

Pencak silat combat match: Time motion analysis in elite athletes championship

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ABSTRACT

Pencak silat is a martial art characterized by full body contact fighting. Its physical demand during official games has so far received little scientific attention. For this reason, the purpose of this study is to investigate the physical intensity based on the time structure during elite pencak silat competition. The classification of intensity in this study namely high intensity activities (HIA), low intensity activities (LIA), and off position (OP). A total of 45 fights from 3 elite competitions were used as samples. Using a time-motion analysis system, all movements relative to the match time were recorded during the fight. Data were obtained by comparing the fights among weight divisions and match rounds. The results showed that activities' intensity relative to match time structure were 2.6 ± 0.6 s for HIA; 11.3 ± 1.8 s for LIA and 8.4 ± 3.6 for OP. In addition, the ratio between combat and non-fight times is 0.1 ± 0.0 . Meanwhile, the duration of HIA and LIA in all weight divisions tends to subsequently increase from round 1 to 3. The difference was found on the duration of OP. Unlike other weight divisions, the duration of OP in the lightweight division tended to decrease over the match rounds. This finding confirms that pencak silat characteristics are intermittent. These results can be useful for trainers aiming to develop training programs to better adapt with the physical demand of the match.

Keywords: Pencak silat; Time-motion analysis; Elite athlete.

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INTRODUCTION

Pencak silat is a martial art that has a combat category which involved full body contact (Subekti et al., 2019), Pencak silat is classified based on body weight, performed on an 8 meter mat, carried out with a duration of 2 minutes with 3 rounds and a rest time of 45-60 seconds between rounds (International Pencak Silat Federation, 2013). Pencak silat has developed rapidly, becoming one of the sports competed at the 2018 Asian Games. Pencak silat in the combat category is one of the categories contested in official competitions, which requires athletes to have complex skills and good physical readiness in order to achieve success (Fatoni et al., 2019). As in fighting sports in general, success in each fight is determined by a point scoring system from successful attack actions such as (hitting, kicking, and slamming) even ending with a KO victory for the specified duration (Ouergui et al., 2013; Silva et al., 2011). Several studies show that success in the combat arena is always associated with biomechanical, physiological and psychological aspects, for example in kickboxing (Miarka et al., 2016).

Several methodological approaches have been developed in martial arts, to obtain detailed information regarding the physiological demands of competition. Martial sports competition system that has special procedures and certain time limits, so that it will affect the physical needs of athletes during the fight. Combat sports are often associated with high-intensity movement activities in short tempos that highlight the anaerobic system (Degoutte et al., 2003), with short-term energy system (adenosine triphosphate-creatine phosphate) and glycolytic system to achieve competitive results (F B Del Vecchio et al., 2012). Combat sports are characterized by four essential elements as follows, physiological (F B Del Vecchio et al., 2012; Miles et al., 2008), physical (Amtmann & Berry, 2003), psychometry (Miles et al., 2008), and time progression (Fabrício Boscolo Del Vecchio et al., 2011).

Judging from the time elements of martial arts movements such as "*pencak silat*", each action is classified based on the intensity of the motion (high, low and resting phase), where the match is held under the official rules of the federation, with a match system that is limited by the time period and the match round period. Time-motion analysis is a non-invasive method that provides a comprehensive approach to the technical, tactical, physiological response, and energy contribution through the identification of the duration of movement activity during competition. (Fabrício Boscolo Del Vecchio et al., 2011; Hughes & Franks, 2007; Moreira et al., 2010). Time-motion considers variations in the duration of time and frequency spent in the various types of movements performed, such as high-intensity movements (consisting mostly of kicks, punches, and takedown,) and low-intensity or pauses associated with steps or pauses. (Challis et al., 2015; Ouergui et al., 2019; Santos et al., 2019; Silva et al., 2011). Martial arts' athletes need to be well prepared to be able to survive in high-intensity activities in every match. This approach has been recommended in several martial arts, such as; judo (Kons et al., 2018), karate (Herrera-Valenzuela et al., 2019), taekwondo (Bridge et al., 2018; Matsushigue et al., 2009), kung fu (Artioli et al., 2009), boxing (Ghosh, 2010; Morton et al., 2010), Muay Thai (Crisafulli et al., 2009), kick boxing (Buse & Santana, 2008), and wrestling (Kraemer et al., 2004). The match analysis procedure has proven to be effective and produces information related to situational and contextual aspects that may differ from each level of competition (Bridge et al., 2011; Casolino et al., 2012).

The scientific approach with the time motion analysis method is increasingly popular, especially among elite athletes, through the use of computer and video-based information technology, this approach has received recognition by applied practitioners as a medium for providing objective information about physical performance (Carling & Bloomfield, 2013), as a guide for coaches in compiling more special training sessions for athletes based on the demands of sports discipline, (Haddad et al., 2011). To have a good technical-tactical performance capacity, a Pencak silat athlete must be supported by excellent physical components

based on the demands of competition (Subekti et al., 2020). A special training model designed to meet the demands of competition can improve the physical performance of athletes. It will result on athletes become familiar with the frequency of technical movements and the ratio of motion when simulating the match (Ouergui et al., 2019). To the date, there is no literature that provides specific information about the structure of the movement of time in official Pencak silat fights. We only found two studies that specifically investigated Pencak silat competitions. The first study we found (Aziz et al., 2002), investigated about the physiological demands relevant to the elite exponents of pencak silat during competition. This study tends to highlight the response during the match and physiological attributes through test procedures in the laboratory, there are no results explained regarding the structure of the time performance required during the pencak silat competition. Second, identify the performance characteristics associated with successful exponents in pencak silat combat (Soo et al., 2018). Although this study involves time-movement analysis, this study specifically emphasizes the description of movement patterns and technical and tactical characteristics during silat competitions. The two studies have not provided information regarding the demands of time movement, based on the intensity of motion of various categories of silat competition divisions.

Based on this phenomenon, researchers are interested in conducting an investigation of the time structure of the movement of elite athletes during pencak silat fights, as a basis for compiling a tactical guide for a special pencak silat training program. The purpose of this study is to describe the structure of the movement time of elite level pencak silat competitions in official competitions (national and international) in different weight class divisions (light, middle and heavy) and the period of the competition rounds (1st round, 2nd round, and 3rd round). The results of this study can be used as a reference for trainers in arranging special training sessions for Pencak silat based on disciplinary demands.

METHODS

Experimental approach to the problem

In accordance with the explanation above, which states that the characteristics of the Pencak silat combat are open and full of body contact. Time movement structure during the match was investigated through video observation of matches at three Pencak silat championships in elite athletes (national and international) downloaded from the official website of the 2016 Indonesian National Sports Week, the 2017 Sea Games in Malaysia and the Asian Games in Indonesia 2018. Analysis of the timing of the championships world is recommended as an alternative to obtain realistic values and comparisons of different variables during high-level athlete competition (Carling & Bloomfield, 2013; Ouergui et al., 2014). Movement time structure (HIA, LIA and Pause) of all fighters were recorded during the battle period (2 minutes, 3 rounds, 1 minute passive rest between rounds).

In this study, the time movement activity profile was differentiated by weight class category and competition round. According to literature (Bridge et al., 2011; Ouergui et al., 2014; Francesco Tornello et al., 2014) considering the characteristics of combat sports activities, the time structure (duration and number of sequences of each time variable) is determined and classified into 3 phases: (a) HIA (high intensity activity): offensive or defensive action; (b) LIA (low intensity activity): preparation and observation; (c) OP (off position) the referee's "stop" signal pauses. The ratio between the duration of HIA and LIA + referee breaks is calculated. In addition, the total game time of each round was identified in this study.

Participants

The University's Bureau of Research and Community Service has approved the conduct of this research in accordance with ethical standards in sports science research. A total of 48 matches in three official

championships (national and international) with a total (n = 144) grouped by weight category; (i.e., lightweight: > 45 to < 60 kg; middle class: > 61 to < 70 kg; and heavyweight: > 71 to < 95 kg).

Procedures

Video observations of matches involve experienced and professional practitioners who are proficient with the pencak silat competition system, this study record the time spent and duration of each variable (HIA, LIA, referee breaks) and the total time of the match. To avoid inter-observer variability, it is recommended to involve a single observer who is responsible for conducting time-motion analysis, referring to similar studies in kick-boxing, Muay Thai (Ouergui et al., 2014; Silva et al., 2011), and taekwondo (Francesco Tornello et al., 2014). To verify reliability, a total of 48 matches were randomly selected with the same number (15 matches each) from 3 elite pencak silat championships (national and international). The selected videos were re-analysed using the Nero ShowTime program (Version 2; Toshiba Samsung Storage Technology Corporation, Tokyo, Japan) for 7 consecutive days after the first observation (Fabrício Boscolo Del Vecchio et al., 2011). Reliability was verified using intraclass coefficients (ICCs). ICC for each variable; HIA = 0.99, LIA = 0.99, and referee pause = 1, representing a high reliability profile for ratters performing combat analysis.

To identify the time structure of the movement, the initial stage is to examine several pencak silat fights from the three official championships (national and international) to identify the characteristics of the typical activities and the phases of activities that occur frequently, as used in other studies (Bridge et al., 2011; Casolino et al., 2012). Furthermore, the results of the identification of the timing motion system were developed as needed (Table 1), to obtain the possibility of a comprehensive assessment of the activity profile during the fight.

Table 1. Classification of movement during Pencak silat combat matches

High Intensity Activity	Low Intensity Activity	Off Position
Offense	Footwork rule	Referee stops (between actions and between rounds)
All tactical "attacking" actions involve technical actions (punches, kicks, and takedown) carried out with full power and speed	Standing, alert attitude, rarely approaching/away, turning, shifting, non-contact active motion.	TKO
Defence	Fake move	Injury
All tactical action (defence) involving or not technical action full power and speed	Movement to deceive the opponent with limbs (hands, feet, head, other body parts)	Foul
Self-defence action (Block, parry slip left/right, role clockwise/anticlockwise, foot defence)		Interruption and error on digital scoring system

Statistical analysis

In this study, the statistical test process was carried out using software; IBM SPSS Version 25.0, is presented in terms of Mean and SD for selected variables. Two-Way Anova analysis (three class categories: light, middle, heavy) with 3 rounds of matches (1, 2, and 3) refers to previous studies; kickboxing (Ouergui et al., 2014). Analysis of variance model to compare the indicators of time and number of HIA, LIA, OP (off position period), the ratio between HIA / (LIA + OP) and total match time determined through repeated measurements

to get round numbers. All variables were measured with their estimated roundness verified according to W Mauchlytes and Greenhouse-geisser correction if necessary. If differences are found, Bonferroni's post hoc test is applied. For effect size calculated at each output is interpreted based on the effect size scale: trivial < 0.2; small 0.2-0.6; moderate 0.6-1.2; large 1.2-2.0; and very large > 2.0 (7). The level of significance $p = .05$ was determined in this statistical test.

RESULT

The results of statistical analysis are presented in Table 2 and Table 3 with information (mean \pm SD). The data shows the average time duration and total time of the HIA, LIA and OP time movement activities from each weight class category during the match. As for the data on the average frequency of repetition of activities as a whole, it is presented in Table 4.

Table 2. The duration of each high, low intensity activity and the referee's pause during a pencak silat fight ($n = 144$)

	HIA (s)	LIA (s)	OP (s)	HIA / (LIA + Pause) ratio
Light Weight Class				
Round 1	2.3 \pm 0.7	11.1 \pm 3.8	11.9 \pm 1.4	0.1 \pm 0.0
Round 2	2.6 \pm 0.6	7.1 \pm 3.3	10.9 \pm 1.2	0.1 \pm 0.0
Round 3	2.6 \pm 0.8	5.5 \pm 2.7	10.4 \pm 2.2	0.1 \pm 0.0
Middle Weight Class				
Round 1	2.6 \pm 0.5	11.3 \pm 3.3	11.8 \pm 1.9	0.1 \pm 0.0
Round 2	2.6 \pm 0.4	8.6 \pm 2.6	11.5 \pm 1.9	0.1 \pm 0.0
Round 3	2.7 \pm 0.7	6.0 \pm 2.5	11.9 \pm 1.4	0.1 \pm 0.0
Heavy Weight Class				
Round 1	2.6 \pm 0.6	10.6 \pm 3.5	11.6 \pm 2.2	0.1 \pm 0.0
Round 2	2.9 \pm 0.7	8.0 \pm 2.7	10.2 \pm 1.8	0.1 \pm 0.0
Round 3	2.8 \pm 0.5	7.1 \pm 2.7	11.3 \pm 1.3	0.1 \pm 0.0
Average of all round 1	2.5 \pm 0.6	11.0 \pm 3.5	11.7 \pm 1.8	0.1 \pm 0.0
Average of all round 2	2.7 \pm 0.6	7.9 \pm 2.9	10.9 \pm 1.7	0.1 \pm 0.0
Average of all round 3	2.7 \pm 0.6	6.2 \pm 2.6	11.3 \pm 1.8	0.1 \pm 0.0
Average of 3 rounds	2.6 \pm 0.6	8.4 \pm 3.6	11.3 \pm 1.8	0.1 \pm 0.0

There was no significant difference for the weight division category ($F_{6,26} = 1.77$; $p > .001$; Wilk's $\Lambda = 0.92$; $\eta p^2 = 0.03$) on the average duration of time for each activity with high, low intensity and off position (Table 2). As for the match period ($F_{6,26} = 9.70$; $p < .001$; Wilk's $\Lambda = 0.67$; $\eta p^2 = 0.18$), there was a striking difference ($p < .001$) in the low intensity activity "LIA" in each round of the match with its effects $\eta p^2 = 0.30$), where the average value of the first half LIA time (11.05 \pm 3.5) was higher than the second half (7.9 \pm 2.9), and the third round (6.2 \pm 2.6). Meanwhile, for the duration of high intensity "HIA" and the referee's pause "OP" no significant difference was found, each of which had a significance value of $p > .001$. Likewise, the interaction factor of weight division and match round did not find the main effect ($F_{12,35} = 0.71$; $p > .001$; Wilk's $\Lambda = 0.93$; $\eta p^2 = 0.02$) on the average duration of time for each movement activity during the fight.

Table 3. The total time duration of each high, low intensity activity and the referee's pause during a pencak silat fight ($n = 144$)

	HIA (s)	LIA (s)	OP (s)
Light Weight Class			
Round 1	20.2 ± 11.9	92.4 ± 20.8	68.6 ± 27.5
Round 2	30.6 ± 16.2	82.8 ± 31.4	97.4 ± 38.6
Round 3	41.5 ± 20.0	76.6 ± 32.3	120.9 ± 63.0
Middle Weight Class			
Round 1	20.1 ± 8.1	92.4 ± 24.9	58.7 ± 30.2
Round 2	30.0 ± 8.4	99.7 ± 25.2	81.6 ± 36.4
Round 3	39.0 ± 14.9	91.1 ± 54.2	112.4 ± 43.5
Heavy Weight Class			
Round 1	18.1 ± 10.1	83.6 ± 30.6	63.2 ± 35.7
Round 2	31.9 ± 13.4	84.7 ± 20.4	76.9 ± 46.9
Round 3	41.6 ± 16.4	99.8 ± 37.9	119.0 ± 50.5
Average of all round 1	19.5 ± 9.8	89.7 ± 25.5	63.2 ± 30.8
Average of all round 2	30.5 ± 12.5	89.7 ± 26.6	85.1 ± 40.7
Average of all round 3	40.6 ± 16.7	89.3 ± 43.5	117.1 ± 51.4
Average of 3 rounds	30.3 ± 15.8	89.6 ± 32.7	88.5 ± 47.1

Table 4. Frequency of the duration of each high, low intensity activity and the referee's pause during the pencak silat fight ($n = 144$)

	Number of HIA	Number of LIA	Number of OP
Light Weight Class			
Round 1	8.0 ± 3.2	9.0 ± 2.5	5.8 ± 2.3
Round 2	11.7 ± 4.7	12.8 ± 4.3	8.9 ± 3.4
Round 3	15.2 ± 4.4	14.4 ± 5.7	11.2 ± 4.9
Middle Weight Class			
Round 1	7.7 ± 2.9	8.6 ± 2.6	4.9 ± 2.3
Round 2	11.3 ± 3.1	12.1 ± 3.2	7.1 ± 3.1
Round 3	14.3 ± 4.3	14.7 ± 3.9	9.6 ± 4.3
Heavy Weight Class			
Round 1	6.8 ± 3.5	8.4 ± 3.4	5.4 ± 3.0
Round 2	10.9 ± 3.8	11.4 ± 4.1	7.4 ± 3.7
Round 3	14.3 ± 4.3	14.7 ± 3.9	10.4 ± 4.2
Average of all round 1	7.5 ± 3.2	8.6 ± 2.8	5.3 ± 2.5
Average of all round 2	11.3 ± 3.8	12.1 ± 3.8	7.7 ± 3.4
Average of all round 3	14.6 ± 4.1	14.9 ± 4.4	10.3 ± 4.4
Average of 3 rounds	11.1 ± 4.7	11.9 ± 4.5	7.8 ± 4.1

There was no significant difference for the weight division category ($F_{6,26} = 1.23$; $p > .001$; Wilk's $\Lambda = 0.94$; $\eta^2 = 0.02$) to the total duration of high, low and off position activities (Table 3). Meanwhile, for the match period ($F_{6,26} = 10.17$; $p < .001$; Wilk's $\Lambda = 0.66$; $\eta^2 = 0.18$), there was a significant difference ($p < .001$) in high-intensity activities "HIA" and off position "OP" with their respective effects ($\eta^2 = 0.29$; $\eta^2 = 0.22$), where the total duration of high-intensity time in the third half (40.6 ± 16.7) was higher than the second half (30.3 ± 12.5) and the third half (19.5 ± 9.8). Likewise, for the "off position" activity, the third half (117.1 ± 51.4) was

higher than the second half (85.1 ± 40.7) and the first half (63.2 ± 30.8). However, for low intensity "LIA" with values ($p > .001$; $\eta^2 < 0.001$), there was no major difference or effect on the total duration of time in each half of the match (1, 2 and 3). Likewise, the interaction factor of weight division and match round did not find the main effect ($F_{12.35} = 0.67$; $p > .001$; Wilk's $\Lambda = 0.94$; $\eta^2 = 0.20$) on the average total time duration of each movement activity during the fight.

There was no significant effect on each weight division ($F_{6.26} = 1.08$; $p > .001$; Wilk's $\Lambda = 0.95$; $\eta^2 = 0.02$) on the frequency of repetition of each high, low and off position activity (Table 4). Meanwhile, for the comparison of the three match periods: (rounds 1, 2 and 3), there were significant differences in body weight ($F_{6.26} = 13.44$; 0.1 ± 0.0 ; Wilk's $\Lambda = 0.58$; $\eta^2 = 0.23$) with respect to the frequency of repetition of the three activities during the fight. The average frequency of each activity tends to increase; HIA (act 1: 7.5 ± 3.2 ; act 2: 11.3 ± 3.8 ; act 3: 14.6 ± 4.1), LIA (act 1: 8.4 ± 3.4 ; act 2: 12.1 ± 3.8 ; act 3: 7.7 ± 3.4), and OP (act 1: 5.3 ± 2.5 ; act 2: 7.7 ± 3.4 ; act 3: 10.3 ± 4.4). Meanwhile, for the interaction factor of weight division and match round, there was no major effect ($F_{12.35} = 0.10$; $p > .001$; Wilk's $\Lambda = 0.99$; $\eta^2 = 0.003$) on the average duration of each movement activity during the fight.

In addition, the ratio of duration of combat and non-combat activities was found (0.1 ± 0.0), for all categories of weight division and round of competition (Table 2). The difference that appeared ($p > .05$) in the match period between rounds 1-2 ($p = .004$), rounds 1-3 ($p = .0001$), but between rounds 2-3 did not show a significant difference ($p = .33$).

DISCUSSION

To the researcher's knowledge, this study is the first to be conducted in the sport of Pencak silat. This study aims to identify the structure of the activity (movement of time) during combat matches at the elite Pencak silat championships (national and international) and linked by weight division and match round. The results of data analysis in this study indicate that the structure of the activity (time motion) of the pencak silat fight is modulated in various fighting periods (rounds of the match). The fact is that during the fighting period, the duration of the low-intensity motion activity and off position is higher than the duration of the high-intensity activity. Although the difference in weight division does not affect, the duration of high-intensity activity and off position is more stable, while for low-intensity activities it is more dynamic in each period of the match. The total time duration of the three weight divisions in each match period, high intensity activities and off position tends to increase from the first, second to third half. However, low-intensity activities have a higher total time duration and are dynamic for each period of the match. As for the frequency of repetition of the three activities (high, low and off position), it shows that it is not influenced by the weight division factor, so it can be explained that there is no significant difference in relation to the three weight divisions for each activity frequency. However, the frequency of repetition of the three activities (high, low and off position) is different from each period of the match round, where it is found that the frequency increases from the first, second to third round.

In general, the results of this study indicate that the duration of combat and non-combat activities during elite pencak silat fights has the characteristics of an intermittent activity pattern. The average duration of HIA combat activity time (2.6 ± 0.6 seconds), and usually interspersed with a preparatory phase of LIA non-fighting activity on average (8.4 ± 3.6 seconds). In addition, in a fighting situation there is a "pause" or period of stopping from the referee (off position) with an average time (11.3 ± 1.8 seconds), while for the ratio of time between fighting and non-combat activities the value (0.1 ± 0.0) is found.

This result is different from taekwondo martial arts, although the structure or pattern of activities is technical-tactical (HIA, LIA, and referee pause), but both show different durations of movement. The combat phase in taekwondo averages 2.2 ± 1.2 seconds, lower than that of pencak silat fights. For the preparatory or non-fighting phase the average was 2.2 ± 0.7 seconds, which is faster than the average duration of time in pencak silat (Table 2). While the referee pause phase is 2.2 ± 1.2 seconds on average, and the referee pause phase is shorter, i.e. 5.4 ± 4.5 seconds on average (Bridge et al., 2011).

In line with the results of field measurements on elite pencak silat exponents carried out by (Aziz et al., 2002), explained that the pattern of pencak silat combat games has characteristics of motion (start-stop), and there is a wide fluctuation between periods of high-intensity movement activity and pauses (non-fighting) during a match. From all periods of time, it shows a 1:9 working ratio between fighting and non-fighting activities. This result is different from the work ratio in other fighting sports, for example muaythai 1:4 (Silva et al., 2011), karate 1:4 (Beneke et al., 2004), taekwondo 1:3 (Bridge et al., 2011; F. Tornello et al., 2011), MMA (Casolino et al., 2012) and Kickboxing 1:1 (Ashker, 2011; Ouergui et al., 2014). Agreed with the statement of (Ouergui et al., 2014) that the difference in combat and non-combat phases in martial arts is influenced by the technical, tactical, and regulatory characteristics of each of these sports, such as the knockout system and control system, the duration of the match.

Without debating the difference in weight class and the referee's pause, the comparison of the movement time of the fight phase in both offense and defence and the preparation phase during the normal time of the match shows the percentage of 40% and 60%. This value is almost similar to the findings in kickboxing (Ouergui et al., 2014), however, in contrast to the findings in Muay Thai combat, which explains that the fighting phase has a percentage of 60% of the total time, and 40% is used for the preparation phase (non-fighting). This proves that there are differences in the demands of time movement in the activity phase of various types of combat sports, although there are similarities in technical and tactical terms (Davis et al., 2013).

From the results of data analysis from the entire match round, information can be obtained that the activity profile of time motion is modulated by the period or phase of the battle in the match, where there is a decrease in the average duration of activity with low intensity "LIA" in each sequence of the match period. As for high-intensity activities, "HIA" and off position "OP" are relatively more stable during each match period. This finding is similar to the results of previous studies in taekwondo competitions, where there was a significant decrease in movement activity during the preparation phase in each round of the match (Bridge et al., 2011). Different from the research results (Santos et al., 2019), which stated that among low-intensity activities (non-fighting) had a higher time duration in the third round than in the previous round (1 and 2). However, there are similar findings related to the frequency of repetition of fighting activities, which both experienced an increase in each match period from rounds 1 to 2 to round 3. The highest number of fighting actions was in round 3, this was explained because of the effort factor of an athlete in position lose points, so to catch up, it is necessary to increase the rhythm of attack in the hope of obtaining victory at the end of the match. Meanwhile, the frequency of low-intensity activities in the "preparation phase" actually decreased the number of repetitions in each match period. This decrease in time duration and frequency.

Likewise, the total time for high-intensity activities "HIA" and off position "OP" increased sequentially in each match period, but it was different for low-intensity activities "LIA" the total time was relatively more balanced in each match period. The decrease in the duration of low-intensity motion activities, followed by an increase in the number of high- and low-intensity motion activities at each turn of the round of the match, may be caused by the change in score and referee intervention during the period of round-by-half match. This can

be observed from the actions or clinch actions taken by the two fighters with increasing numbers from round to round, especially for athletes who feel they have higher points than their opponents, so as not to be overtaken, they try to block attacks from their opponents. On the other hand, in the position of a fighter who is missing a point, in each round of the match he tries to attack as much as possible to generate points in the hope of winning the fight.

Although the duration of high-intensity movement activity did not change in each round, the total time duration and frequency of repetition of high-intensity activity increased in the second and third rounds. This can be explained by the possibility that pencak silat exponents tend to use combination techniques (punches and kicks), or attacks of more than 2 types in a row rather than using a single technique (one point), as an effort to change the situation and the numbers on the scoreboard. While the decrease in the duration of low-intensity motion activities in the second and third rounds, explained the possibility that in the first half the silat exponents carried out the process of observing the movement and characteristics of the opponent's motion, as their consideration of executing attack actions.

CONCLUSION

This study shows that there is a change in the intensity of each movement activity during a silat competition, where the weight division has no real effect on the three types of activity. Timed movement activity during combat is modulated over various periods of the match; the duration of time for high-intensity activities has a shorter record time (2.6 seconds/round) than low-intensity activities (8.4 seconds/round) and the off position phase is 11.3 seconds/round) and the ratio of fighting and non-combat activities is found (1:9). The total time required for each weight division, for high-intensity activities and off position tends to increase in the period of the next round of matches (1-2-3), while low-intensity activities are more varied. The frequency of repetition of the three movement activities, all weight divisions tend to increase in each subsequent round of the match (1-2-3), where the frequency of low-intensity activities is the highest compared to high-intensity activities and off position.

These results provide important information for special training sessions for pencak silat considering the duration of time, the ratio of combat vs non-combat, and the frequency of technical and tactical actions (for example, offensive and defensive actions) that reflect the structure of movement activities in pencak silat fights in the arena. So that athlete will get used to or quickly adapt to real fighting situations.

What is interesting and should be noted is that the time structure and intensity of the pencak silat fight are proven not to be influenced by the weight class category but are modulated by each period of the match. The same is found in kickboxing (Ouergui et al., 2014). In contrast to the literature found on taekwondo (Bridge et al., 2011), which explains that the activity profile in international taekwondo competitions is modulated by weight category. There is no difference in the pencak silat match, it could be because the physical demands and technical maturity in elite competition athletes have the same standards from various weight divisions.

Practical application

Pencak silat from the point of view of the work of the metabolic energy system leads to intermittent nature, involving high-intensity movement activities and interspersed with periods (intervals) of low intensity. The findings of this study provide important information and a framework for trainers in planning special conditioning sessions for pencak silat based on the demands of elite-level match-time movement activities. To achieve athlete fitness standards, coaches can develop training plans by considering the structure of specific activities of pencak silat combat, including the ratio of fighting vs non-fighting work. High-intensity

interval training is recommended as an exercise method developed specifically involving the technical aspects of either a single technique or a combination, a duration of 2-3 seconds for high-intensity activities and rest breaks of 5-10 seconds for periods of low or moderate intensity. In addition, circuit training protocols may be used for training technical and tactical functional demands, paying attention to movement patterns in dynamic matches.

CONFLICT OF INTERESTS

The author declares that there is no conflict of interests regarding the text of this article.

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