Energy expenditure and movement activity analysis of sepaktakraw players in the Thailand league

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Abstract

Background: The analysis of energy expenditure (EE) and movement activity in specific positions among sepaktakraw players during competition is important for planning training and appropriate nutrition programs.

Objective: The study aimed to compare the EE and movement activity of different positions among sepaktakraw players during competition.

Methods: Forty-two sepaktakraw players in the Thailand League, assigned to 1 of 3 positions - servers (n = 14), feeders (n = 14), and strikers (n = 14) - aged 20–40 years, were asked to wear a GT9X ActiGraph on the upper Achilles tendon of their dominant leg during a simulated competitive match.

Results: Servers and strikers showed a higher activity kcal and MET than feeders (p < 0.01). Servers (4914.32 ± 509.041 CPM) and strikers (4655.38 ± 55764 CPM) performed in vertical axis movement more than feeders (3428.11 ± 453.86CPM) (p < 0.01).

Conclusions: The results of the study will aid in designing specific training programs based on playing positions, so as to provide the athletes with the appropriate and consistent energy intake required and the direction of movement with specific positions.

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Introduction

Sepaktakraw is a sport that combines gymnastics skills with volleyball. The team on defense must kick the sepaktakraw ball towards the front of the net, try to make their three (3) best hits, and beat their opponent by setting and spiking the ball. Most players prefer using their feet to kick the ball over the net. The court used for play is similar in size to a doubles badminton court. A team consists of three different players, one in each position, each using a different skill during competitive play. Sepaktakraw is popularly played in Southeast Asia and widely played in the Middle East, Europe, and America. The Thailand national team is number one in the World ranking, and all of the players compete in the Thailand League.

Elite players expend more energy expenditure (EE) than amateurs; they also require a higher intensity of training and enough energy for competition. Previous studies show that national Malaysian sepaktakraw players had a total daily EE of 3004 ± 298 kcal, while Thai female national sepaktakraw players had a total daily EE of 400.37 ± 44.03 kcal per game. However, those previous studies did not focus on the different positions, including movement activity. The roles of each team player demonstrated different percentages of positive and negative scores, which may affect individual energy requirements. Sepaktakraw players generally change of directions (COD) a lot during play. An analysis of the sport activity of the players using an activity monitor was conducted. Vector magnitude as a covariate with counts from each axis separately entering the model possibly improves the estimation of activity EE using tri-axial accelerometers. The data obtained from triaxial accelerometers in different positions can provide information like EE and movement activity during a match. Recently, the GT9X ActiGraph tri-axial accelerometer, which is useful in the assessment of EE and various movement activity measurements in sport, was used in different studies and proven to be reliable.
The analysis of EE and movement activity, such as the COD of players, is influenced by various aspects, reciprocally interconnected, and includes individual position activity movement factors. However, to the researchers’ knowledge there are currently no studies on EE or the movement activity of sepaktakraw players since every movement occurs rapidly and affects the quality of skills, including vertical jumps and rapid COD to receive the ball within a second. Therefore, the objective of this research was to compare the EE and movement activity of sepaktakraw players playing in different positions.

Methods

Participants

Forty-two male sepaktakraw players, aged 20–40 years, equally playing 3 positions (server, feeder, striker), from 7 randomized clubs (consisting of team A and team B in a club) in the sepaktakraw Thailand League of 2019 participated in the study (Fig. 1). Before the start of the study, all participants completed an informed consent by the ethical committee of Khon Kaen University #HE622157. The participants were excluded if they had severe injuries or voluntarily withdrew.

Procedures

In the experiment, team A competed against team B in a simulated match. They started with a 15-min warm-up that consisted of jogging, and dynamic stretching, as well as a specific warm-up consisting of bouncing, serving, feeding, and striking the ball. At 3:00 p.m. they were asked to wear an ActiGraph GT9X (1-s epochs) on the ankle of their dominant leg during the simulated match on a rubber court in the gymnasium. The completion protocol was based on the International Sepaktakraw Federation (ISTAF) rules, only the extra score was not applied. The simulation was judged by licensed referees.

The data was downloaded via ActiLife Data Analysis Software (version 3.6 for Windows, ActiGraph, Pensacola, FL). Estimating EE and axis of movement from the accelerometer was applied via the specific equation by Puyau 2002.

Statistical analysis

The statistical analysis was expressed as mean and standard deviations in the baseline characteristics. Differences in movement activity with different positions (servers, feeders, and strikers) were analyzed using a one-way analysis of variance (ANOVA) and the Bonferroni post-hoc test. The Pearson correlations coefficient was used to analyze the relationship between EE and movement activity. p < 0.05 was set as significant.

Results

Table 1 shows that differences exist in all 3 positions in terms of the weight, height, flexibility, vertical jump height, and agility of the players. Servers were taller and had a higher mean weight, compared to their counterparts (p < 0.01). In terms of physical fitness, the feeders had the lowest values in flexibility, while the strikers showed the greatest in vertical jump. Servers scored the lowest in agility performance (p < 0.01).

Table 2 shows that servers and strikers spent more activity kcal and MET than feeders (p < 0.01). The highest time-spent percentage in sedentary and moderate activity levels was found among the feeders, while strikers spent the highest amount of time in moderate-to-vigorous activity.

Table 3 shows that servers performed greater vertical axis movement than the other positions. There were similar results for the anteroposterior axis and vector magnitude between the servers and strikers (p > 0.05). Although horizontal-axis movement was not significantly different among the 3 positions, the feeders were likely to score the lowest value in that category.

In Table 4, MET has a positive high correlation with movement of the vertical axis and the vector magnitude and MVPA level (r = 0.83–0.94, p < 0.01). However, it had negative correlation with light activity (r = -0.65) for the servers. The vigorous activity had high positive correlation with vertical axis (r = 0.87) and MVPA (r = 0.62), whereas it is correlated negatively with light activity (r = -0.77). The variables with a positive correlation with vector magnitude were MET, moderate activity, vigorous activity, vertical axis, and horizontal axis (r = 0.73–0.85, p < 0.05).

Table 5 shows that the feeders had moderate positive correlation with light movement (r = 0.62) with activity kcal, but a high negative correlation with sedentary movement. MET was affected by a high positive correlation with vertical axis (r = 0.98), as was anteroposterior axis (r = 0.83) in vigorous activity (r = 0.81), as well as vector magnitude (r = 0.63). Vigorous activity had a high positive correlation with vertical axis (r = 0.82) and anteroposterior axis (r = 0.56); in contrast, vigorous activity had a high negative correlation with light activity (r = -0.58, p < 0.05). MVPA had a negative correlation with the horizontal axis (r = -0.59, p < 0.05).

Among strikers (Table 6), activity kcal had a higher positive correlation with MET (r = 0.66, p < 0.01). However, MET had a higher positive correlation with vigorous activity, MVPA activity, vertical axis, anteroposterior axis, and vector magnitude.

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![Fig. 1. Two teams within a specific club from 7 clubs participated in the simulated competition.](image-url)
Significant difference of Feeders (**p < 0.01). Significant difference of Strikers (p < 0.01). Significance difference of Servers (p < 0.01).

Table 2
Energy expenditure and physical activity levels between positions.

| Energy expenditure | Servers (n = 14) | Feeders(n = 14) | Strikers(n = 14) | Total (n = 42) |
|---------------------|-----------------|-----------------|-----------------|---------------|
| Activity kcal       | 94.28 ± 17.35 **| 63.47 ± 9.87    | 86.57 ± 17.01 **| 81.44 ± 19.84 |
| MET                 | 5.17 ± 0.51 **  | 3.99 ± 0.37     | 5 ± 0.47 **     | 4.72 ± 0.69   |
| PALs               | Minute (%)      | Minute (%)      | Minute (%)      | Minute (%)    |
| Sedentary           | 5.23 ± 0.93 (34.39 ± 4.49) | 5.36 ± 1.24 (36.09 ± 8.94) | 5.01 ± 1.04 (30.80 ± 8.53) | 5.13 ± 1.06 (33.76 ± 7.73) |
| Light               | 4.18 ± 0.68 (27.04 ± 3.94) | 4.02 ± 2.12 (25.05 ± 12.35) | 3.19 ± 0.74 (21.76 ± 2.92) | 3.71 ± 1.36 (24.62 ± 7.81) |
| Moderate            | 3.47 ± 0.81 (23.78 ± 3.89) | 4.40 ± 1.51 (28.84 ± 6.35) | 4.18 ± 1.42 (27.92 ± 5.60) | 4.02 ± 1.31 (26.85 ± 5.69) |
| Vigorous            | 2.04 ± 0.55 (14.09 ± 3.94) | 1.35 ± 0.79 (9.23 ± 4.84) | 2.25 ± 0.76 ** (14.09 ± 6.39) | 1.87 ± 0.79 (12.47 ± 5.54) |
| MVPA                | 6.07 ± 1.01 (38.77 ± 5.67) | 6.17 ± 1.51 (40.45 ± 5.49) | 7.02 ± 1.44 (43.73 ± 4.82) | 6.02 ± 1.37 (40.98 ± 5.61) |

Table 3
Movement activity during competition.

| Verticalaxis (CPM)  | Servers (n = 14) | Feeders (n = 14) | Strikers (n = 14) | Total (n = 42) |
|---------------------|-----------------|-----------------|-----------------|---------------|
| 4914.42 ± 909.41 ***| 3478.11 ± 453.86 | 4655.38 ± 557.64 ** | 4332.61 ± 822.53 |
| Horizontal axis (CPM) | 4295.06 ± 401.93 | 3902.83 ± 483.75 | 4304.77 ± 410.35 | 4167.55 ± 463.38 |
| Anteroposterioraxis (CPM) | 4144.67 ± 384.28 ** | 3580.79 ± 420.41 | 4240.91 ± 370.83 ** | 3988.79 ± 483.03 |
| Vector magnitude (CPM) | 7813.19 ± 557.91 ** | 6415.41 ± 456.76 | 7675.41 ± 687.07 ** | 7301.34 ± 848.39 |

Table 4
Correlations between energy expenditure and movement activity among servers.

| Activity kcal | MET | % Sedentary | % Light | % Moderate | % Vigorous | % MVPA | Vertical axis | Horizontal axis | Anteroposterior axis | Vector magnitude |
|---------------|-----|-------------|---------|------------|------------|--------|---------------|------------------|-------------------|------------------|
|               | 0.24 | -0.14       | -0.42   | 0.33       | 0.24       | 0.26   | 0.34          | 0.52             | 0.21              | 0.36             |
|               | -     | -0.49       | -0.65   | -0.18      | -0.17      | -0.88  | -0.69         | -0.49            | -0.67             | -0.32            |
|               | %    |             |         |            |            |        |               |                  |                   |                  |
| % Sedentary   |     |             |         |            |            |        |               |                  |                   |                  |
| % Light       |     |             |         |            |            |        |               |                  |                   |                  |
| % Moderate    |     |             |         |            |            |        |               |                  |                   |                  |
| % Vigorous    |     |             |         |            |            |        |               |                  |                   |                  |
| % MVPA        |     |             |         |            |            |        |               |                  |                   |                  |
| Vertical axis |     |             |         |            |            |        |               |                  |                   |                  |
| Horizontal axis |     |             |         |            |            |        |               |                  |                   |                  |
| Anteroposterior axis |     |             |         |            |            |        |               |                  |                   |                  |
| Vector magnitude |     |             |         |            |            |        |               |                  |                   |                  |

*Correlation is significant at p < 0.05, **Correlation is significant at p < 0.01.

(r = 0.61–0.94, p < 0.01). In addition, MVPA and vigorous activity had a higher positive correlation with vertical axis (r = 0.58, p < 0.05). Horizontal axis had a positive correlation with vertical axis (r = 0.81, p < 0.01). Finally, the vector magnitude had a high positive correlation with activity kcal, vertical axis, horizontal axis, anteroposterior axis, and MET (r = 0.66–0.98, p < 0.01).

Discussion

The results of the current study can create insight into anthropometric and physical performance of sepaktakraw players in different positions. The feeders were found to be the oldest and had the most experience playing, followed by the servers and strikers. The feeders played a necessary role in making good decisions to predict the direction of the ball; therefore, experience is important for being setters. The strikers were the youngest, since his position is linked to injury. Moreover, the servers had the maximum height because taller players can gain more advantage in controlling and serving the ball. While the agility of the feeders occurred over a shorter time compared to the other positions,
feeder had a lower balance point, which is appropriate for changing direction rapidly.23 Strikers are involved in higher jumping than the other positions, which is similar to elite volleyball strikers.24

The results of the EE indicated that most players performed sedentary activity in the game, the highest amount being in feeders. This means most players normally wait for an opportunity and time to move in order to play the ball based on their responsibility. The game takes quite a long time, which can cause muscle and center fatigue and delayed nerve signal transmission.25 Strikers spent the most MVPA (43.73%), indicating that the nature of the striker position is to jump and roll the body and to kick and block the ball, which requires a high amount of energy. Feeders ranked second highest in this category. Vigorous activity was found to be 9.23% among the 3 positions. Interestingly, servers and feeders spent equal amounts of EE for vigorous activity, indicating that the level of vigorous activity has a high correlation to MET among servers and feeders. The potential explanation is that they are frequently performed quickly. The servers had the highest vertical movement, followed by strikers and then feeders. The nature of sepaktakraw is that an attack game can be played with an offensive serve and offensive strikers. Certainly, an effective attack involves hitting the ball over the net, which has a height of 1.55 m, and this needs to be done with an overhead kick.27 The effectiveness of the serve depends on the position of the body and hips, leg flexibility, and the spot on which the ball is touched. When comparing all positions on the team, servers had the highest body flexibility, which is correlated to the height of touching the ball; touching the ball at a greater height can create more momentum for kicking the ball harder.20 The direction of the strikers when vertically jumping is important.28 Each mechanic is generated from the attempt to escape gravity by swinging the arms to increase jump height.21 The difficulty in vertical hitting is escaping an opponent’s attempt to block. Therefore, the kicking height and intellectual skill of the strikers are essential in playing when they may face a double block.22 Meanwhile, the feeders hardly performed any vertical movements because their nature of play was focused on horizontal movement in order to run and set the ball;21 feeders do not use their feet for overhead kicks. The horizontal axis is no different with statistical significance. In the anteroposterior axis, strikers and servers are different from feeders in their statistical significance, which is consistent with the characteristics of the feeders, who need to be in front of the net to hit the ball; they need to both slide forward and run forward.24 At the same time, servers seem to be back position players. However, servers are important for moving to the front and to the back for when the opponent serves the ball by short kicking and dropping it in front of the net.
However, when analyzing the movement of players in all positions, the servers and strikers were found to have similar movements-vertical, horizontal, and anteroposterior because their duty in attack phase is to perform overhead and rolling kicks over the net.20 This includes jump blocks, which are similar to strikers in the game of volleyball,35 where vertical movement can provide 71–83% effectiveness of hitting and blocking.30 For receiving the ball and preparing for attack with the speed of the ball and a short period of play, a sliding movement helped the player move and cover the area effectively.3 Although the average movement of the feeders in any direction was less than other positions on the team, when considering this particular position, feeders were found to be outstanding in moving aside in a short time to set the ball.27

MET is the rate of metabolism of energy for doing any activity.38 For servers, MET level was found to be caused by vector magnitude. The most effective direction is the vertical axis because the main duty of servers is to send the ball across the net, overhead.39 To perform effectively a server needs the intensity from MVPA to be vigorous, which provides a negative relationship with MET. In this study, an accelerometer with specifications to record physical data from an accelerating appendicular skeleton was used.39 A vigorous energy level was found to be generated from the vertical axis, mainly by kicking. All directions of movement and level of MVPA were vigorous, and needed for focused training in order to enhance speed of movement and endurance with level of energy.

Although the activity kcal of feeders is created from light activity, since they need much accuracy to create various attacking games,40 they must focus on decision making. The direction affecting vector magnitude and intensity of movement comes from the vertical axis, while raising a leg to set, strike, or block comes from the anteroposterior axis by moving to follow the ball. Therefore, coaches should focus on speed and accuracy of movement in any direction, including endurance of muscles, because a higher level of MET causes fatigue and reduces error. Moreover, MVPA has a positive correlation with moderate activity, meaning that if feeders use moderate energy, MVPA also increases. In contrast, a more horizontal axis movement decreases MVPA intensity level. Less movement or EE leads to mistakes in decision making or reduces the correspondence of muscle fibers due to a lack of enthusiasm during competition since feeders need to have imagination in performing skills in a short period of time.42

In strikers, MET and activity kcal have a high correlation with vertical axis because most participation in games is in the vertical axis, such as striking and blocking. High speed overhead kicks, according to the laws of physics, require more energy.42 The correlation of each activity level seems to be similar to servers, since both positions attack rapidly or make it difficult for the opponent to predict the direction of ball. Activity kcal is caused by the correlation in the spent energy of moderate level activity and vertical axis, which means the vertical axis of the strike needs a more moderate activity level. These findings provide valuable data that could encourage coaches, trainers, and athletes in training. Notably, amateur and lower-division athletes can apply these findings to develop their potential to become elite athletes.

Conclusion

Elite sepaktakraw players in the Thailand League have specific differences in EE, PALs, activity movement, and vector magnitude among the 3 positions. A precisely designed training program is needed, consistent to the authentic situation. The information gained from this study can lead to training model applications for young players.

Authorship

Conception and design of study: Udomtaku, konharn. acquisition of data: Udomtaku, konharn. analysis and/or interpretation of data: Udomtaku, konharn. Drafting the manuscript: Udomtaku, konharn. revising the manuscript critically for important intellectual content: Udomtaku, konharn.

Declaration of competing interest

Conflicts of interest has no declared.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesf.2020.04.001.

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