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Original Scientific Article

Physical activity of football players in different speed modes and tactical formations

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Abstract

Background and Study Aim. The relevance of the study is stipulated by the search for criteria for assessing the playing activity of football players based on the distance covered in the mode of individual threshold of maximum running speed (PD>70%). The goal is to find out the features of the physical activity of football players in different speed modes and PD>70% during the game in the 1-4-1-4-1 and 1-5-4-1 tactical formations.

Material and methods. The total distance (TD), the length of the distance run at low intensity, less than 14.4 km/h (LIR), in the running mode 14.41-19.8 km/h (R), with high, more than 19.8-25.2 km/h (HSR) speed and sprint - 25.21 km/h (SD) were determined in 15 football players, using the GPS system. Additionally, the distance in high-speed running HSR+SD (VHIR) and the distance in the PD>70% mode were studied. The results of the distance run in the 1-4-1-4-1 and 1-5-4-4-1 tactical formations, per game and in the first and second half, were compared. The number of observations was 30 (n=189).

Results. Comparison of the distance in the running mode TD, LIR, R and SD in football players in the 1-4-1-4-1 and 1-5-4-1 tactical formations did not reveal any significant differences (p>0.05).

The distance per game in the 1-4-1-4-1 tactical formation for the high-speed mode VHIR was statistically significantly greater (p=0.023) than in the formation 1-5-4-1. In the 1-5-4-1 tactical formation, the distance covered by players in the running mode VHIR was statistically significantly greater in the first than in the second half (p=0.045).

Comparison of the results for the parameter of intensive running PD>70% in the conditions of different tactical schemes showed significant differences in the volume of motor activity of football players. This is confirmed by a statistically significant greater distance in the mode of intensive running PD>70% for the 1-4-1-4-1 tactical formation per game (p=0.012) than in the 1-5-4-1 formation. Also, in the 1-5-4-1 tactical formation we found a statistically significant greater distance in PD>70%1 compared to PD>70%2 (p=0.002).

Comparison of the results for the parameter of intensive running PD>70% in the conditions of different tactical formations showed significant differences in the volume of motor activity of football players. This is confirmed by a statistically significant greater distance in the mode of intensive running PD>70% for the 1-4-1-4-1 tactical formation per game (p=0.012) than in the 1-5-4-1 formation. Besides, in the 1-5-4-1 tactical formation, we found a statistically significant greater distance in PD>70%1 compared to PD>70%2 (p=0.002).

Conclusions. The studies have found that playing in the 1-4-1-4-1 and 1-5-4-1 tactical formations does not make any significant differences in the amount of total motor activity TD and in the low LIR, R intensity and SD running mode.

Analysis of the motor activity of football players in the 1-4-1-4-1 tactical formation revealed a significant advantage in the distance covered in running mode according to the parameter of the individual threshold of maximum speed PD>70% and HSR and high intensity VHIR, compared to the 1-5-4-1 game formation

Key words: physical activity, tactical formations, distance length, GPS systems, running modes.

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Анотація

Фізична активність футболістів різних швидкісних режимах і тактичних формаціях

Валерій Шамардін, Вячеслав Мулик, Володимир Лизогуб, Віталій Шпанюк

Передумови та мета дослідження. Припустили, що одним з точних критеріїв оцінки ігрової активності футболістів може бути обсяг дистанції у режимі індивідуального порогу максимальної швидкості бігу (PD>70%). Мета - з'ясувати особливості фізичної активності футболістів у різних швидкісних режимах та PD>70% під час гри в тактичних формаціях 1-4-1-4-1 і 1-5-4-1.

Матеріал і методи. У 15 футболістів за допомогою GPS системи визначали загальну відстань (TD), довжину дистанції, яку пробігали з низькою інтенсивністю, меншою за 14,4 км/год (LIR), у режимі бігу 14,41 - 19,8 км/год (R), з високою, більшою ніж 19,8-25,2 км/год (HSR) швидкістю та спринту - 25,21 км/год (SD). Додатково, досліджували відстань у високошвидкісному бігу HSR+SD (VHIR) та дистанцію в режимі PD>70%. Порівнювали результати пройденої відстані в тактичних схемах 1-4-1-4-1 і 1-5-4-4-1, за гру та першому і другому таймі. Кількість спостережень становила 30 (n = 189).

Результати. Порівняння дистанції в біговому режимі TD, LIR, R і SD у футболістів в тактичних формаціях 1-4-1-4-1 і 1-5-4-1 істотних відмінностей не виявили (p > 0,05). Дистанція за гру в тактичній формації 1-4-1-4-1 для високошвидкісного режиму VHIR була статистично значуще більшою (p=0,023), ніж у формації 1-5-4-1. У тактичній формації 1-5-4-1 пройдена дистанція гравцями в режимі бігу VHIR була статистично значуще більшою в першому, ніж у другому таймі (p=0,045). Порівняння результатів за параметром інтенсивного бігу PD>70 % в умовах різних тактичних схем показало значні відмінності обсягу рухової активності футболістів. Це підтверджує статистично значуща більша відстань у режимі інтенсивного бігу PD>70 % для тактичної схеми 1-4-1-4-1 за гру (p=0,012), ніж у формації 1-5-4-1. Також у тактичній формації 1-5-4-1 ми виявили статистично значущу більшу дистанцію в PD>70%1 порівняно з PD>70%2 (p=0,002).

Висновки. Дослідженнями встановлено, що гра в тактичній формації 1-4-1-4-1 і 1-5-4-1 не вносить будьяких суттєвих відмінностей в обсяг загальної рухової активності TD і в режимі бігу низької LIR, R інтенсивності та SD. Аналіз рухової активності футболістів у тактичній схемі 1-4-1-4-1 виявив істотну перевагу пройденої дистанції в режимі бігу за параметром індивідуального порога максимальної швидкості PD>70% та HSR і високої інтенсивності VHIR, ніж ігрова формація 1-5-4-1.

Ключові слова: фізична активність, тактичні схеми, довжина дистанції, GPS-системи, режими бігу.

Introduction

Football is one of the most technologically advanced sports. Many benefits of technology in football include helping players and coaches achieve peak performance, providing fans with informational content, video analysis, etc. [1]. At the same time, elite football matches require players to perform repeated sprints at varying speeds, alternating with short and long rest periods [2, 3, 4, 5]. Both training and competition demands typically dictate the intensity and speed of movement and can change at any time. In addition to regular changes in intensity or speed of movement, decisive aspects of games such as goals are most often preceded by accelerations, sprints, dashes, jumps, and shots [6].

It is important that training is aimed at improving and recreating repetitive, maximal and high-intensity game actions. Previous research supporting this view has shown that for football players to be successful, they need to be able to perform technical and tactical actions at high speed with excellent recovery capabilities [7].

Technological innovations have paved the

way for a new era of football where players can train better, coaches can gain comprehensive data-driven insights to improve in-game decision making, and medical staff have access to effective player health monitoring. These innovations are improving the game of football, helping teams gain a competitive advantage over others.

Player physical activity monitoring is one of the most common technologies in football. The equipment uses GPS systems and wearable tracking devices to collect data on players' physical activity during training and competitions. These devices can measure distance covered, speed, acceleration, heart rate and other parameters, which allow coaches to assess players' performance and develop individual training for each of them. It also helps coaches to determine football requirements, players' performance during matches and improve the training process [6, 8].

The outcome of a game in football is considered to be influenced by various factors, such as technical, tactical and physical training, as well as mental training and genetically determined typological properties of the nervous system, etc. [9,

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10, 11, 12].

In general, the strategy of assessing physical fitness by using GPS tracker systems is widely used in modern football. This technology allows assessing the physical activity of football players, the distance covered in certain speed ranges, average speed, maximum number of sprints, etc. for each athlete during games and training [5, 13].

A football player is known to cover on average from 9 to 13.5 km during a game [6, 14, 15]. However, due to the variable nature of the game, the total distance covered is a rather superficial method of assessing the physical fitness of football players [14]. It is necessary to consider the amount and frequency of high-speed running and other actions that players perform at maximum intensity.

Elite football players have been observed to perform 8 to 18 sprints during a game [16]. The sprints that a football player performs during a game usually last from 10 to 25 meters for 3-5 seconds [15]. Recently, attention has been drawn to the importance of reducing the number and duration of recovery after intense game actions in a competitive environment. This has increased attention to the specificity of training, opened new discussions and research in the field of repeated sprint training (RST) in football [2]. Therefore, according to some studies, the importance of RSA as a fundamental physical component in team sports is unquestioned [17]. However, the development of fatigue in team sports such as football is associated with the ability to reproduce sprints.

Many researchers [6, 18, 19] have investigated the distance covered by football players in different tactical formations. Players in the 1-4-4-2 and 1-4-3-3 formations covered greater distances when running, while those in the 1-4-5-1 formation had an advantage when walking [20].

It has been shown that the total distance covered was the same for players in different tactical formations [21]. However, the amount of highand very high-intensity running was different for different tactical formations. Players in the 1-4-5-1 formation performed less very-high-intensity running when their team had the ball, but more when they did not have the ball, compared to the 1-4-4-2 and 1-4-3-3 formations. Attackers used 30% more very-high-intensity running in the 1-4-3-3 formation than in the 1-4-4-2 and 1-4-5-1 formations [22]. Although the amount of highintensity running and recovery time in very-highintensity bouts were the same, more effort was observed in players in the 1-4-4-2 and 1-4-3-3 formations. These differences in the 1-4-5-1 formation may be due to tactical reasons. The use of this formation is aimed at increasing the number of players who perform a defensive function and occupy a smaller playing space [9].

There are only limited studies [19], that have attempted to study the running performance of professional football players in specific patterns. Various factors in the studies may influence the preparation and participation of professional football teams in official matches. This is likely the reason for the limited number of studies on this issue.

It is considered that the study of various aspects of physical activity is an important component of training and competitive work. Therefore, the influence of various tactical formations on the special physical performance of professional football players is constantly being discussed and requires close study [23, 24].

Based on the above, we assumed that: 1) different tactical formations should form the characteristics of game activity with different speed modes; 2) we expected that the results of the players' running volume, in the PD>70% mode of individual maximum speed and the distance covered in the high-speed VHIR mode can contribute to a deeper understanding of the characteristics of the game organization in different tactical formations.

Therefore, the study is aimed to experimentally verify and contribute to the science that studies the characteristics of physical activity in different speed modes when playing in the 1-4-1-4-1 and 1-5-4-1 tactical formations. Such results can provide information on which aspect of physical fitness should be developed in football players and understand their development mechanisms. Based on the above, the aim of this study was to find out the characteristics of physical activity in different speed modes when playing in the 1-4-1-4-1 and 1-5-4-1 tactical formations. It is necessary to test the experimental hypothesis of whether the distance in the individual threshold of maximum speed PD>70% is a more accurate estimate of specific performance in football compared to the volume of high-speed work VHIR.

Materials and methods

Participants

The experiment involved 15 elite football players. The studies were approved by the Biomedical Ethics Committee, and the subjects were informed of the experiment purpose and gave written consent. The experimental design included research in competitive conditions. Physical activity data were collected from 30 matches played in the 1-4-1-4-1 and 1-5-4-1 tactical formations. These are the games of the Championship (Premier League) and the National Cup, as well as the Champions League in the 2022 (second round) – 2023 seasons.

During the experiment, the team played 48

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official games, the main team and the coaching staff did not change. 15 players withstood the experimental conditions (26 games in the 1-4-1-4-1 formation and 4 in the 1-5-4-1 tactical formation).

The experiment was conducted: only for official matches of the Championship, Cup (opponents from the Premier League) and the Champions League; the teams had to finish the match without disqualifying players; the tactical formation from the start of the game remained unchanged throughout the match; only outfield players participated; the players had to start and finish the match in the same position and tactical formation.

We determined the main anthropometric indicators, age, height, weight, fat percentage, playing experience, assessed the qualifications, whether the football player was involved in national teams. In 15 football players, their age was 26.40 ± 1.15 , the height was 181.4 ± 1.77 cm, the body weight: 73.23±1.71 kg. The percentage of body fat was measured during the experiment: "Tanita BC-545 N" and it was: 9.78±0.47%, and sports experience was 19.67±1.20. It was established that 13 (87%) football players participating in the experiment were involved in various teams and 11 players (73%) - in the national team. Based on this, we can assume that the skill level of the players is quite high. The number of observations was n = 189. A single research regimen was followed for all subjects.

Procedure

Using the database (cloud) of the Catapult Vector X7 tracking system and its OpenField console software (version 3.11.0), we determined the physical activity indicators of football players in the field during scheduled football games. We determined the total distance traveled (TD), the length of the distance that the team ran at low intensity (LIR<14.4 km/h), runs with an intensity of -14.41–19.8 km/h (R), at high speed (HSR -19.8 km/h–25.2 km/h) and in sprint mode (SD>25.21 km/h). Additionally, we determined the distance that the football players ran in a running mode of more than 70% of the individual maximum speed (PD>70%) and the distance covered in the high-

speed running mode VHIR, that was established in similar studies [4, 6, 25].

Statistical processing of results

The statistical analysis of Microsoft Excel 2019 software was applied to the results. The data were checked for normal distribution using the Shapiro-Wilk criterion. Since the data fell under the law of normal distribution, we determined the mean value (m), the error of the mean (\pm m). Comparison of the results of physical activity of the same players in the first and second halves, as well as game tactical schemes, was conducted using a comparison of the means of two dependent samples (Paired T-Test). Pearson's coefficient was used for correlation analysis. The level of statistical p-significance was <0.05 [26, 27].

Results

During the calendar games of the National Football Championship and Cup, as well as the Champions League of the 2022-2023 season, physical activity in the 1-4-1-4-1 and 1-5-4-1 tactical formations was studied. TD, LIR, R, HSR and SD were determined. In addition, the distance that the players ran in the running mode of more than 70% of the individual maximum speed (PD>70%) and the distance covered in the highspeed running mode HSR+SD (VHIR) were determined. The number of observations was 189 in 30 games.

A study of the physical activity of football players in game conditions showed that the average distance of team movement in the 1-4-1-4-1 tactical formation was $10,273.89\pm223.82$ m, and in the 1-5-4-1 tactical formation - 10,123.04±267.07 m. No statistically significant differences in the distance covered during the game were found (p=0.429) (Table 1).

In the 1-4-1-4-1 and 1-5-4-1 tactical formations, we did not find statistically significant differences in the distance covered by the team players in the LIR, R and SD running modes (p > 0.05). However, it was found that during the game in the 1-4-1-4-1 tactical formation, the team players ran a statistically significant greater distance in the HSR running mode than in the 1-5-4-1 tac-

Table 1. Distance covered by football players in various tactical formations and speed modes $(X\pm m)$

| Tactical | Distance covered, m. | | | | | | | |
|---|----------------------|---------------------|---------------------|------------------|------------------|------------------|--|--|
| formations | TD | LIR | R | HSR | SD | PD>70% | | |
| 1-4-1-4-1 | 10 273.89 ±223.82 | 7 815.60 ±101.05 | 1 680.98 ±102.74 | 617.35 ±40.01 | 159.62 ±18.39 | 400.00 ±30.31 | | |
| 1-5-4-1 | 10 123.04 ±267.07 | 7 912.81 ±143.77 | 1 541.15 ±112.57 | 544.57 ±43.87 | 124.24 ±7.93 | 309.42 ±27.32 | | |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.429 | 0.406 | 0.233 | 0.034 | 0.062 | 0.012 | | |

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Table 2. Total distance covered by football players during the game, in the first and second halves in different tactical formations ($X\pm m$)

| Tactical formations | Dis | t-Test: Paired Two Sample for Means – P (T<=t) | | |
|--|----------------------|--|---------------------|---------------|
| | TD | TD ₁ | TD ₂ | $TD_1 - TD_2$ |
| 1-4-1-4-1 | 10 273.89 ±223.82 | 5 203.86 ±110.92 | 5 097.03 ±114.83 | 0.015 |
| 1-5-4-1 | 10 123.04 ±267.07 | 5 089.76 ±139.22 | 5 033.28 ±138.45 | 0.469 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.429 | 0.316 | 0.516 | |

Table 3. Total distance covered by football players in low-speed running mode in the first and second halves when playing in different tactical formations $(X\pm m)$

| Tactical formation | Dis | t-Test: Paired Two Sample for Means - P(T<=t) | | |
|--|---------------------|---|--------------------|-------------------------------------|
| | LIR | LIR ₁ | LIR ₂ | LIR ₁ - LIR ₂ |
| 1-4-1-4-1 | 7 815.60 ±101.05 | 3 932.83 ±50.95 | 3 903.84 ±54.87 | 0.292 |
| 1-5-4-1 | 7 912.1 ±143.77 | 3 945.15 ±63.71 | 3 967.66 ±91.27 | 0.731 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.406 | 0.804 | 0.439 | |

Table 4. Total distance covered by football players in low-speed running mode per game, in the first and second halves in different tactical formations $(X\pm m)$

| Tactical formations | Di | t-Test: Paired Two Sample for Means - P(T<=t) | | |
|--|------------------------------|---|------------------|-------------|
| | R | R ₁ | R ₂ | $R_1 - R_2$ |
| 1-4-1-4-1 | 1 680.98 ±102.74 | 868.76 ±52.44 | 816.06 ±50.43 | 0.001 |
| 1-5-4-1 | 1 541.15 ± <i>112</i> .57 | 790.86 ±70.06 | 750.29 ±44.54 | 0.244 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.233 | 0.298 | 0.144 | |

tical formation (p=0.034). In the PD>70% speed mode, we found statistically significant differences (p=0.012) between the studied tactical formations. Whereas the distance covered by the football players during the game, as well as in the first and second halves in different tactical formations was almost the same (p>0.05) (Table 2).

It should be noted that when playing in the 1-4-1-4-1 tactical formation, a statistically significant greater distance was found that the players covered in the first than in the second half (p=0.015). Whereas, when playing in the 1-5-4-1 tactical formation, no such differences were found.

The distance covered by the football players in low-speed running mode during the game, as well as in the first and second halves when playing in different tactical formations, was almost the same (Table 3). There were no statistically significant differences in the distance covered in the LIR running mode per game, nor for the first and second halves in the 1-4-1-4-1 and 1-5-4-1 tactical formations (p>0.05). Comparison of the results of the football players' physical activity of in the conditions of game activity in the LIR running mode both in the 1-4-1-4-1 and 1-5-4-1 tactical formations did not reveal statistically significant differences between the halves (p>0.05).

The results of the study of the football players' physical activity in the conditions of game activity showed that the average distance of the team's movements in running mode with intensity R (14.41-19.8 km/h), in the 1-4-1-4-1 tactical formation was 1,680.98 \pm 102.74 m, and in the1-5-4-1 tactical formation, respectively -1,541.15 \pm 112.57 m. (Table 4).

We did not find any statistically significant dif-

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Table 5. Total distance covered by football players in high-speed mode per game, in the first and second halves in various tactical formations $(X\pm m)$

| Tactical formations | Distance covered, m | | | t-Test: Paired Two Sample for Means - P(T<=t) |
|---|---------------------|------------------|------------------|---|
| | HSR | HSR ₁ | HSR ₂ | HSR ₁ - HSR ₂ |
| 1-4-1-4-1 | 617.35 ±40.01 | 319.31 ±22.12 | 299.62 ±19.65 | 0.145 |
| 1-5-4-1 | 544.57 ±43.87 | 281.19 ±23.59 | 263.38 ±24.86 | 0.401 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.034 | 0.083 | 0.051 | |

Table 6. Total distance covered by football players in high-speed sprint mode per game, in the first and second halves in various tactical formations (X±m)

| Tactical formations | Dis | tance covered | t-Test: Paired Two Sample for Means - P(T<=t) | |
|---|------------------|-----------------|---|---------------|
| | SD | SD ₁ | SD ₂ | $SD_1 - SD_2$ |
| 1-4-1-4-1 | 159.62 ±18.39 | 82.76 ±10.30 | 77.37 ±9.18 | 0.41 |
| 1-5-4-1 | 124.24 ±17.93 | 72.43 ±10.71 | 51.81 ±8.51 | 0.013 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.062 | 0.340 | 0.017 | |

ferences in the total distance covered during the game and between halves in the R speed mode. The distance in the first half in the R running mode for the 1-4-1-4-1 tactical formation was statistically significantly greater than in the second half of the game (p=0.001). Whereas, for the 1-5-4-1 tactical formation, no differences in the distance covered in the R running mode between halves were found (p=0.244).

The game using the 1-4-1-4-1 tactical formation showed that the average distance covered by the team's players in the HSR speed mode was greater being to 617.35 ± 40.01 m, than with the 1-5-4-1 tactical formation - 544.57 ± 43.87 m. These values were confirmed by statistically significant differences (p=0.034). We did not find any other statistical differences between the studied schemes and comparison between halves (Table 5).

Comparison of the study results of the distance covered by football players in the HSR speed mode in the first and second half did not allow to establish any statistically significant differences (p>0.05). This feature of motor activity in the HSR running mode was characteristic of both 1-4-1-4-1 and 1-5-4-1 tactical formations.

The results we obtained when analyzing the physical activity in the 1-4-1-4-1 and 1-5-4-1 tactical formations for the SD running mode show that there are no statistical differences in physical activity in the sprint mode. Thus, football players in the sprint mode with the 1-4-1-4-1 formation covered a distance of 159.62 ± 18.39 m during the game, and in the 1-5-4-1 game formation - 124.24 ± 17.93 m (p=0.062). When comparing the characteristics of the physical activity of foot-

ball players in the SD running mode for the 1-4-1-4-1 and 1-5-4-1 tactical formations between halves, we found statistically significant differences (p=0.017) only between the distances in the second half of the game (Table 6).

Comparing the distance of SD_1 and SD_2 in the 1-4-1-4-1 tactical formation we did not find statistically significant differences (p=0.41). Whereas, for the1-5-4-1 the formation, distance covered by SD_2 players was statistically significantly less than SD_1 (p=0.013).

For further comparison of high-speed running with the distance of running in the submaximal and maximal intensity mode, we conducted a statistical analysis of the distance covered in the VHIR running mode. This is the sum of the HSR and SD speed modes. It shows that when playing in the 1-4-1-4 formation, players run a statistically significant longer distance than when playing in the 1-5-4-1 formation (p=0.023). Comparing the distance covered by players between halves, in these tactical formations, we found statistically significant differences (p=0.016) only in the VHIR₂ indicator (Table 7).

Comparing the results of the distance covered, which we obtained between the halves within the tactical formations, we found statistically significant differences (p=0.045) in the distances between the first and second halves only in the 1-5-4-1 tactical formation. In the 1-4-1-4 formation, we did not find statistically significant differences.

We were also interested in the question of the characteristics of the football players' physical activity in the 1-4-4-1 and 1-5-4-1 tactical formations for high-intensity running greater than 70%

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Table 7. Total distance covered by football players in submaximal and maximal intensity speed mode during the game, in the first and second halves in various tactical formations $(X\pm m)$

| Tactical formations | Dis | tance covered | t-Test: Paired Two Sample for Means - P(T<=t) | |
|---|------------------|-------------------|---|---------------------------------------|
| | VHIR | VHIR ₁ | VHIR ₂ | VHIR ₁ - VHIR ₂ |
| 1-4-1-4-1 | 776.97 ±53.19 | 402.08 ±28.27 | 376.99 ±27.12 | 0.132 |
| 1-5-4-1 | 668.81 ±56.82 | 353.63 ±27.72 | 315.18 ±31.61 | 0.045 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.023 | 0.079 | 0.016 | |

Table 8. The total distance covered by the football players in terms of the intensive running parameter more than 70% of the maximum individual speed threshold under different tactical formations $(X\pm m)$

| Tactical formations | Dis | tance covered | t-Test: Paired Two Sample for Means - P(T<=t) | |
|--|--------------------------|---------------------|---|---|
| | PD>70% | PD>70% ₁ | PD>70% ₂ | PD>70% ₁ - PD>70% ₂ |
| 1-4-1-4-1 | 400.00 ±30 .31 | 207.16 ±17.12 | 193.83 ±15.37 | 0.288 |
| 1-5-4-1 | 309.42 ±27 .32 | 171.36 ±12.53 | 138.06 ±15.99 | 0.002 |
| t-Test: Paired Two Sample for Means – P (T<=t) | 0.012 | 0.070 | 0.005 | |

of the individual maximum speed PD>70%. The results obtained reflect the distance that the football players covered in the high-intensity running mode PD>70% (Table 8).

Comparing the results of the PD>70% studies in different tactical formations, we found that players covered a statistically significant greater distance playing in the 1-4-1-4-1 formation than in the 1-5-4-1 formation (p=0.012). Comparing the distance covered by PD>70% between halves revealed statistically significant differences only in the second half. The distance covered by the players in the PD>70% mode in the 1-4-1-4-1 formation was statistically significantly greater than when playing in the 1-5-4-1 formation (p=0.005).

The results of the statistical analysis of the distance covered by the players between halves within the formations under study allowed us to establish a statistically significant difference (p=0.002) between the PD>70%₁ and PD> PD>70%₂ indicators in the 1-5-4-1 tactical formation. In the 1-4-1-4-1 tactical formation, we did not find any reliable differences between the PD>70%₁ and PD>70%₂ indicators (p=0.288).

Thus, the above results of the study show that playing in the1-4-1-4-1and 1-5-4-1 tactical formations does not introduce any significant differences in the volume of motor activity TD and in the low LIR, R intensity and SD running mode. Whereas, the game activity of the team's football players shows that the 1-4-1-4-1 tactical arrangement in high-speed running activity modes HSR, VHIR running mode, and, especially, according to the parameter of the individual threshold of maximum speed PD>70% has a significant advantage in the distance covered than the 1-5-4-1 formation.

Discussion

The article presents the study results of football players' physical activity with different running intensities for different tactical formations. The results were obtained in the matches of the group stage of the AFC Champions League and the Premier League, as well as the National Cup of the 2022-2023 seasons and classified depending on the game tactical formation. The analysis was conducted according to the indicators of the distance covered by the football players TD, LIR, R running intensity HSR and SD, and VHIR and PD>70% were additionally determined per game, in the first and second halves. The results showed that the1-4-1-4-1 or 1-5-4-1 tactical formation has little effect on overall physical activity and the distance covered in low-intensity running mode.

Comparison of the results in the TD, LIR, R and SD running modes of football players when playing in the 1-4-1-4-1 and 1-5-4-1 tactical formations did not reveal any significant differences. In addition, in the 4-1-4-1 tactical formation, a statistically greater distance was covered by the football players in the first (TD₁) than in the second (TD₂) half of the game (p=0.015) (Fig. 1).

When playing in the 1-5-4-1 tactical formation, no statistically significant difference was found in the distance covered in the first (TD_1) and second (TD_2) halves of the game (p=0.469). It seems that the tactical formation of players

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Fig. 1. Total distance covered (m) by football players during the game (TD), in the first (TD₁) and second (TD₂) halves when playing in tactical formations: \Box - 1-4-1-4-1 and \blacksquare - 1-5-4-1



Fig. 2. Total distance covered (m) by football players in high-speed mode (HSR), in the first (HSR₁) and second (HSR₂) halves when playing in tactical formations: - 1-4-1-4-1 and - 1-5-4-1

has a weak relationship with the total distance covered by the team (TD) and the distance covered in the low-intensity running mode LIR and R. Most likely, the overall technical and tactical preparation has a greater impact on the game results than the tactical formation of the team on the distance covered in the low-intensity running mode, as previously suggested [28, 29]. However, since we did not analyze the technical and tactical characteristics of players in relation to the formations and the distance covered in different running modes in this study, such considerations should be confirmed in future studies. It will be necessary to conduct an analysis of the distance covered by the team's players in low and high intensity running modes in the 1-4-1-4-1 and 1-5-4-1 formations, which will be integrated with the technical and tactical characteristics.

The results of our study demonstrate the high physical demands on players participating in the football championship. It is shown that the results of the distance covered by team players per game TD, LIR and R in the 1-4-1-4-1 and 1-5-4-1 tactical formations do not differ from the results obtained by other studies and football players from other countries. These results clearly show that the overall physical activity of players in matches is poorly related to tactical formations. An insignificant effect of tactical formation on the distance covered in the first and second halves in elite football is demonstrated. Although these results may seem contradictory if we take into account the considerations that a high level of physical activity and the total distance covered per game is an important indicator that affects the success of the match [10, 29].

Considering that previous studies have shown higher running fitness rates in elite football players [14, 30, 31], it is not surprising that the scientific community often points out that a high level of distance covered per game can be an expression of successful game activity [10]. However, this postulate is not supported by our results, which we obtained in this study for the TD total motor activity and low-intensity running mode. We did not obtain statistically significant differences in the LIR and R running mode. Therefore, the results of researchers [4, 5], were analyzed, which showed that the distance covered at higher speeds could have an advantage, especially in the



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Fig. 3. TTotal distance covered (m) by football players in high-speed mode (SD), in the first (SD₁) and second (SD₂) halves when playing in tactical formations: - 1-4-1-4-1 and - - 1-5-4-1



Fig. 4. Total distance covered (m) by football players during the game in high-speed mode (VHIR), in the first (VHIR₁) and second (VHIR₂) halves in tactical formations: - 1-4-1-4-1 and - 1-5-4-1

last segment of the match. In particular, it was found that the winning result was characterized by an increase in the distance covered only in the HSR running mode [5]. We also obtained the differences in the distance covered in the HSR running mode during the game in the 1-5-1-4 and 1-4-1-4-1 tactical formations (Fig. 2).

Our results showed that the distance covered in the HSR running mode was greater in the first than in the second half for the 1-4-1-4-1 formation than for the 1-5-4-1 formation (p=0.034).

Significant statistical differences ($p \le 0.05$) were found among the different formations in terms of the distance covered with a running intensity of more than 25.2 km/h. The results we obtained when playing in the 1-4-1-4-1 formation showed the advantages of motor activity in the sprint mode compared to the players who played in the 1-5-4-1 formation (Fig. 3.)

This advantage was especially evident during the second half, which might indicate greater activity in the attacking actions of the football players in the conditions of the 1-4-1-4-1 tactical formation than in the conditions of the game in the 1-5-4-1 formation.

Whereas, in the 1-4-1-4-1 tactical formation, the distance covered in the VHIR running mode was statistically significantly greater (p=0.023) than for the 1-5-4-1 game formation. For the distance of the first (VHIR₁) halves of these same tactical formations, we did not find any reliable differences in covering the distance (p=0.079) (Fig. 4).

The distance covered per game by players in the 1-4-1-4-1 tactical formation for the highspeed VHIR mode was statistically greater in the second half (p=0.016) than in the 1-5-4-1 formation. Additionally, in the 1-5-4-1 tactical forma-

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Fig. 5. Total distance covered (m) by football players during the game in high-speed mode (PD>70%), in the first (PD>70%1) and second (PD>70%2) halves in tactical formations:

tion, the distance covered by players in the running VHIR mode was statistically greater in the first half than in the second half (p=0.045).

Studies in the Spanish La Liga showed similar performance of players at higher speeds [29]. Similarly, studies were conducted in the German Bundesliga and found that the total distance and high-intensity running of the players were similar regardless of the total number of points scored [10]. Similar results for HSR and SD running physical activity preceding goal scoring were also found by other researchers. It is clear that group differences become more evident as the game reaches its final stage. This is similar to the studies that reported higher sprint and high-intensity running actions during the last 15 minutes of the game. These differences were only evident in sprinting actions, which are considered key to success in football [25, 32]. Thus, the ability to maintain players' running speed in VHIR mode in the late stages of a match may be beneficial to the team and increase the likelihood of winning, especially given the drop in physical activity in the second half of the match in both the 1-4-1-4-1 and 1-5-4-1 formations [6, 33].

It should be emphasized that our research was one of the first to study differences in physical activity in terms of distance covered in individual high intensity running mode PD>70% in different tactical formations (Fig. 5).

Comparison of the results of the study on the parameter of intensive running PD>70% of the maximum individual speed threshold under the conditions of different tactical formations showed significant differences in the volume of motor activity of football players. This is confirmed by a statistically significant greater distance in the intensive PD>70% running mode for the 1-4-1-4-1 tactical formations per game (p=0.012) and in the second half (p=0.005). Besides, for the 1-4-1-4-1 tactical formation we found no statistically signifi-

cant differences in the distance covered PD>70%, and PD>70%, (p=0.288). Whereas, in the $1-5^{-1}$ 4-1 tactical formation we found a statistically significant greater distance covered in PD>70%, compared to PD>70%, (p=0.002). However, the key role of these high-speed parameters should not be underestimated. The increased intensity and speed of the players' movements lead to the maximum production of pyruvate, which initiates the Krebs cycle and chemical reactions for energy production. This energy cycle is assumed to be directly responsible for the production of adenosine triphosphate (ATP) and, according to previous reports, is known for its numerous benefits: lower blood lipids, increased endurance during training, aerobic activity, increased ATP/energy production [6]. Thus, the presented results of the study show that playing in the1-4-1-4-1 or 1-5-4-1 tactical formation does not introduce any significant differences in the volume of motor activity TD and in the mode of running low LIR, R intensity and SD. Whereas, a more thorough analysis of the study results of the team's football players motor activity showed that the1-4-1-4-1 tactical formation had a significant advantage in the distance covered in the mode of running HSR and high intensity VHIR, especially in the parameter of the individual threshold of maximum speed PD>70%, than the 1-5-4-1 game formation (Fig. 6).

Fig. 6 shows that the 1-4-1-4-1 tactical arrangement has a significant advantage in the distance covered in the high-intensity running mode VHIR, especially in terms of the individual threshold of maximum speed PD>70%, compared to the 1-5-4-1 game formation.

Statistical analysis of the distance covered by the same players in the speed modes VHIR and PD>70% allowed us to establish a high level of correlation, within the range (r=0.78-0.85; p=0.023-0.005) for various tactical formations (Fig. 7).



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Fig. 7. Correlation (r) of the distance covered VHIR and PD>70% in tactical formations: - 1-4-1-4-1 and *- 1-5-4-1.* a – per game, b – in the first and c – in the second half.

The results of Fig. 7 indicate the existence of a relationship between the VHIR and PD>70% indicators in various tactical formations. Football players with a high level of physical activity in the 1-4-1-4-1 tactical formation were in most cases characterized by high values of the studied VHIR and PD>70% indicators also in the 1-5-4-1 tactical formation.

In conclusion, it should be emphasized that the research results of special game activity presented in the work show that the distance covered by football players in various running modes depends on the tactical formation used by the team (Table 9).

The obtained differences (Table 9) in the physical activity of football players in high-power zones (VHIR and PD>70%) indicate that these indicators are associated with the peculiarity of the tactical organization of the game. The results

indicate that with different game formations, the same players have reliable differences in running activity only in the VHIR zones and individual high-intensity power PD>70%. This may indicate that with different tactical formations, players exhibit different volumes of high-intensity actions depending on their individual capabilities. As a rule, a team that plays in the 1-4-1-4-1 tactical formation spends a lot of time in possession of the ball, performing a large volume of running work (reorganization, opening) in high-speed running modes based on tactical and strategic needs. It becomes clear why high intensity efforts are crucial to the outcome of matches, as they are associated with actions that are key to the final result of the match, such as ball-winning moves, false openings and many others that allow you to beat the opposing team [18].

Thus, various tactical formations have a spe-

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| Table 9. | Features of | the game | activity | of football | players | depending | on the | tactical | formation |
|----------|--------------------|----------|----------|-------------|---------|-----------|--------|----------|-----------|
|----------|--------------------|----------|----------|-------------|---------|-----------|--------|----------|-----------|

| Speed modes | Tactical formations | | | | | |
|-------------|---|--|--|--|--|--|
| Speed modes | 1-4-1-4-1 | 1-5-4-1 | | | | |
| TD | Creates the benefit of the distance covered in the first half | Promotes an even distribution of physical activity in the first and second half of the game | | | | |
| LIR | There are | e no advantages | | | | |
| R | Creates the benefits of higher game activity, especially in the first half | Promotes an even distribution of game activity in the first and second halves of the game | | | | |
| HSR | There are benefits to a higher physical activity compared to the 1-5-4-1 tactical formation in both the first and second halves of the game | Overall physical activity is slightly reduced; physical activity of players is statistically significantly reduced in both the first and second halves | | | | |
| SD | Creates the benefits of higher game activity, especially in the second half | Has reduced motor activity, especially in the second half. Creates the benefits of motor activity in the first half | | | | |
| VHIR | The benefits of higher game activity in both the first and second halves compared to the 1-5-4-1 tactical scheme were established | Significantly inferior in overall motor activity, especially in the second half | | | | |
| PD>70% | Has a significant benefit in the distance covered in high-intensity running mode from the individual maximum speed threshold and maintains it throughout the game | Has slightly reduced special game activity in high-intensity running mode from the individual maximum speed threshold. Creates speed mode benefits in the first half of the game | | | | |

cific effect on the motor activity of football players in various running modes. It seems that in training conditions, effective ratios of various running modes are formed to achieve tactical tasks that will be implemented in competitive activities. They constitute the content of the tactical and technical training of the team and players. We believe that planning and implementation of tactical schemes should consider the goals and objectives of the team, the functional capabilities of the players, as well as the ability of players to overcome the distance in the mode of the individual threshold of maximum speed PD>70%.

The results contribute to a deeper understanding of the characteristics of physical activity of football players, and also offer practical recommendations for coaches on managing the training process and optimizing the team's competitive activities.

Conclusion

The results of the work provide an idea of the features of the game activity of elite football players when using the 1-4-1-4-1 and 1-5-4-1 tactical formations. The results show that playing either in the 1-4-1-4-1 or 1-5-4-1 tactical formations does not introduce any significant differences in the volume of motor activity in the LIR, R and SD running mode. The 1-4-1-4-1 tactical formation has a significant advantage in the distance covered in the high-intensity running mode VHIR,

especially in terms of the individual threshold of maximum speed PD>70%, compared to the 1-5-4-1 game formation. The results show that the distance covered in the VHIR speed mode and PD>70% can be predictive variables and provide more accurate information about the state of special performance of football players in different 1-4-1-4-1 and 1-5-4-1 tactical formations than the LIR, R, HSR and SD running modes. The coaching staff must analyze matches, monitor the physical activity of players, plan training sessions that most accurately simulate game conditions, and develop training protocols in specific tactical game plans.

The next stage of our research is planned to study the modes of running activity in the1-4-1-4-1 and 1-5-4-1 tactical game schemes for players of different game positions.

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Conflict of interest

All authors confirm that there is no conflict of interest in this study.

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