is to increase the performance indicators of physical fitness and activity of referees during the annual cycle. Most referees prefer the game method. For a football referee or referee's assistant during a game, physical activity is similar to that of runners/athletes. Football referees are engaged in performance that is more intense, as compared to their assistants, at the international level especially. Such conditions are close to extreme and are characterized by an intense physical load dictated by game duration. This study suggested using athletics in comprehensive sustainable training of football referees. As it turned out, athletics-based training significantly improved the motor activity of football referees.

Keywords: football referee; referee’s assistant; heart rate; physical activity

1. Introduction

Football is among the most popular team games of our time [1]. A distinguishing feature of football is that it is played by people of all nationalities and ages [2]. There is also no gender inequality in football: women’s teams are well-known and popular in the world. Thus, football is quite democratic; it is played by teams of both professionals and amateurs. Football teams have multimillion-strong armies of fans around the world who are attracted by a dynamic simultaneous movement of players, referees, and professionally performed tactics [3,4]. Often these actions and techniques are performed at speeds inaccessible to an average person and the result of such actions is quite unpredictable [5].

Professional football has been recently characterized by an increase in game speed and complexity [6]. From this, it follows that football referees also need to improve their skills to keep up with players and adequately respond in various disputed situations. The referee must be present at an optimal distance from the players and their interactions to adequately assess the situation and make an appropriate, qualified decision [6]. This requires the referee to select a right place on the pitch and position while making his/her decision. In addition, good physical fitness is required. A referee’s lack of preparedness generally results in wrong decisions during a match [7].

It is known that referees most often make mistakes at the end of each half of a match or during the last minutes [8]. The reason for this is, first of all, physical fatigue, which accumulates during the match and lowers alertness. Due to physical fatigue, a referee also makes decisions more slowly in controversial situations.

Given the importance of the referee profession, a large number of studies have been conducted in recent years. They were devoted to various areas, for example:
• the process of preparing a referee at the initial level;
• formation of basic skills in the process of preparation;
• organizational aspects of preparation;
• development of psycho-physiological skills necessary for a professional referee [8–10].

Some researchers focused on the psychological aspects of a referee’s activity [9,11]. A small number of works are devoted to the underlying component of referee’s activity: physical activity [7,12,13]. However, there are no works on the annual training cycle for referees. This determines the relevance of this work.

The activity of athletes including football referees takes place under the conditions of a triple load: educational, physical, and competitive. To withstand the latter, significant and systematic volitional efforts are needed. Such efforts are possible only with the motivation expressed through sustainable learning. Sustainable training involves a set of training activities for football referees. Such training will allow referees to be in good physical shape, corresponding to their professional level. This sustainable training takes a long time and contributes to the achievement of high professional results.

The Czech Republic has its own teams (Athletic Club Sparta Praha Football, FC Viktoria Plzen and others), which constantly participate in various football competitions. Some of them took first places in the championships of the Czech Republic, the Czech Cup, and the Czech Super Cup. To a large extent, the effectiveness of the team is determined by the quality of the referee’s work. There are no special studies on the sustainable training of referees in the Czech Republic, which also determines the relevance of this study.

Most of the issues related to the professional activities of referees in football are not fully studied [14], in particular, the physical activity of the referees and their assistants on the football pitch during the match. There is only fragmentary information on the basic training for referees, namely, the standards of physical fitness, physical activity, and the physical load that referees have to endure during the match [11].

All of the above indicates the lack of systematic information about the physical activity of referees during football matches. Existing data do not reflect the specifics of the profession of a football referee [12]. However, there is the variety of constantly changing situations on the football pitch, from which the need arises to identify a certain set of psychophysiological qualities of a referee. Existing standards reflect the level of physical fitness required for matches. It is necessary to have special standards of referees’ physical activity [15].

Athletics are a universal tool in the sustainable training of athletes in various sports [16,17]. It is used in triathlon, figure skating, orienteering, and other sports. For football referees, athletics offer a system of exercises but there is no scientific justification for the effectiveness of their application [18]. Thus, this issue remains relevant. To incorporate athletics into the physical training program for referees, it is necessary to take into account the performance of referees during the match. The transfer of athletics to their training improves their physical fitness and positively affects the quality of refereeing. However, an organized and scientifically sound integration of athletics into the training system of football referees is necessary. At the moment, there is no such system, which determines the need for this study. This study, in accordance with the goals and objectives, is devoted to the scientifically sound implementation of athletics training as a mandatory component of referees’ training. In addition, the authors investigated the effect of athletics training on the physical fitness of referees in comparison with the control group of referees that trained without elements of athletics. The proposed training methods for referees should increase the level of their physical preparation and professional activity, since all kinds of sports are multi-vector and multi-factor activities.

The set of athletics exercises is aimed at increasing the physical fitness of referees, without hindering their professional activities. Moreover, referees with better physical training (acquired during training with elements of athletics) will better cope with their duties, appearing more quickly in the right place on a football pitch at the right time.
The purpose of this work is to increase the performance indicators of physical fitness and activity of referees during the annual cycle.

In this case, the object of study is the process of training football referees, and the subject is the content of this training.

The authors put forward a hypothetical assumption that the increase in the level of physical fitness of referees in football is based on:

- means of athletics that are adapted to the motor activity of referees;
- standards for the level of physical activity, corresponding to the level of requirements for referees;
- drawing up a sustainable training plan for football referees, depending on their skill level.

The authors set the following tasks based on the purpose of the study:

1. identifying the main parameters of physical training for referees of different skill levels;
2. application in practice of the methodology (developed by the authors) of using athletics in football referees’ training.

In practical terms, the proposed methodology reflects the relevance of athletics for the motor activity of football referees.

The use of the proposed methodology will enhance physical fitness of football referees and allow them to react adequately and quickly in controversial situations during the match. The developed methodology is a set of sound methodological solutions that represent the results of the research. The study is based on athletics and physical training methods for athletes who specialize in endurance running. Besides, in the proposed methodology, the authors use various situational exercises in combination with athletics (simulating situations during matches). These exercises comprise elements of professional motor activity of football referees and enable a comprehensive psychophysiological development. The methodology is aimed at improving the physical fitness necessary for the professional activities of football referees of various qualifications. The main idea of this technique is to develop a training process program for football referees in the annual training cycle. The loads are planned using athletics and take into account the peculiarities of physical activity.

At the first stage of developing the methodology, it has been decided to implement the following:

- monitoring motor activity of football referees of various qualifications and specializations;
- analysis of the calendar plans of football competitions at various levels;
- studying the current physical training of referees;
- studying modern training techniques for athletes specializing in endurance running.

In the second stage of developing methodology, the one-year training cycle has been divided into periods and the motor activity with the use of athletics has been developed. Namely, the annual macrocycle is divided into periods and stages, the structure of mesocycles and microcycles is created, and the volumes and types of load are established. The third stage of developing the methodology is about its practical application, monitoring the expected results, correction and testing. A special situational control standard is developed to determine the level of physical fitness of football referees.

The physical activity of football referees of various qualifications has been monitored during the refereeing of matches. Thus, the motor activity of football referees is characterized and the requirements are identified for the level of physical fitness depending on the level of competition. This study understands athletics as a practice of activities engaged in normally to improve physical fitness. Physical training programs for referees lack a scientifically well-grounded athletic component, as compared to training programs for football players. Therefore, developing physical training program for referees with an athletic component is a relevant task. This study uses elements of athletic training to improve the physical training program for referees and justifies the resultant program design in a practical setting.
2. Materials and Methods

2.1. Research Design and Sample

In 2018, the authors conducted a survey of 41 football referees. The studies were conducted anonymously; all participants gave their consent to the experiment. The survey was conducted in the territory of Prague (Czech Republic). The authors aimed at determining the level of physical fitness depending on the qualifications of the referees. The authors also wanted to identify the most important professional qualities of referees from this point of view.

In addition, the authors conducted practical observations in order to identify the features of referees’ physical activity during football. At the same time, the authors took part in the sustainable training, which was then evaluated. Observations were made among the referees of the Organization of Football Referees (Czech Republic) during their training sessions. A total of 15 experimental games were held with the participation of the referees.

Based on the methods used, the group of subjects was divided into two subgroups. The first consisted of 20 people, the second 21. Participants were male, age differences were not significant (average age 25 ± 2.3 years). The first group included initial-level referees (12 people), as well as referees taking part in football matches of professional level (8 people). The second (control) group consisted of 11 referees of the initial level and 10 of the professional. In order to ensure the uniformity of the groups, the selection of referees was carried out through testing. Testing was an initial level of training, as described in the Methods section. Thus, the referees from the first group were engaged in the proposed program for adapting athletics to training, and the second (control) group in the usual program, without athletics elements.

2.2. Experiment

In order to identify the degree of physical load for referees of different skill levels, physiological indicators and physical activity were measured using a sports watch (PolarM400, with Global Positioning System (GPS), and also with a heart rate sensor). The following parameters were evaluated:

- the method of referee’s movement in the pitch;
- movement route (in meters, m);
- distance of movement at different speeds (meters per second, m/s).

Heart rate was evaluated as an indicator of the physical load (heartbeats per minute). The parameters were fixed both for the entire match and for the halves taken separately. This more accurately indicated the relationship between the investigated parameters. For the route of movement, the total duration was estimated, as well as for different ranges of speed of movement. Heart rates for different ranges are presented in % of the total match time. A separate comparative assessment of the physical load level (heart rate, etc.) was carried out depending on the level of the match.

The percentage of error in the heart rate sensor on a sports watch did not exceed 1%, nor up to 2% on a GPS sensor.

The level of physical fitness of referees was also checked. To do this, the authors used the Yo-Yo test, as well as the interval test, followed by fixing the following parameters: heart rate, as well as the distance covered by the referee (in meters). Testing took place on a football pitch with artificial turf (grass), with a mandatory warm-up for half an hour. Yo-Yo tests are used in football. There are two types of tests: (1) a regular intermittent Yo-Yo endurance test; (2) a Yo-Yo recovery test. In the regular Yo-Yo test, players perform a shuttle run with short recovery intervals between jerks. The usual Yo-Yo test assesses the ability of players to perform long variable work after already completed significant physical work on endurance (in this test, players are given 5 s rest periods between jerks). The objective of the Yo-Yo intermittent recovery test is to determine the ability of players to recover from intense
physical activity. In this test, the speed is higher than in the endurance test, and the rest intervals are 10 s.

To justify the differences in the applied methods of athletics between the referees from the experimental group, the Yo-Yo method was also used. This method was used by referees from the experimental group at the beginning and at the end of the training period using athletics methods. These referees performed 6 repetitions of running at maximum speed on 40-meter distance, as well as the Yo-Yo test. During the run, the rest time between each of its stages (from the first to the sixth repetition) did not exceed 1 min. At the start of the run, the run-up was carried out from a distance of up to 1.5 m from the start line. For accuracy, the Microgate system was used. In the next step, after the run, the referees performed the Yo-Yo test. The test was performed after 8 min of recovery from running load. The Yo-Yo test was performed as a shuttle run between two markers; the distance between the markers was 20 m. After each run between the markers, the recovery time was 10 s. With the help of sound signals, an ever-increasing running speed was set. If the referee did not have time to reach the second marker twice on a signal, the run was considered completed. Thus, the test results were reduced to the number of retries passed or to the distance in meters. To unify the data, the test was conducted on a football field with artificial turf, and all participants were wearing the same shoes. The required physical warm-up time was half an hour.

The results of the initial and final tests of referees from the experimental group were compared among themselves, from which a conclusion was drawn about the effectiveness or inefficiency of the applied methods of athletics. In addition, similar tests, also at the beginning and at the end of the research period, were applied to referees who did not use athletics methods in their training. Differences were detected for referees within the same group. All measurements were made during training hours and revealed referee progress.

2.3. Statistical Analysis

Data were processed using the program Past v 3.0. Past v 3.0 program is a package of statistical analysis that allows one to calculate various statistical values: significance of differences, arithmetic mean and error of the mean, and correlation values (if any). The normal distribution of attributes determined the choice of parametric methods of mathematical statistics [19,20]. The tables give the mean values and mean errors. Differences between parameters were determined using Fisher’s exact test for independent samples. The differences were significant at \( p \leq 0.05 \).

3. Results

3.1. Survey and Pedagogical Experiment

Referees can be divided in two groups according to their responses:

(a) 65% are referees who have experience in football competitions at various levels, from primary (children’s and youth teams) to professional;

(b) 35% are referees who have no football training experience; they have switched to football from other sports.

The majority of referees in the first group work with children and youth teams (70%), others work with non-professional teams consisting of adults (25%). The first group also includes referees from professional football clubs. Referees in the second group were engaged in other sports before switching to football.

When processing the results, significant differences were obtained between groups (Figure 1). Referees in the first group highly assessed their capabilities and experience, their level of physical fitness, and physical load tolerance during training and games. They also had a lower percentage of injuries, as compared to the second group.
Figure 1. Referee survey results in the first and second groups as a %.

Significant differences in the first three indicators were recorded (at $p \leq 0.05$) in favor of more experienced referees (group 1). There is a slight difference with regard to the frequency of injuries in favor of less experienced referees (at $p \leq 0.05$).

Figure 2A shows physical characteristics that are important for a football referee.

An endurance indicator is more important for the first group of more experienced referees. Regarding other indicators (speed, agility, and strength), no significant differences between groups were found. Respondents in the second group evaluated flexibility by assigning minimum importance to it. For these respondents, flexibility was three times less important than for respondents in the first group (at $p \leq 0.05$). During the match, the referee must stay in shape, perform physical activity, and be focused on completing tasks.

At the same time, the first group is heterogeneous in composition. It includes football referees with different levels of experience. This affected their training system (Figure 2B). First-category and FIFA (Fédération Internationale de Football Association) referees spend twice as more time on training than lower-category referees do (at $p \leq 0.05$). They use a training system eight times more often during training (at $p \leq 0.05$) and turn to the trainer’s help and advice seven times more often (at $p \leq 0.05$). Referees of the second category spend more time playing football as part of the team and many are engaged in self-training. Thus, even referees in the first group follow no training system or have irregular training sessions.
Figure 1. Referee survey results in the first and second groups as a %. Significant differences in the first three indicators were recorded (at $p \leq 0.05$) in favor of more experienced referees (group 1). There is a slight difference with regard to the frequency of injuries in favor of less experienced referees (at $p \leq 0.05$).

Figure 2A shows physical characteristics that are important for a football referee.

(A) Survey results in groups 1 and 2 as a %. (B) Survey results in group 1 as a %.

The results of the pedagogical experiment show that referees prefer specific training methods (Figure 3).

Figure 2. (A) Survey results in groups 1 and 2 as a %. (B) Survey results in group 1 as a %.

The results of the pedagogical experiment show that referees prefer specific training methods (Figure 3).

Figure 3. Referees’ football training methods used in the experiment.
Most referees preferred the game method; the even, interval, and variable methods were 4 times less popular ($p \leq 0.05$). The repeated method occupies the bottom place in the list; it was 12 times less popular compared to the game method ($p \leq 0.05$).

### 3.2. Experimental Data

The authors recorded the following types of referees’ physical activity during the games: walking, running at different exercise intensities, sidestep walking, and backward running. Depending on the referee’s competence and competition, the types of motor activity varied. Walking was the main motor activity when it came to the lower levels of competition and lower referee’s categories. This applied to both referees and their assistants. Side steps and backward walking were used depending on the personal qualities of each referee as well as on the game.

The city championship games raised minimum requirements for physical activity to both referees and their assistants (Table 1). Competitions of this type normally involve lower category referees, although there might also be referees of higher qualification.

<table>
<thead>
<tr>
<th>Average Motor Activity Per Game</th>
<th>Referee</th>
<th>Assistant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6988 ± 347</td>
<td>2957 ± 198</td>
</tr>
<tr>
<td>Speed m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01–2.5</td>
<td>3245 ± 256</td>
<td>1403 ± 109</td>
</tr>
<tr>
<td>2.5–3.0</td>
<td>2654 ± 341</td>
<td>1117 ± 124</td>
</tr>
<tr>
<td>3.0–4.5</td>
<td>851 ± 99</td>
<td>334 ± 48</td>
</tr>
<tr>
<td>4.5–5.0</td>
<td>141 ± 29</td>
<td>69 ± 15</td>
</tr>
<tr>
<td>&gt;5.0</td>
<td>97 ± 17</td>
<td>34 ± 10</td>
</tr>
</tbody>
</table>

The city-level games were characterized by minimal intensity of physical activity. Players mostly moved with a speed of 0.01–2.5 m/s, sometimes up to 3 m/s. The referee’s speed of movement was two times higher than that of the assistant referee ($p \leq 0.05$). This difference is relevant for all kinds of physical activity ($p \leq 0.05$).

Speeds grow in a regional championship (Table 2). As in city-level competitions, movement speeds of 3 m/s and lower prevail here. However, there is more than a twofold difference between referees and assistants ($p \leq 0.05$).

<table>
<thead>
<tr>
<th>Average Motor Activity Per Game</th>
<th>Referee</th>
<th>Assistant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7536 ± 345</td>
<td>3140 ± 199</td>
</tr>
<tr>
<td>Speed m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01–2.5</td>
<td>3477 ± 231</td>
<td>1305 ± 131</td>
</tr>
<tr>
<td>2.5–3.0</td>
<td>2876 ± 287</td>
<td>1372 ± 151</td>
</tr>
<tr>
<td>3.0–4.5</td>
<td>921 ± 117</td>
<td>357 ± 59</td>
</tr>
<tr>
<td>4.5–5.0</td>
<td>153 ± 27</td>
<td>75 ± 18</td>
</tr>
<tr>
<td>&gt;5.0</td>
<td>109 ± 23</td>
<td>30 ± 13</td>
</tr>
</tbody>
</table>

At international competitions, referees and their assistants move at even higher speeds (Table 3). However, significant differences were recorded ($p \leq 0.05$) in motor activity between referees and their assistants in international, regional, and city competitions.
Table 3. Motor activity of referees and their assistants in international championship.

<table>
<thead>
<tr>
<th>Average Motor Activity Per Game</th>
<th>Referee</th>
<th>Assistant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19998 ± 465</td>
<td>3705 ± 281</td>
</tr>
<tr>
<td>Speed m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.01–2.5</td>
<td>4215 ± 261</td>
<td>1356 ± 137</td>
</tr>
<tr>
<td>2.5–3.0</td>
<td>3701 ± 245</td>
<td>1687 ± 167</td>
</tr>
<tr>
<td>3.0–4.5</td>
<td>1692 ± 102</td>
<td>522 ± 56</td>
</tr>
<tr>
<td>4.5–5.0</td>
<td>203 ± 34</td>
<td>97 ± 14</td>
</tr>
<tr>
<td>&gt;5.0</td>
<td>187 ± 28</td>
<td>43 ± 11</td>
</tr>
</tbody>
</table>

Thus, competitions hold at the international level set higher fitness requirements that must be met by referees and their assistants. The gap between referees and their assistants increased by more than 2.5 times, especially with movement speeds of more than 5 m/s (fourfold increment, at $p \leq 0.05$) and < 2.5 m/s (2.6-fold increment, at $p \leq 0.05$). Thus, referees and their assistants move 30% faster during the international play, as compared to city and regional championships.

The body of a football referee must withstand significant physiological load to overcome large distances and sharp changes in speed. In particular, heart rate in athletes of this level tended to increase (Table 4).

Table 4. Different heart rates for referees and their assistants in matches of different levels, %.

<table>
<thead>
<tr>
<th>Heart Rate, Category, Beats Per Minute</th>
<th>City-Level Championship</th>
<th>Region-Level Championship</th>
<th>International Championship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Referee</td>
<td>Assistant</td>
<td>Referee</td>
</tr>
<tr>
<td>&lt;110</td>
<td>9</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>111–130</td>
<td>33</td>
<td>56</td>
<td>29</td>
</tr>
<tr>
<td>131–150</td>
<td>32</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>151–170</td>
<td>23</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>171–180</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>&gt;180</td>
<td>1</td>
<td>&lt;1</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

When considering city-level, regional-level, and international competitions, significant differences might be noticed. For instance, the proportion of referees with a heart rate of <110 beats per minute declined by 3% (at $p \leq 0.05$), while their assistants demonstrated no trend that could be considered similar. Data in the table above show a 12% drop in referees with a heart rate of up to 130 beats and a 13% drop in assistant referees (at $p \leq 0.05$). This suggests that referees and their assistants both experienced an increase in their heart rates with higher levels of championship. The proportion of referees with a heart rate of 131–150 beats per minute increased by 5% in international games, as compared to regional and city games. In contrast, the proportion of assistant referees grew significantly more, by 10%. From this, it follows that for assistants, changes starting from heart rate of 131–150 are more significant (up to 2 times) than those of referees (at $p \leq 0.05$).

International football referees and their assistants with a heart rate of 151–170 showed an opposite trend: The proportion of referees increased by 10% (at $p \leq 0.05$) and the proportion of assistants grew only 4%. Apparently, the performance of assistants during the international game corresponds to the heart rate of 131–150, while the performance of referees falls within the range from 151 to 170. In the territories of ≥171 bpm, changes were insignificant: the proportion of referees increased twofold, from 2% in city and regional championships to 4% in the international championships (Table 4, at $p \leq 0.05$). This suggests the existence of a physiological threshold, beyond which no effective changes in the heart rate can be detected. Referees, thus, demonstrate greater stamina, as compared to assistants.

To sum up, the referee’s work is more intense, as compared to their assistants, especially in international championships. Conditions to which football referees are exposed during the international game are close to extreme and are characterized by an increased physical load. The authors detected
an improvement in football referees’ physical fitness throughout the experiment (in the experimental group). Undoubtedly, the proposed training methodology with the athletic component allowed referees to get the best physical shape and perform effectively at competitions of various levels. To conclude, higher levels of competition associate with better referee performance. Similarly, the greater the referee’s experience, the better the results.

Tests of referees from the experimental group showed a significant increase in the results in the final test compared to the initial one (Table 5).

Table 5. The average results of the initial and final tests in 6 repetitions of running at a distance of 40 m and Yo-Yo tests among referees from the experimental and control groups.

<table>
<thead>
<tr>
<th></th>
<th>Start of experiment, control group, in seconds</th>
<th>Start of experiment, experimental group, in seconds</th>
<th>End of experiment, control group, in seconds</th>
<th>End of experiment, experimental group, in seconds</th>
<th>Yo-Yo test, start of experiment, control group, in meters</th>
<th>Yo-Yo test, start of experiment, experimental group, in meters</th>
<th>Yo-Yo test, end of experiment, control group, meters</th>
<th>Yo-Yo test, end of experiment, experimental group, in meters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.61 ± 0.02 *</td>
<td>5.60 ± 0.02 *</td>
<td>5.60 ± 0.02 *</td>
<td>5.45 ± 0.03 *</td>
<td>1492 ± 66 **</td>
<td>1487 ± 64 **</td>
<td>1490 ± 65 **</td>
<td>1755 ± 69 **</td>
</tr>
</tbody>
</table>

Notes. * differences are significant at p ≤ 0.05 between the results of running in the experimental group at the end of the study and the rest of the results; ** similarly for Yo-Yo tests.

Thus, differences were observed between the end result of the experimental group and all other results. In the control group, the results of running and Yo-Yo tests did not show significant changes between the beginning and end of the experiment, while the experimental group showed significant progress. This indicates the effectiveness of the applied methods of athletics for training football referees.

4. Discussion

There are diverse ways to investigate the performance of football referees on the pitch during the match. Recently, in addition to standard methods, computer simulation of the game process has also been used [21,22].

For a football referee or referee’s assistant during a game, physical activity is similar to that of runners/athletes. The average distance covered by a football referee per match is 8–10 km. At the same time, heart rate varies at different intervals, depending on the intensity of movement in a given game context. The body of a football referee is subjected to significant stresses, physical and psychological [23]. In addition to motor activity, a constant alertness is necessary for adequate refereeing. The physiological load imposed on football referees is mainly aerobic. As it rises (i.e., in the international game setting), the duration of aerobic activity prolongs.

The athletic set of exercises in modern realities is used in various sports (e.g., orienteering and triathlon). The reason for this adaptation lies in the availability of means offered by athletics for athletes. These athletes include football referees.

Today, many athletes use systematic sustainable training, which includes a set of training tools and methods [24]. Football referees also need to apply a comprehensive and systematic approach to their training. These diverse methods need to be scientifically systematized [25]. In the case of football referees, an individual approach is necessary that will take into account physical parameters and capabilities. For referees, both intermittent and continuous training methods are suitable. Continuous training is performed at different speeds with either even or variable exercises. Interval or repeated methods include rest periods [14].
The annual training program for referees can provide for the use of all methods in different combination. This may be considered an advantage. Programs that are shorter or longer in duration can use each of the above training methods separately [16].

For football referees, sustainable training planning is one of the most difficult aspects [26]. Different stages in the preparation cycle contain a large number of diverse tasks. For the most successful planning and achieving high results, one needs to have an idea of the competition schedule. The specificity of football referees’ work is that most often they learn about the upcoming game with their participation in just one to two weeks. Therefore, football referees need to be in good physical shape throughout the season [27]. This is especially critical for those who participate in high-level competitions. Programs dedicated to football referees and their training exist in all EU countries, for example, in France, Belgium, and the Czech Republic [28–31]. In the Czech Republic, there is a program for training and advanced training of football referees. The program has been implemented since 2009; the age of candidates for referees should be between 21 and 30 years [32].

The program includes methods of theoretical and practical training of referees, as well as tactics and techniques for different game situations [33]. This reflects an integrated approach to the education of future referees and advanced training of existing ones. Referees are also trained at the University of Brno, in a physical education and sports program launched in 2011, a specialty “team sports referee”. Up to date, there are about 4000 registered referees in the Czech Republic [34,35]. Such a mass character implies the need for comprehensive sustainable training. Athletics methods, proposed by the authors of this article, are the most suitable in this case. As shown in this article, athletics-based training significantly increases the level of motor activity of football referees. More experienced referees, as data showed, gave priority to qualities such as endurance. Referees of this category showed maximum results at all levels of competition. Accordingly, their training system is the most optimal. However, such a training system will provide even greater results if it includes regular athletics exercises. The introduction of the proposed methodology and comparison of the results can be discussed in future works.

5. Conclusions

The survey results in group 1 show that first-category and FIFA referees spend twice as much time on training compared to lower-category referees (p ≤ 0.05). They use a training system eight times more often during training (p ≤ 0.05) and turn to the trainer’s help and advice seven times more often (p ≤ 0.05). Referees of the second category spend more time playing football as part of the team and many are engaged in self-training. Thus, even referees in the first group follow no training system or have irregular training sessions. Referees and their assistants move 30% faster during international play, as compared to city and regional championships. Performance of assistant referees in international football games corresponds to a heart rate of 131–150 beats, while football referees themselves have a heart rate that falls under into range of 151–170. The referee’s work is more intense, as compared to their assistants, especially in international championships. Conditions to which football referees are exposed during the international game are close to extreme and are characterized by an increased physical load. The present findings may be used as a framework in designing development programs for football referees. As it may well be seen, physical training using athletics enables a higher physical fitness, compared to training without the athletic component. The study showed that the introduction of a new factor in the training process, namely athletics, significantly improved the results. However, this introduction of a new factor only improves the general indicators of endurance and other characteristics of the physical fitness of football referees and can be recommended as a new, non-invasive method.

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analysis. K.A., R.O., H.T. and P.X. wrote the final draft and conducted the review, proof reading, and editing for final submission. All authors have read and agreed to the published version of the manuscript.

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**References**

17. Petrov, R.E. Sustainable sport: Cardio-differentiated planning of fitness programs for school boys engaged in speed skiing. *For high school boys engaged in speed skiing*. *Sustainability* **2019**, *11*, 6077. [CrossRef]


29. Lombardo, G.; Mazzochetti, A.; Rapallo, I.; Tayser, N.; Cincotti, S. Assessment of the economic and social impact using sroi: An application to sport companies. *Sustainability* **2019**, *11*, 3612. [CrossRef]


35. Córdova Paredes, M.J.; Calabuig Moreno, F.; Alonso Dos Santos, M. Key determinants on non-governmental organization’s financial sustainability: A case study that examines 2018 fifa foundation social festival selected participants. *Sustainability* **2019**, *11*, 1411. [CrossRef]

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