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ORIGINAL ARTICLE

ENERGY EXPENDITURE DURING TRAINING AND OFFICIAL LEAGUE MATCH IN PROFESSIONAL FEMALE SOCCER PLAYERS – A PILOT STUDY

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ABSTRACT

Background. The most important component of a well-balanced diet is the proper energetic value. However, adequate estimation of the body's energy needs is difficult for professional athletes, including soccer players. There is little research showing energy expenditure during training and lack of studies on the energy expenditure of professional female soccer players during a match.

Objective. The aim of our study was to estimate energy expenditure during training and official league match in female soccer players and comparing it.

Material and methods. Seven Polish professionally practicing soccer females (23.4±6,6 years old; 63.5±7.8 kg; 168.5±5.8 cm; 46±4.4 kg fat-free mass) participated in the study. The participants had their height and body mass measured. Energy expenditure during activities was measured by means of a SenseWear Pro3 Armband device. Body composition was assessed with Akern BIA 101 Anniversary Sport Edition device.

Results. Statistically higher energy expenditure was achieved in the study group during the match hour (452±55 kcal/ hour) compared to the training hour (353±28 kcal/ hour) as well as in the case of energy expenditure per hour of activity per kg of fat-free mass (match: 9.94±1.75 kcal/kg fat-free mass/hour; training: 7.71±0.8 kcal/kg fat-free mass/hour). During one hour of training, more time was spent on sedentary, light, and moderate activities, but the difference was statistically significant only for light activities. More time during the match hour than during the training hour was spent on vigorous and very vigorous activities.

Conclusions. In conclusion, the energy expenditure of the players during the match was greater than in the case of the planned intensive training, which was caused by the timeshare of more intense physical activities and going a longer distance during match.

Key words: *training, soccer match, league match, intensity of activities, physical activity, athletes*

STRESZCZENIE

Wprowadzenie. Najważniejszym elementem dobrze zbilansowanej diety jest jej odpowiednia wartość energetyczna. Jednakże odpowiednie oszacowanie potrzeb energetycznych zawodowych sportowców, w tym piłkarzy nożnych, jest niezwykle trudne. Niewiele jest badan wskazujących na wydatek energetyczny w trakcie treningu oraz brak jest badan wskazujących na wydatek energetyczny w trakcie meczu wśród piłkarek nożnych.

Cel. Celem naszych badań było oszacowanie wydatku energetycznego w trakcie treningu i oficjalnego meczu piłkarskiego w grupie kobiet trenujących piłkę nożną oraz porównanie tych wartości.

Materiał i metody. W badaniu wzięło udział siedem polskich profesjonalnych piłkarek nożnych (23,4±6,6 lat; 63,5±7.8 kg; 168,5±5,8 cm; 46±4,4 kg beztłuszczowej masy ciała) Zmierzono masę i wysokość ciała. Wydatek energetyczny w trakcie aktywności mierzono za pomocą opasek naramiennych SenseWear Pro3. Skład ciała oceniono przy użyciu analizatora Akern BIA 101 Anniversary Sport Edition.

Wyniki. Statystycznie wyższy wydatek energetyczny obserwowany był w trakcie godziny meczowej (452±55 kcal/godzinę) w porównaniu do godziny treningowej (353±28 kcal/godzinę) podobnie jak miało to miejsce w przypadku wydatku energetycznego w trakcie godziny aktywności w przeliczeniu na beztłuszczową masę ciała (mecz: 9,94±1,75 kcal/kg beztłuszczowej masy ciała/godzinę; trening: 7,71±0,8 kcal/kg beztłuszczowej masy ciała/godzinę). W trakcie godziny treningu więcej czasu poświęcone było na odpoczynek, aktywności lekkie i o umiarkowanym natężeniu, ale różnica była

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istotna statystycznie jedynie w przypadku aktywności lekkich. Więcej czasu w trakcie godziny meczowej, niż w przypadku godziny treningowej, było poświęcone na aktywności o wysokim i bardzo wysokim natężeniu.
Wnioski. Wydatek energetyczny w trakcie meczu był wyższy niż podczas intensywnego treningu, co było skutkiem większej ilości czasu poświęconego na aktywności o wysokim natężeniu oraz dłuższe dystanse pokonywane w trakcie meczu.

Słowa kluczowe: *trening, mecz piłkarski, mecz ligowy, intensywność aktywności, aktywność fizyczna; sportowcy*

INTRODUCTION

Diet is undoubtedly an element affecting the athlete's exercise capacity. Adequate food and fluid supply before, during and after physical performance may help maximise exercise performance and accelerate recovery time [26].

The most crucial component of a well-balanced diet is the proper energetic value. An adequate energy supply increases the probability of appropriate macro- and micronutrient amounts in the diet. This can have an influence both on health aspects and the optimisation of exercise capacity. Therefore, correctly estimated energy needs are crucial for proper diet preparation. Deficient energy intake may lead to the development of the Relative Energy Deficiency in Sport syndrome (RED-S), which may cause serious health problems (impairment of immunological functions, menstrual-function disorder, osteoporosis, disorders of the growth, as well as endocrine, metabolic, hematological, psychological, gastrointestinal, and cardiovascular systems) and affect exercise capacities (increased injury risk, decreased training response, impaired judgment, decreased motor coordination and concentration, irritability, depression, decreased glycogen supplies, and decreased muscle strength and stamina) [21].

However, adequate estimation of the body's energy needs is difficult for professional athletes, including soccer players. Research shows that soccer players can perform 726 different actions, moves, and turns during a match, while time spent on individual activities varies considerably between players in various field positions [5]. Other studies also show differences in physical activity between players in different positions on the field – midfielders covered greater distances (even by 15%) than players playing in other positions [25]. Factors crucial to success in soccer are agility, strength, the ability to perform repetitive sprinting and stamina [24], which increase individual players` energy needs. Therefore, a unique approach to energy needs assessment is a crucial component of setting proper personal nutritional strategies for soccer players. These athletes should adjust their energy intake from diet to their activity level and aims, which are individual for every player [6]. Also, the energy supply adjustment depends on the training type, activities performed during it, and the training macro- and micro-cycle. Training to improve exercise capacity and prepare for matches may be full of activities with various loads. *Helgerud* et al. [11] showed that training with very high intensity (4 x 4 minutes of running at the level of 90-95% VO2max) resulted in improved performance, increased distance, increased number of sprints and contact with the ball during the match compared to control group, but did not adversely affect parameters such as jump height, strength, speed or precision of passing the ball. *Hoff* and *Helgerud* [13] indicated that the participation of soccer players in strength training with high loads improved their efficiency during a sprint and better jumping ability, with a simultaneous improvement in aerobic capacity, thanks to the progress of the economy of physical exertion . Even tactical training can be very strenuous. As *Hoff* et al. [14] demonstrated, specific football training with ball dribbling and mini-team games can be performed as interval aerobic training, the intensity of which can be as high as 91.7% and 84.5% VO2max, respectively. Therefore, knowing how to translate training into matches is crucial to planning appropriate nutritional strategies for soccer practitioners.

In addition, it should be pointed out that the number of women practising soccer continues to increase. In its plans, FIFA (fr. *Fédération Internationale de Football Association*) has set itself the task of increasing the number of women soccer players to 60 million by 2026 and doubling the number of affiliated members by that year [9]. Despite the growing number of female footballers and affiliated clubs, interest in women's soccer is already huge. In 2015, the Women's World Cup was watched via media by 750 million users, while 1.35 million fans watched the struggles on the pitch [9]. Despite the interest in the topic of women's soccer and development strategies indicating the need for interest in the topic from professional player care, the topic of women's soccer is still marginalised in research. Appropriate energy intake is essential because it supports optimal body function, determines the capacity for the information of macronutrients and micronutrients, and assists in manipulating body composition [1]. Energy deficiencies are often observed in athletes, especially women, resulting in reduced physical performance and growth and adversely affecting health [16]. Some studies examined the fulfilment of energy needs in a group of women training soccer. In their study, *Martin* et al. [20] showed the daily energy expenditure of female soccer players at the level of 2154±596 kcal/day while the daily energy intake with a diet was 1904±366 kcal/day. *Gibson* et al. [10], in turn, in their study group, noted the energy value of the food ration of soccer players at the level of 2079±460 kcal/day, with the daily energy needs averaging 2546±190 kcal/day. *Mullinix* et al. [22] also reported insufficient energy intake with the diet (2014 kcal/day) compared to the needs of the study group (2716 kcal/day). Proper energy supply on training and match days is, therefore, a key to covering the energy needs of soccer players. However, the studies have generally observed too low energy intake from the diet in this group of athletes.

Considering the above, our study aimed to estimate the female soccer players' energy expenditure generated during regular training and official league matches and then compare the analysis of these expenses between activities and players' field positions. The aim of our research was also to examine whether it was necessary to carry out research during the start-up period (during official soccer matches) on a wider group and to test the applicability of the research tools described further on.

MATERIAL AND METHODS

Seven professionally practicing soccer females participated in this pilot study (23.4±6.6 years old). In the study participated: 4 defenders, 2 midfielders and one striker. All the female soccer players were players from one of the teams from the highest Polish women's league (extra league). Also, all the players had many years of training experience. Therefore, they are one of the best Polish female soccer players and should be considered professional. Additionally, it should be emphasised that such a group size, given the nature of the study and the measurement during official competitions, is a representative sample (especially given the pilot nature of the study), looking at the number of female players playing at this league level. The approval of participation in the research and conducting any measurements and tests used during the study was obtained from each participant or their legal guardians (if participants were underage). The study and all procedures used in it were accepted, and permission from the local Ethics and Scientific Research on Humans Commission was obtained (approval number: 24/2017, 19 June 2017).

Inclusion criteria include being under 35 years old, registered in the local Soccer Association and actively participating in training sessions. Exclusion criteria were long-term injuries (without permitting to train within the last six months), those who underwent metal implants operation or were diagnosed with any long-term disease.

Participants' body mass and height were measured twice by means. Height measurement was measured using a standard stadiometer (accurate to within 0.1 cm), and weight was measured using a standard scale, accurate to within 0.1 kg. During body-mass measurements, participants were asked only to wear underwear; during height measurements, no footwear or socks were allowed. From obtained data, a Body Mass Index was calculated.

The fat mass and fat-free mass content were measured by the bioelectrical impedance method (BIA), using the Akern BIA 101 Anniversary Sport Edition (Akern Srl., Italy) device. During the measurement, the participants were not during their period and did not suffer from any mental or physical stress. The analysis was carried out in a tetrapolar system. Before placing the electrodes, the contact points were cleaned with alcohol to remove the stratum corneum and dried. The participants were also asked to remove all metal items and jewellery. During the analysis, all the conditions of measurement correctness recommended by the manufacturer were used. BIA is a simple, reliable, valid body composition assessment tool [17, 18]. This method has a low predictive or standard error [17] and is a non-invasive and accurate [27].

After taking anthropometric and body composition measurements, the participants were put on armbands measuring energy expenditure. Participants wore the armbands for at least one hour before and after training and before and after an official league match. The training structure was not interfered with to avoid disturbing the naturally occurring exercises. However, it was agreed with the trainer that the monitored training would be filled with strenuous exercises of considerable intensity, intended to increase the motor skills and endurance of the players. According to the arrangements with the team's coach, this type of training is the most strenuous and intense for the players.

To measure energy expenditure, the SenseWear Pro3 Armband device was used (Body Media Inc., Pittsburgh, PA, USA). The armband is equipped with five sensors: two skin galvanometers (which measure the electrical conductance of skin), a skin temperature sensor, a heat-flux sensor (that measures the rate at which the body dissipates heat relative to air temperature), and a 3-axial accelerometer (to calculate the motion and intensity of physical activity and the output of total energy expenditure resulting from the intensity of the physical activity). The structure of the device enables measurement reading, including total energy expenditure (TEE), activity energy expenditure (AEE), the average physical-activity level (PAL), the average METs (METs; one MET is the equivalent of aspirated oxygen in 3.5 mL O2/kg body mass/min), the time expenditure of different intensity activities (divided into five categories: <1.5, 1.5–3.0, 3.0–6.0, 6.0–9.0, and >9.0 METs), and many others. Research conducted by using this method is marked by high-accuracy measurements [15, 28], repeatability [15] and a low mean error rate [4]. After collecting the armband results, data on the training unit and the match were separated. The data contained in this way was analysed and compared with each other. Analysis of the records was completed using SenseWear 8.1. software (Body Media Inc., Pittsburgh, PA, USA).

This study omitted the discussion of meeting the nutritional and energy needs of the study group. The intake of energy and other nutrients by study participants has been the subject of other studies and has been published elsewhere [8]. However, it is worth highlighting in the light of these data that the majority of the group studied did not cover their energy needs.

Statistical analysis was conducted using the SPSS v. 20 software (IBM Corp., USA). To verify the normality of distribution, the *Shapiro–Wilk* test was used. For comparison of data collected during training and a league match, in the case of the normal distribution, we used the *Student's* t-test. In the case of a distribution deviating from normality, the *Wilcoxon* test was used. Correlations were tested using the *Spearman* test. The study's defined significance level was set to α=0,05.

RESULTS

The mean body mass in the study group was 63.5±7.8 kg. The mean height in the study group was 168.5±5.8 cm. The average BMI in the study group was 22.3±1.7 kg/m^2. Body composition analysis showed an average body fat content of 27.3±4.3% (17.5±4.4 kg). This meant the lean body mass was 73±3.9% (46±4.4 kg).

Table 1 presents the results obtained during the measurement of energy expenditure. Due to the different amounts of time spent on the pitch during training and a soccer match among other players, the energy expenditure [kcal] was converted into an hour of physical activity. The average energy expenditure during the match was 628±101 kcal, and the average energy expenditure during training was 534±43 kcal. However, no statistically significant difference was observed (p>0.05). Energy expenditure per kilogram of body mass per hour of activity for the match and training was 6.54±0.8 kcal/kg bm/h and 5.6±0.66 kcal/kg bm/h, respectively, and did not differ significantly (p>0.05, *Wilcoxon* test). Statistically, substantially higher energy expenditure was achieved in the study group during the match hour (452±55 kcal/h) compared to the training hour (353±28 kcal/h) (p≤0.05). Significant differences were also found in the case of energy expenditure per hour of activity per kg

Table 1. Energy expenditure during training and a league match

	Energy expenditure [kcal]	Energy expenditure over time [kcal/h]	Energy expenditure depending on body mass [kcal/kgbm/h]	Energy expenditure depending on fat free mass [kcal/kgffm/h]
	Mean±SD (median)			
Match	628±101 (657)	452±55 (453)	6.54±0.8 (6.25)	9.94±1.75 (9.83)
Training	534±43 (540)	353±28 (354)	5.6±0.66 (5.34)	7.71±0.8 (7.36)
p*	0.063	0.018	0.063	0.018

kgbm – kg of body mass; kgffm – kg fat-free mass
* *Wilcoxon* test

Table 2. Number of steps and activity time of varying intensity during training and league match per hour

	Steps	S	L	M	V	VV
	Mean±SD (median)					
Match	5953±588 (5914)	0±0 (0)	0.14±0.37 (0)	18.53±15.42 (14.68)	29.21±9.8 (32.17)	13.12±17.0 (0.61)
Training	4213±363 (4263)	1.21±1.56 (0)	6.42±5.38 (3.33)	27.78±9.95 (22.89)	20.24±8.08 (19.33)	5.01±3.62 (4.33)
p*	0.018	0.109	0.023**	0.128	0.091	0.345

S – Sedentary; L – Light; M – Moderate; V – Vigorous; VV – Very vigorous
All values are based on the hour of activity.
* *Wilcoxon* test
** Due to the normal distribution of the data, the *Student's* t-test was used instead of the *Wilcoxon* test

of fat-free mass (9.94±1.75 kcal/kg FFM/h vs 7.71±0.8 kcal/kg FFM/h, for match and training, respectively).

The time spent on physical activity of varying intensity and the number of steps taken during the match and training per hour is shown in Table 2. Significantly more ($p=0.018$, *Wilcoxon* test) steps were taken during the match hour (5953±588) compared to the training hour (4213±363). During one hour of training, more time was spent on sedentary, light, and moderate activities (1.21±1.56, 6.42±5.38 and 27.78±9.95, respectively) compared to the match hour (0±0, 0.14±0.37 and 18.53±15.42, respectively). However, the difference was statistically significant only for light activities ($p=0.023$, t-test). In turn, more time during the match hour than during the training hour was spent on vigorous and very vigorous activities. Still, the observed difference was not statistically significant ($p>0.05$, *Wilcoxon*'s test).

A correlation was found between the energy expenditure during the match hour and the number of steps during the match hour ($p<0.001$, rho=0.964, *Spearman's* test), which was not observed during the training hour and the number of steps during the hour ($p=0.180$, rho=0.571, *Spearman's* test). The number of steps performed per hour of activity also correlated with the energy expenditure per kilogram of fat-free mass per hour of physical activity during the match ($p=0.003$, rho=0.929, *Spearman's* test) as well as training ($p=0.007$, rho=0.893, *Spearman's* test). However, these relationships were not observed compared to the expenditure per kg of body mass per hour of activity ($p>0.05$, *Spearman's* test).

Energy expenditure during the match hour was strongly correlated with the time devoted to very vigorous activities ($p<0.001$, rho=0.964, *Spearman's* test) and inversely correlated with moderate intensity activities ($p=0.036$, rho=-0.786, *Spearman*'s test). Similar relationships were observed in the expenditure per kilogram of fat-free mass per hour of activity (for vigorous activities: $p=0.003$, rho=0.927; for moderate intensity activities ($p=0.036$, rho=-0.786). The expenditure per kilogram of fat-free mass during training was, in turn, correlated with vigorous activities ($p=0.007$, rho=0.893, *Spearman's* test). Energy expenditure during the training hour, regardless of body mass, was inversely correlated with the activities of sedentary ($p=0.028$, rho=-0.808, *Spearman's test*) and light ($p=0.039$, rho=-0.778, *Spearman's* test) intensities.

DISCUSSION

According to our knowledge, this is the first study of this type to compare energy expenditure and intensity of activities during training and an official league match among women practicing soccer professionally. It is also the first study that uses measuring equipment to classify activity and measure energy expenditure during an official league match.

The energy expenditure during the match was higher than during the training. This applies to absolute values and time (per hour of activity) or per competitor's body mass (total and fat-free mass). However, statistical significance was demonstrated when calculating the energy expenditure per hour of exercise and depending on the athlete's fat-free mass. Energy expenditure per hour of activity is a better indicator for observing differences in expenditure than energy expenditure in absolute terms. This is due to the different periods of participation in the match and training. A comparison of a player who played only 45 minutes during the match and who participated 90 minutes in the training session with a player who played 85 minutes during the match and who participated 80 minutes in the training session would be inadequate. It could give false beliefs about activity intensity during the match and training. Therefore, it should be assumed that the energy expenditure during the match was significantly higher than in the case of training. This raises questions about the fulfilment of nutritional needs by the female participants in the study. As previous studies [8] have shown, female soccer players did not cover their energy needs on training days, when energy expenditure has been shown to be lower. Thus, even more so on a match day, energy shortages can be expected to be even greater than on training days. This, in turn, will result in an increased likelihood of negative health effects, as well as impaired performance.

Many factors may cause a higher energy expenditure during match activity. As indicated by *Olthof* et al. (2019) [23], the energy expenditure will be greater during the match due to the awareness of the need to win and the efforts that go with it, as well as technical and tactical interactions between teams. A study of physical activity and energy expenditure of male soccer players conducted by *Anderson* et al. [2] showed that each of the players covered a longer distance and had higher speed on match days compared to training days, which expressed as higher energy expenditure on match days. Also, the results of studies by *Djaoui* et al. [7] suggest higher energy expenditure during the match. Comparing the maximum sprint speed, the players achieved higher values during the match compared to training in the form of Small Sided Games. However, this study did not evaluate players' total distance travelled. Also, neither of these studies measured energy expenditure. Naturally, the energy expenditure is an individual matter, depending, for example, on the player's position on the pitch, as shown by studies involving men and women training soccer. To create nutritional recommendations for soccer practitioners, knowing the energy expenditure during training and match is essential to cover their needs and ensure optimal physical performance [3].

It is clear that the amount of the energy expenditure of individual players in our study was a derivative of the amount of physical activity. It was shown that it depended on the number of steps taken during training and the match. Naturally, with the increase in the number of steps, the work of the muscles increases, and thus the energy expenditure associated with it is on the rise too. The more significant number of steps taken during the match compared to training for the same amount of time is not surprising. However, no correlation was found between the number of actions taken and the energy expenditure per kilogram of body mass per hour of activity. This may indicate a similar level of involvement in the game between players, regardless of their body weight, which proves a uniform method of preparation for the match and training. The other research showed greater distances during the match compared to training, which had to be connected to a more significant number of steps [2]. According to our knowledge, however, no studies are comparing the number of actions taken during a match and training among female soccer players.

The present study found that female soccer players had much more time during training on low-intensity activities than during a match, and high-intensity activity lasted longer during a match. Awareness of the result's significance during the match and the necessity to win could be a mobilising factor for the players, resulting in greater involvement and increased physical effort, intensity, frequent sprints, sudden turns, and very intense short ball plays. Compared to these activities, the intense training had to be full of breaks between individual exercises. High involvement in the game during the match will result in more time devoted to vigorous or very vigorous activities compared to training, which will include breaks of several minutes between exercises, breaks for hydration, discussing mistakes with the coach between exercises, and consequently - more time devoted to low-intensity physical activity. It was also observed that there was a positive correlation between the amount of energy expenditure during the match and the time of very vigorous physical activity (the more significant amount of which increased the spending) and a negative correlation with the time of moderate intensity physical activity (the more significant amount of which decreased it). The analysis of soccer players' energy expenditure showed higher spending during the match hour compared to the training hour due to the differences in the intensity of physical exertion.

However, it is worth paying attention at this point to the lack of correlation between the number of steps during the hour of the match and training and the energy expenditure per kg of body mass and the significant correlation between the number of steps during the hour of the match and training and the energy expenditure per kg of fat-free mass among the players. Total body weight comprises all components, not only the amount of muscle tissue but also the amount of adipose tissue. While the content of muscle tissue causes a higher amount of effort performed, and thus the amount of energy expenditure, the amount of adipose tissue, to a lesser extent. Naturally, the content of adipose tissue can translate into energy expenditure because greater body weight is associated with the need to perform more effort and greater involvement of muscle tissue in this effort. However, fat-free mass is the most metabolically active tissue and primarily affects the amount of energy expenditure, in particular resting metabolism rate [12]. It can be concluded from the observed relationship that while the energy expenditure incurred by each kilogram of body mass was not related to the activity - in this case, the number of steps - it could have been related to the presence of adipose tissue, which is less metabolically active and had not as much effect on the performance. On the other hand, the energy expenditure incurred by each kilogram of fat-free mass - as a metabolically active tissue, which is, i.a., responsible for the performance of activities - was related to the number of steps taken. The greater number of steps taken forced the muscle tissue to expend more energy so that the tissue could perform specific work and activity. Physical activity can have an impact on energy expenditure, for example by modulating body composition. The greater content of an athlete's lean body mass will result in higher energy expenditure than a person with similar body weight. In this study, however, no relationship was found between fat free mass and energy expenditure during the hour of training and the hour of the match ($p>0.05$, *Spearman* test). However, this may result from a small study group, making it difficult to observe such relationships. There are also hypotheses that training exercise directly influences resting metabolic rate [19]. This research indicates, however, that this will be more related to the energy expenditure done by fat-free mass rather than the overall energy expenditure. It emphasises how important it is to take care of the proper body composition in athletes.

Our study has both strengths and weaknesses. Undoubtedly, the strength is the direct measurement of energy expenditure during the match and training on the same people using the same method. This allows the comparison of various factors influencing energy expenditure and physical activity parameters between the two key forms of physical activity for athletes - competition and preparation. The direct measurement of physical activity and energy expenditure is a solid study point. Due to the nature of the competition and the consent of the referee, coach and players, such measurements are extremely rare and have a significant cognitive value. Taking measures with the same players during training and the match is also essential. However, despite these strengths, limitations should also be highlighted. The small study group is undoubtedly a limitation. Too small a group does not allow for complete observation and statistical comparison of some parameters, which will prevent specific dependencies from being often observed. The small group, however, is the result of the nature of the study. Frequent changes in the pitch, injuries, and tactics, as well as the consent of the coaches to perform the measurement, severely limit the possibility of conducting the study on a larger, more representative group. The second limitation is the length of the study. The research was conducted only during a single match and training session. Matches differ by the necessity to involve players in particular activities and the game itself. A more demanding opponent will also result in a higher involvement of players in specific football positions compared to an opponent who will be dominated in a particular phase of the game. Also, the expenditure during training will depend on the training cycle. Although the measurements were taken during one of the more demanding training sessions to relate the results to a match, training of a different nature could provide different results. Long-term research would undoubtedly give more reliable results.

CONCLUSIONS

In conclusion, the energy expenditure of the players during the match was more significant than in the case of the planned intensive training. This was mainly due to the timeshare of more intense physical activities and taking more steps, which was associated with going a longer distance during the match than during training. More high-intensity actions resulted in higher energy expenditure during the match. In contrast, the time spent on vigorous activities during training was shorter in favour of moderate-intensity activities, reducing energy expenditure. In addition, the number of steps performed was related to energy expenditure per kilogram of fat-free mass, suggesting body composition's influence in shaping the body's energy expenditure. More studies involving more players and lasting longer are needed to accurately determine the energy expenditure during training and matches and the factors influencing this. This knowledge will help meet athletes' nutritional needs and thus may contribute to better results.

Given the pilot nature of the study, it is important to point out the need to conduct research on a larger group of women soccer professionals at different levels of training and on different levels of the league ladder. The methodology used allows for an adequate comparison of energy expenditure during the key activities for professional athletes - training and competition - and conducting a full study will allow clear conclusions to be drawn. Conducting further research is therefore strongly recommended.

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Conflict of interest

The authors declare no conflict of interest.

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