

SCIENTIFIC EVIDENCE ABOUT THE FIGHT OF THE SHOTOKAN KARATE OF COMPETITIONNelson Kautzner Marques Junior¹**ABSTRACT**

The kumite of the shotokan karate occurs in an area of 8x8 meters with a time of fight of 2 minutes. The offensive techniques during the kumite are with light contact on the trunk of the karateka. The purpose of this paper was to demonstrate the effort during the fight, the attack and the defense during the fight, the reaction time and the decision making during the fight. The karateka during the fight practices effort and pause during. The metabolic during the fight is aerobic or anaerobic, depends on the velocity of movement during the kumite and the time of pause determined by the referee. Heart rate during the kumite is of 170 to 180 beats per minute corresponds to an effort aerobic and anaerobic, usually the lactate accumulation is the range of 3 to 8 mmol/l. The karateka practiced more points (waza-ari or ippon) of attack and with the anticipation. During the fight of the shotokan karate, occurs the simple reaction time or the choice reaction time. In conclusion, is important the karate coach know the effort during the kumite for elaborates the physical training or work the karateka in technical training with the metabolic demands of the fight. The attack techniques with the offensive actions that results in more points the karate coach needs of orients the athlete for a more use during the fight.

Key words: Sport. Martial Arts. Athletic Training.

RESUMO

Evidências científicas sobre a luta do karatê shotokan de competição

O kumite do karatê shotokan ocorre numa área de 8x8 metros com tempo de luta de 2 minutos. As técnicas ofensivas durante o kumite são com leve contato no tronco do karateca. O propósito deste artigo foi demonstrar o esforço durante a luta, o ataque e a defesa durante a luta, o tempo de reação e a tomada de decisão durante a luta. O karateca durante a luta pratica esforço e pausa. O metabolismo durante a luta é aeróbio ou anaeróbio, depende da velocidade do movimento durante o kumite e do tempo de pausa determinado pelo árbitro. A frequência cardíaca durante o kumite é de 170 a 180 batimentos por minuto correspondendo a um esforço aeróbio e anaeróbio, usualmente o acúmulo de lactato fica entre 3 a 8 mmol/l. O karateca pratica mais pontos (waza-ari ou ippon) de ataque e com a antecipação. Durante a luta do karatê shotokan, ocorre o tempo de reação simples ou o tempo de reação de escolha. Em conclusão, é importante para o técnico de karatê conhecer o esforço durante o kumite para elaborar o treino físico ou trabalhar o karateca no treino técnico com a demanda metabólica da luta. A técnica de ataque e as ações ofensivas com mais pontos o técnico de karatê precisa orientar os atletas para usar mais durante a luta.

Palavras-chave: Esporte. Artes Marciais. Desempenho Atlético.

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INTRODUCTION

Shotokan karate is a new sport because the first competition of kumite (fight) occurred in 1936 (Nakayama, 2012).

Between 1950 and 1951, the shiai kumite (fight of competition) developed and in 1957, the Japan Karate Association (JKA is authorized by the Ministry of Education of the Japan to conduct championship) promoted the first Japanese championship of kumite of the shotokan karate (Silva and Juvêncio, 1996).

Only in 1970, occurred the first World Shotokan Karate championship, with the presence of 33 countries (Girardello, 2004). Actually, the World Shotokan Karate championships occur every two years.

The shiai kumite of the shotokan karate by JKA and by International Traditional Karate Federation (ITKF) occur in an area of 8x8 meters with a time of fight of 1 minute and 30 seconds to 2 minutes. The shiai kumite does not divide the fighters by weight categories. The offensive techniques (punch or/and kick) during the kumite are with light contact on the trunk of the karateka (El-Daly, 2010).

When executed an offensive techniques in opponent the fight is stopped and can be restarted (without point or occur waza-ari, efficient technique of half point) or not (occur ippon, perfect technique of one point or occur the second waza-ari, equivalent an ippon) (Marques Junior, 2012).

However, studies about various contents (energy metabolism, heart rate, score of the offensive techniques, zone of the points so on) on the kumite the literature of the shotokan karate not researched (Fernandes and collaborators, 2011; Franchini and Del Vecchio, 2011).

Then, a review article on the kumite of the shotokan karate is relevant. The purpose of this paper was to demonstrate the effort during the fight, the attack and the defense during the fight, the reaction time and the decision making during the fight.

EFFORT DURING THE FIGHT

The kumite (fight) of competition has a duration is of 1 minute and 30 seconds to 2 minutes, but Ravier and collaborators (2009) informed that during the fight the karateka practices effort and pause because the kumite

of the shotokan karate is a sport intermittent. The metabolic demand during the fight of the karate is aerobic and anaerobic (Sterkowicz and Franchini, 2009) because the physical effort causes interaction in energy system (Gastin, 2001).

Energy demand during the combat of the shotokan karate and of others sports occur with the three energy system (anaerobic alactic metabolism, anaerobic lactic metabolism and aerobic metabolism) (Artioli and collaborators, 2012; Sterkowicz-Przybycien, 2010).

The difference of the percentage of the energy demand aerobic and anaerobic (alactic and lactic) during the kumite depends on the velocity of movement during the fight and the time of pause determined by the referee (Chaabène and collaborators, 2012).

Doria and collaborators (2009) informed that the percentage of the energy demand during the fight is different between female kumite (61% of effort aerobic and 39% of effort anaerobic – 21% in anaerobic lactic and 18% in anaerobic alactic) and male kumite (74% of effort aerobic and 26% of effort anaerobic – 14% in anaerobic alactic and 12% in anaerobic lactic).

The literature of the shotokan karate determines that during the kumite occurs the tactical action (the study of the karateka before of the attack), attack action (moment of the offensive karate techniques) and break of the fight by referee with objective of determines a point (waza-ari or ippon) or mark a punishment (invalid attack, little combativeness so on) (Arriaza, 2009).

Attack action occurs in few seconds and maximal velocity, the metabolism predominant is the anaerobic alactic (Doder and collaborators, 2011).

After of the attack action occur break of the fight by referee with a time between 2 or 3 seconds to 4 minutes (Beneke and collaborators, 2004).

When the referee stop the fight by few seconds, and the karateka immediately practices an offensive techniques, probably the karateka used anaerobic metabolism lactic because incomplete resynthesis of the creatine phosphate (Roschel and collaborators, 2009).

Marques Junior (2012b) evidenced that attack action occurred in velocity and in few seconds (female kumite was of 2,66±1,71 seconds and male kumite was of 1,75±0,70 seconds) and break of the fight by referee has

in time varied because the standard deviation was high (break of the fight during the female kumite was of $15,33 \pm 15,01$ seconds and break of the fight during the male kumite was of $18,68 \pm 18$ seconds) with a pause between 2 to 83 seconds (1 minute and 23 seconds) for female kumite and for male kumite. So, attack actions can occur predominantly in the system

anaerobic alactic, but a short break from fighting with an immediate attack causes higher use of anaerobic lactic metabolism.

The figure 1 illustrates the duration of the attack during the female kumite and the figure 2 illustrates the duration of the attack during the male kumite (Marques Junior, 2012b).

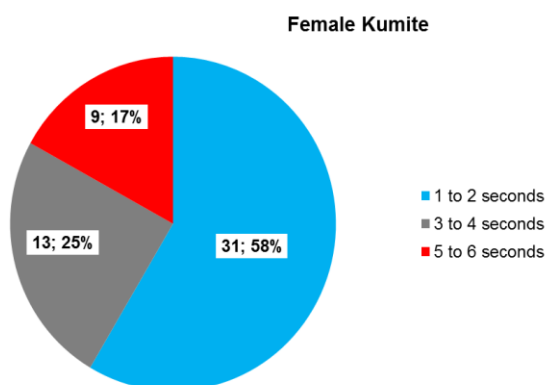


Figure 1 - Fast attack in a few seconds (total and percentage).

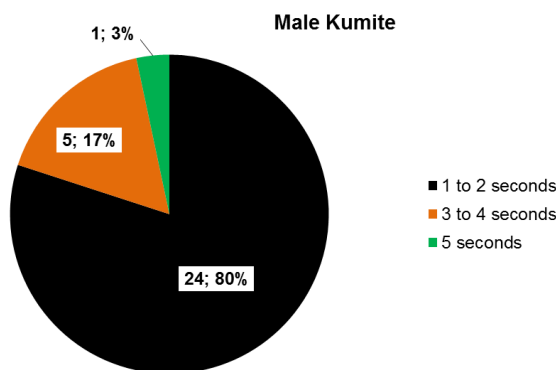


Figure 2 - Fast attack in a few seconds (total and percentage).

The duration of the attack action of the female kumite and of the male kumite are reference for prescription of the training (Casas, 2008; Marzzoco and Torres, 2011).

The coach needs prescribe the technical training (kihon in Japanese) and situational training (kihon ippon kumite, gohon kumite and others) with the time of the attack action (1 to 4 seconds in female kumite and 1 to 2 seconds in male kumite) and with pause of time varied (between 2 seconds to 4 minutes) for simulates the fight of competition of the shotokan karate.

In tactical action the karateka practices before of the attack because he studies the

opponent to make an effective attack technique. Tactical action occurs predominantly in aerobic metabolism when the karateka practicing movement of low to medium velocity or remains immobile for the exact moment to attack (Arriaza, 2009).

Also, tactical action occurs predominantly in anaerobic metabolism alactic when the karateka practicing movement of high velocity and of few seconds (~ 15 seconds) (Iide and collaborators, 2008).

Bangsbo (2003), Cometti (2002) informed that intermittent sports occurs actions in high velocity during important moments of the dispute in anaerobic metabolism alactic

and after, occur short pause and long pause. When the karateka practiced an attack in high velocity and the opponent defended the attack, the predominance of the energy system was the anaerobic metabolism alactic, the referee stopped the fight by few seconds and the combat starts in high velocity with the tactical actions. Probably the tactical action in high velocity used anaerobic metabolism lactic because the break of the fight was short and occurred an incomplete resynthesis of the ATP-CP (Wilmore and Costill, 2001).

Marques Junior (2012b) informed that the duration of the tactical action occur between 1 second to 1 minute and 10 seconds, depends on the moment of the fight.

The table 1 summaries the effort and pause for prescription of the kumite training.

The table 2 is based in Janssen (2001) and Marques Junior (2012c), and serves to assist in prescription of the kumite training because its shows the characteristics of the energy metabolism.

Table 1 - Times and actions for the kumite training.

Kumite	Tactical Action	Attack Action	Break of the Fight
Female	1 second to 1 minute and 10 seconds low or high velocity aerobic or anaerobic metabolism	1 to 4 seconds high velocity anaerobic alactic metabolism	2 seconds to 4 minutes passive or active pause
Male	1 second to 1 minute and 10 seconds low or high velocity aerobic or anaerobic metabolism	1 to 2 seconds high velocity anaerobic alactic metabolism	2 seconds to 4 minutes passive or active pause

Table 2 - Activities of the three energy systems.

Predominance of the Energy Metabolism	Velocity of the Action	Resynthesis
1) Anaerobic Alactic (ATP): 1 to 5 seconds	very high velocity	30 s = 50% 1 min = 80%
2) Anaerobic Alactic (ATP + CP): 6 to 15 seconds	very high velocity	1 min 30 s = 88% 2 to 3 min = 90% 4 to 5 min = 100%
3) Anaerobic Alactic (ATP + CP) + Anaerobic Lactic (muscle glycogen): 16 to 30 seconds	high velocity high velocity	-
4) Anaerobic Lactic (muscle glycogen): 31 seconds to 1 minute (min) and 59 seconds		
5) Anaerobic Lactic (muscle glycogen) + Aerobic (muscle glycogen): 2 to 3 minutes	high velocity low to medium velocity	-
6) Aerobic (muscle glycogen + fatty acids): 1 second to 3 minutes or more		

Determine the level of lactate is a good indicator for identification of the maximum effort and the level of physical preparation of the athlete (Mooren and Völker, 2012).

For some authors (di Prampero and Ferretti, 1999; Bertuzzi and collaborators, 2010), the lactate is an information for

determine the level of energy of the anaerobic lactic metabolism.

In World Championships of 1998, the average of lactate was 11,1 mmol/l in twenty karatekas after the fight (Arriaza, 2009).

lide and collaborators (2008) verified a lower lactate accumulation, after of 2 minutes of fight the lactate was 3,1±1 mmol/l and after

of 3 minutes of fight the lactate was $3,4 \pm 1$ mmol/l. The fight of the study of lide and collaborators (2008) occurred in training.

Costa (2006) identified a lactate of $8,2 \pm 2,1$ mmol/l of eleven karatekas after of several fights simulating the competition.

Milanez and collaborators (2011) identified the lactate during a karate competition between karate team of the Paraná, Mato Grosso do Sul and São Paulo. The subjects of the study were four males and three females ($n = 7$), the average of lactate was $8,5 \pm 1,1$ mmol/l.

Doria and collaborators (2009) determined in Italian top-level karate athletes ($n = 3$ in female and $n = 3$ in male) the level of lactate during the female kumite of 3 minutes and the male kumite of 4 minutes. The average

of lactate was $10,6 \pm 4,8$ mmol/l in female kumite and $7,5 \pm 2,4$ mmol/l in male kumite.

Voltarelli and collaborators (2009) collected the lactate every 5 minutes of fight. The duration of the training of kumite was of 40 minutes and the level of lactate of four karatekas was 4 mmol/l, classified how of lactate threshold. The authors concluded based on lactate that the fight of the shotokan karate is a sport predominant aerobic (50%) and has high participation during the attack and during the defense of the anaerobic metabolism (alactic or lactic).

In six studies about the accumulation of lactate in fight of the shotokan karate, the concentration was between 3 to 11,1 mmol/l. The figure 3 illustrates the mean and standard deviation of lactate of the studies.

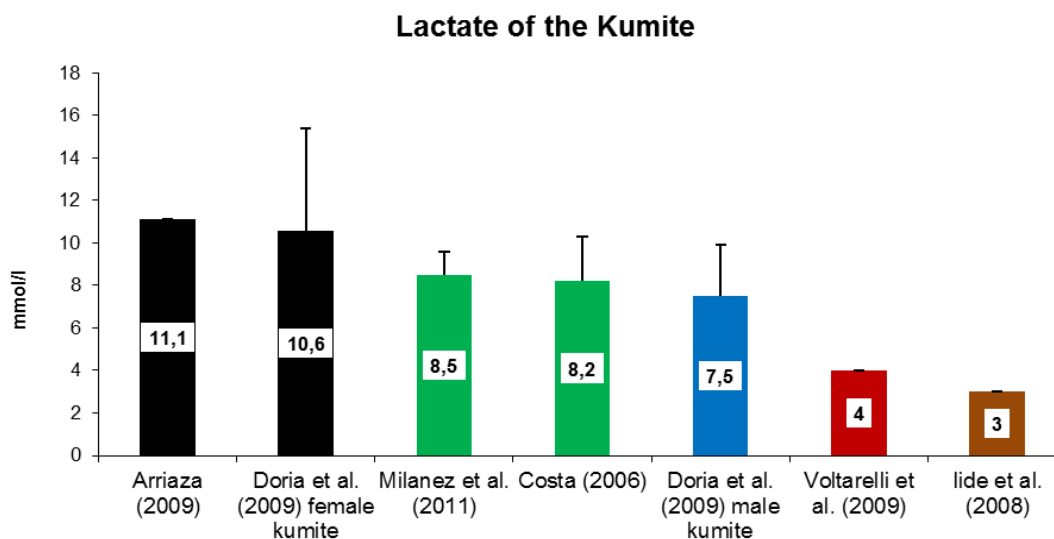


Figure 3 - Lactate concentration in karateka after of the kumite, the numbers on the bar is the mean.

Heart rate is an important indicator of the physical effort during sport activities (Seiler, 2010). The sport causes a specific response of the heart rate (Gibala and collaborators, 2012).

Shotokan karate is an intermittent sport with heart rate between 123 to 195 beats per minute (bpm), correspond an effort of predominance aerobic or anaerobic (alactic or lactic) (Milanez and collaborators, 2012).

Costa (2006) detected during the kumite an average and standard deviation of the heart rate of 179 ± 4 bpm. lide and

collaborators (2008) determined during 3 minutes of fight an average heart rate of ~ 170 bpm. Arriaza (2009) informed that the heart rate is high during the karate fight with beats per minute above of 200 and the average heart rate was of 175 bpm.

Doria and collaborators (2009) determined during the fight an average and standard deviation of the heart rate of 187 ± 12 bpm in female kumite and $175 \pm 2,4$ bpm in male kumite. The figure 4 illustrates the mean and standard deviation of the heart rate of the studies.

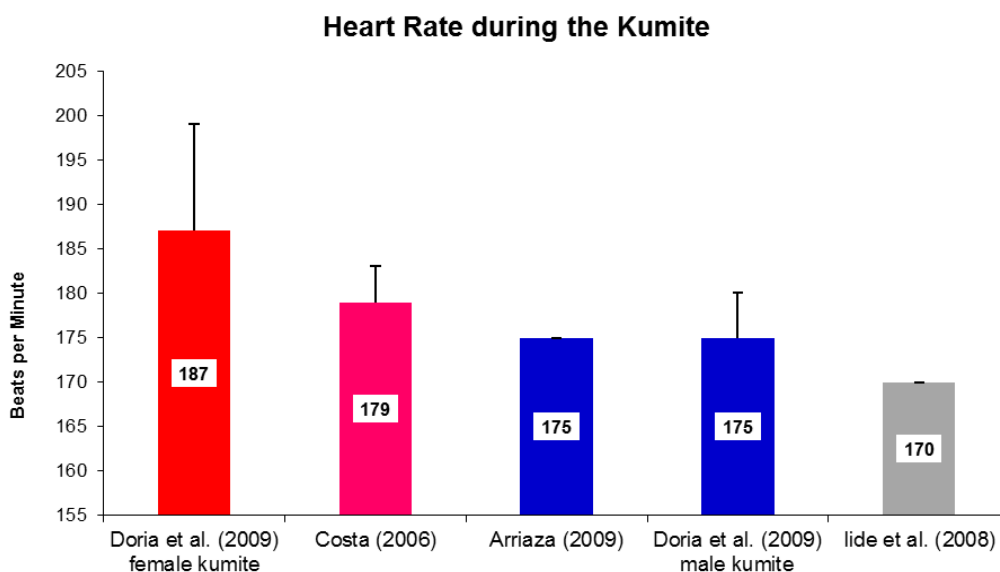


Figure 4 - Heart rate of the karateka during the fight, the numbers on the bar is the mean.

The results about the average heart rate during the kumite (177,2 bpm) are classified with an effort high by Marques Junior (2004). Zakharov (1992) informed that the heart rate between 170 to 180 bpm corresponds to an effort aerobic and anaerobic, usually the lactate accumulation is in the range of 4 to 8 mmol/l. In four articles (Arriaza, 2009; Costa, 2006; Doria and collaborators, 2009 – in male kumite; lide and collaborators, 2008) the heart rate was between 170 to 180 bpm during the fight and the result was with effort aerobic and anaerobic. In four articles (Costa, 2006; Doria and collaborators, 2009; Milanez and collaborators, 2011; Voltarelli and collaborators, 2011) the lactate was between 4 to 8 mmol/l after of the fight and the result was with effort aerobic and anaerobic.

In conclusion, the kumite of the shotokan karate has a metabolic response aerobic and anaerobic (alactic and lactic).

ATTACK AND DEFENSE DURING THE FIGHT

Nakayama (2012) informed that during the kumite (fight) of competition the karateka has three way of practicing a point (waza-ari or ippon). The karateka does an attack (called of sen no sen in Japanese), anticipation makes an offensive techniques before of the attack of the opponent (sen no sen), defend an attack and immediately counter-attack with an

offensive technique (called of go no sen in Japanese).

The studies about scores of the offensive techniques during the kumite determined that sen no sen (attack and anticipation) caused more point (Koropanovski and Jovanovic, 2007; Koropanovski, Dopsaj and Jovanovic, 2008).

Marques Junior (2012d) detected in 22 championships (total of 54 fights) of the female kumite more points of the attack (occurred in 20 championships), in second was the anticipation (occurred in 13 championships) and in third was defend and counter attack (occurred in 3 championships). Defend and counter attack occurred less because it is very difficult defend an opponent's attack (Katic and collaborators, 2009).

In shotokan karate the karateka use with defense the anticipation and practicing an attack (Marques Junior, 2011). The figure 5 illustrates the total and percentage of 22 championships analyzed.

The result of the offensive actions of the male kumite was similar. Marques Junior (2012) verified in 32 championships (total of 90 fights) of the female kumite more points of the attack (occurred in 30 championships), in second was the anticipation (occurred in 21 championships) and in third was defend and counter attack (occurred in 10 championships). The figure 6 illustrates the total and percentage of 32 championships analyzed.

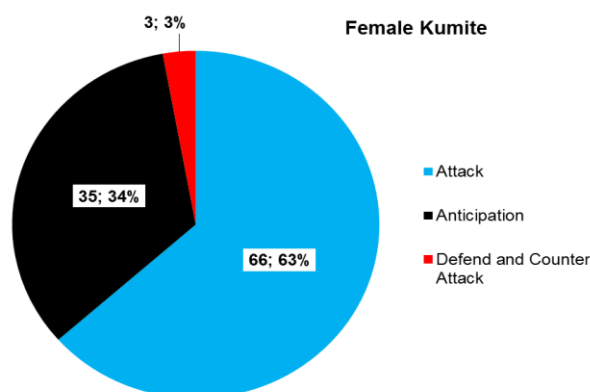


Figure 5 - Offensive actions (total and percentage).

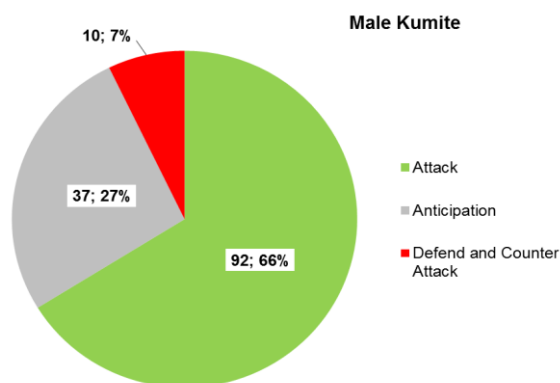


Figure 6 - Offensive actions (total and percentage).

The offensive techniques with more points (waza-ari or ippon) during the kumite of competition were with punches (gyaku zuki, kizami zuki and oi zuki), kicks (mae geri and mawashi geri) and foot sweep followed by punch (ashi barai followed by gyaku zuki) (Marques Junior, 2011b).

Sertic, Segedi and Vidranski (2012) identified other attack technique that caused more points, the ura mawashi geri in female kumite. Ura mawashi geri has complex biomechanics of execution (Abdel-Baser, 2010) and is easy of the karateka defend this kick with a soto uke or with other defense (D'Elia, 1987).

The gedan barai uke was the most used defense in kumite, second was the soto uke (Marques Junior, 2012; 2012d). The defense was more used to defend the kick (mae geri or mawashi geri).

The punches cause more points during the fight because the karateka has the better

ability with the arms (Ajamil and collaborators, 2011).

The others points are with kick and with foot sweep followed by punch. However, Doder and Doder (2006) recommended for karatekas of 1,80 meter or more (are athletes high for the shotokan karate), that use more kick because they place the opponent away, with less chance of occur an attack.

Marques Junior (2011) indicated two kicks for the karateka has success during the attack, the kick are the mae geri and the mawashi geri. Mae geri (front kick) and mawashi geri (semicircular kick) are good kick because are fast attacks (Alsamad, 2012; Pozo, Bastien and Dierick, 2011) and the karateka practices the offensive technique with the face directed toward for the opponent, permitting good vision (El-Daly, 2010).

The success of the kick (mae geri or mawashi geri) depends of some factors, they are: distance that the karateka is of the opponent, exact time to apply the kick (fight

time) (El-Kader, 2010), speed and accuracy of the (Katic, Blazevic and Zagorac, 2010), the characteristics of the opponent and opportunity during the kumite of use a kick (Nakayama, 2012) and practicing a kick with the low base (center of gravity near to the ground) because the position of the knee and of the hip provides less strength for the karateka executes the kick and produces a mae geri and mawashi geri faster (Marques Junior, 2012e).

The low base needs to be accompanied by a median position between the feet to provide adequate position of the karateka in the execution of the attack and of the defense and difficult the opponent to take down the karateka with foot sweep (Nakayama, 2012b).

Paz-Y-Miño (2000) evidenced that during the kumite the offensive techniques more used were the mae geri (25 to 40%) and the gyaku zuki (40 to 60%). The karatekas prefer to use the mae geri and the gyaku zuki because these attacks are the fastest of the shotokan karate (Gianino, 2010).

The mae geri kekomi is the faster technique of the shotokan karate, the linear velocity of the kick is of $15,76 \pm 5,45$ meters per

second (m/s) (Marques Junior, 2012f). The gyaku zuki tchudan is the second faster technique of the karate, the linear velocity of the punch is of $9,2 \pm 2,86$ m/s.

Marques Junior (2012, 2012d) detected that the attacks with more points during the female kumite (In 54 fights, the female kumite not practiced ippon) and during the male kumite (occurred waza-ari and ippon) was the gyaku zuki and the kizami zuki. The kizami zuki tchudan is the fourth (penultimate faster) technique of the shotokan karate, the linear velocity is of $7,1 \pm 1,88$ m/s (Marques Junior, 2012f). There are two explanations for more points of the gyaku zuki and of the kizami zuki: the karateka has the better ability with the arms (Roschel and collaborators, 2009) and the lever arms are smaller than the legs, facilitating the execution of the attack (Challis, 2004).

The figure 7 presents the total and percentage of the attack techniques with the offensive actions that result in waza-ari (In 54 fights, the female kumite not practiced ippon) during the female kumite (Marques Junior, 2012d). The attacks and the actions are most frequents in the fight.

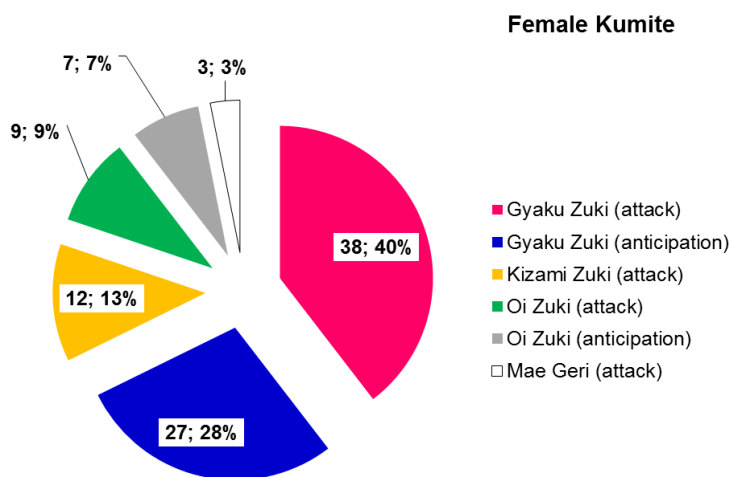


Figure 7- Attack technique and offensive action (total and percentage).

The oi zuki tchudan is the less fast attack ($5,83 \pm 2,54$ m/s) (Marques Junior, 2012f) of the techniques that executed more points in fight, but in figure 7 of the female kumite the oi zuki ranked fourth and fifth place in practice of points.

The figure 8 presents the total and percentage of the attack techniques with the

offensive actions that result in point (waza-ari or ippon) during the male kumite (Marques Junior, 2012). The attacks and the actions are most frequents in the fight.

The mawashi geri kekomi ($8 \pm 3,24$ m/s) is less quick than the mae geri ($15,76 \pm 5,45$ m/s) (Marques Junior, 2012f), but practiced more points (see figure 8). This occurs

because the mawashi geri has a semicircular trajectory, the opponent has little chance of defense when the technique is well executed (Marques Junior, 2011c).

The figure 9 illustrates mean and standard deviation of the linear velocity of the offensive techniques that caused more points in kumite (Marques Junior, 2012f).

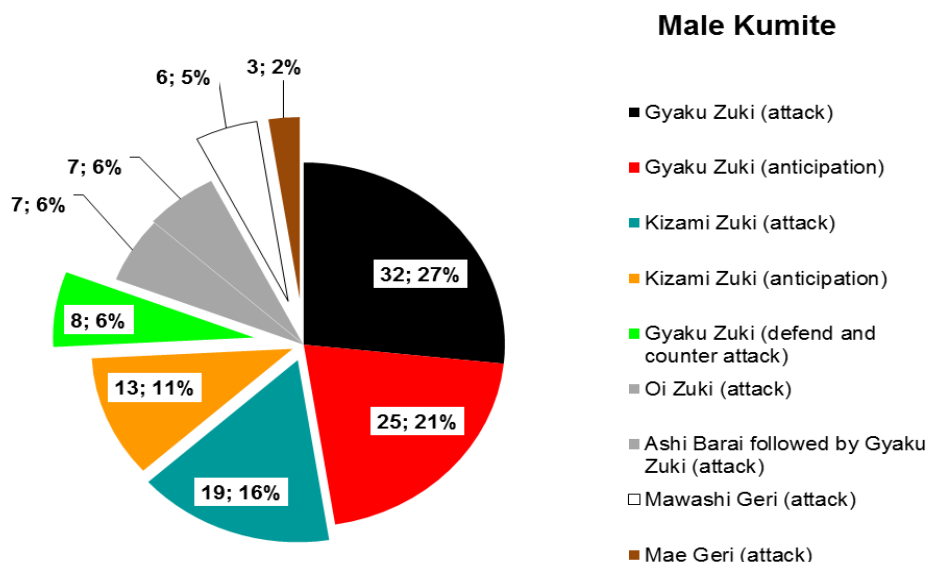


Figure 8 - Attack technique and offensive action (total and percentage).

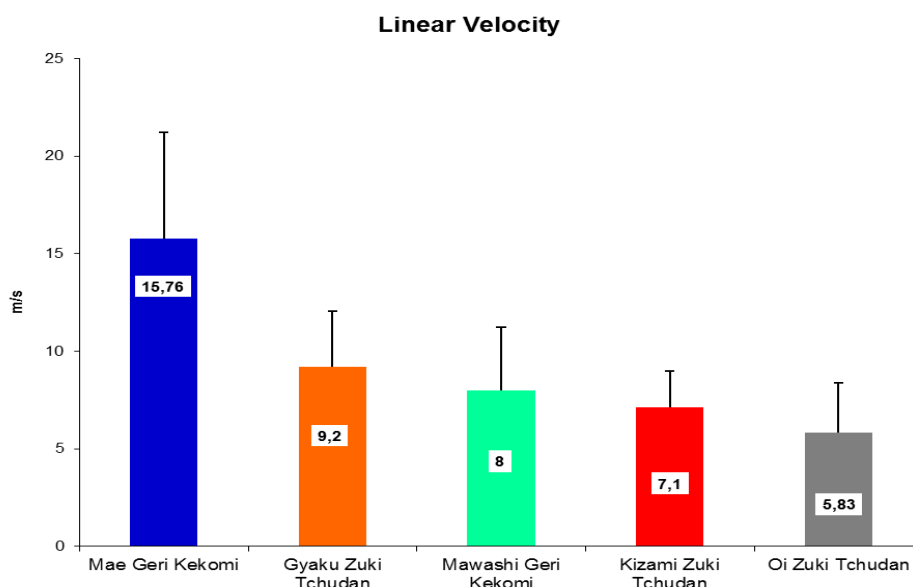


Figure 9 - Linear velocity of the attack techniques, the numbers on the bar is the mean.

Koropavanovski and Jovanovic (2007) determined that central zone occurred more points (76,67%) and lateral zone occurred less point (23,33%).

Central and lateral zone pertain to combat zone of the shotokan karate. The figure 10 illustrates the explications.

Franchini and Del Vecchio (2011) informed that combat sports the tactics is

important during the fight. Therefore, the coach can teach the karateka for use more the lateral zone because this area causes less point. This

action can be used when the fighter is winning kumite.

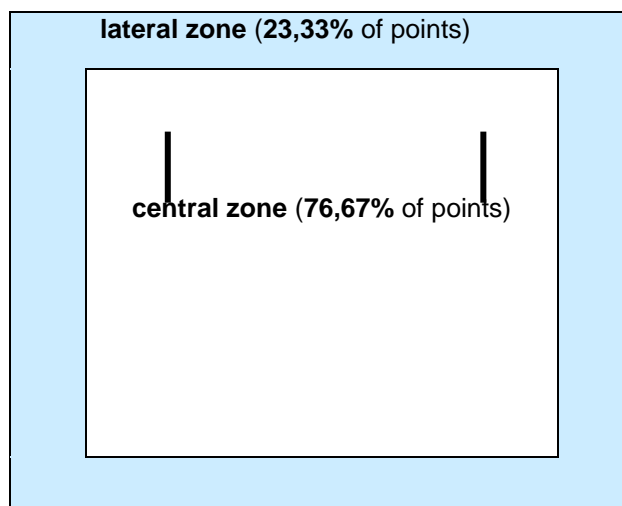


Figure 10 - Fight zone with points of the shotokan karate.

The karate coach that needs of technology for studies technical and tactical action of the karateka during the fight is recommended to use of the software Kinovea (free software in www.kinovea.org/en/). The review article of Frutos and Palao (2012) teaches how to use this software.

In conclusion, the karateka more practice during the fight the attack and the anticipation. The offensive techniques with more points are punches (gyaku zuki, kizami zuki and oi zuki), kicks (mae geri and mawashi geri) and foot sweep followed by punch (ashi braai followed by gyaku zuki). The techniques with more velocity are the mae geri (15,76±5,45 m/s), the gyaku zuki (9,2±2,86 m/s) and the mawashi geri (8±3,24 m/s), deserving to be much used in the fight. The central zone (5 zone) occur more points during the kumite, the karateka needs more attention in this zone.

REACTION TIME AND DECISION MAKING DURING THE FIGHT

The attack technique the karateka practices in high velocity with the objective of make the point (waza-ari or ippon) (Halwish, 2011) or executes a defense with speed and immediately counter attack (Farouq, 2011). Actions in high velocity the karateka needs of execute during the kumite for the opponent

unable to defend the attack (Halwish and Labib, 2012).

The tactical intelligence of the karateka is important for the quality of the actions during the fight (El-Kader, 2012). The intelligent karateka has more probability of obtaining victory in the fight.

However, the reaction time is a coordination capacity very important for the karateka (Barbanti, 2010) for execution of the attack and of the defense during the fight (Bessa, 2009).

The combat of the shotokan karate the athlete needs of excellent visual reaction time to make adequate action (Brito and collaborators, 2011). Presently, the visual reaction time of the karateka is measured simulating the fight (Mori, Ohtani and Imanaka, 2002).

The karateka is in front of a big screen with a movie that passes an opponent fighting against you (Witte and collaborators, 2012).

The virtual reality technology has a karateka that practices attack the karateka tested need to defend and counter attack or practice anticipation with attack. The reaction time is measured by electromyography or electroencephalogram (Marques Junior, 2011d).

What is the importance of the reaction time for the fight of the shotokan karate?

Scientific knowledge of the karate coach about reaction time can help the karateka. For example, Villani and collaborators (2009) determined that karatekas kumite specialists (n = 10) had reaction time shorter than the karatekas kata specialists (n = 10) during the attack techniques. Knowing this difference in reaction time, the coach can determine the type of competition of the karateka. Reaction time during a competition season of the karateka needs of attention. When the karateka expresses in reaction time a decrease in speed and the duration is constant in time of movement, the coach must train the decision making (Magill, 2000).

But when karateka expresses in reaction time stay with a constant time and the movement decrease in speed, the problem is during the execution of the attack technique. The coach can evaluate linear velocity and angular velocity of the offensive technique of the karateka with software of the biomechanics Skill Spector (free software in www.video4coach.com/) - Marques Junior 2012g, produced a manual teaching how to use this software, see in www.pluridoc.com/) for determines the quality of the technique sports. For this reason it is important to measure and evaluate the reaction time and the movement time.

Reaction time is defined as the stimulus reaches sensorial system before starting of motor response (Marques Junior, 2011d). Is also defined as the rate of preparation necessary to produce movement, is the time before starting the action. The reaction time has amplitude in milliseconds (ms) and manifests with different values depending on the sensory systems (Teixeira, 2006).

The tactile reaction time is approximately 110 ms, auditory reaction time is around 150 ms and visual reaction time is approximately 200 ms. Reaction time is manifested by a stimulus of the afferent pathway that reaches in primary somatosensory cortex (operate on the senses) and in posterior parietal cortex (operates on vision and audition) (Grol and collaborators, 2006), the sensory motor integration between primary somatosensory cortex and posterior parietal cortex that forwards the information for area 6 of the motor cortex, where occurs the movement planning (Bear, Connors and Paradiso, 2002).

This moment of the reaction time is called of pre-motor. The motor period of the reaction time, the area 6 forwards the information for area 4 of the motor cortex with the objective of result the start of the intention of movement, the cerebellum has an important participation in oriented of the future action (Kurata and Hoshi, 2002).

The degree of the cortical excitability determines the velocity of the reaction time, shorter speed or slower speed. Also the number of stimuli responses affects in reaction time speed and the quality of the decision making (Schmidt and Wrisberg, 2010).

For Brito and Silva (2011) during the kumite of the shotokan karate, occurs the simple reaction time or the choice reaction time. For example, the karateka executes an attack technique in high velocity and the opponent responds this stimulus with the simple reaction time and after with the movement, defend and counter attack or anticipation with an attack. In other example, the karateka simulates that executes a kizami mae geri (kick with the leg kick of the base), but practices a kizami zuki (punch with the front hand of the guard) and opponent needs to choose one of the stimulus of attack with the choice reaction time and after with the best movement, defend and counter attack or anticipation with an attack. Reaction time is fastest when is only one possible response (simple reaction time) and becomes slower as additional response options are added (choice reaction time) (Pérez, 2003).

What is the reason of the choice reaction time slower? In situations in which two stimuli are presented very close unexpectedly, the encephalon of the karateka capture the first stimulus attack and begins select and generate a response to it (Schmidt and Wrisberg, 2010).

So when the second stimulus of attack is presented, the encephalon is processing the first, and causes an interference with the second pair of stimulus and response. This delay in reaction time is longer when the interval between stimulus and response is very short. Therefore, karate coach can orient the athlete to use the scientific information of the reaction time during the kumite.

For Mori and collaborators (2002), the action of the karateka is faster during the fight when the reaction time is shorter. The reaction time is a cortical stimulation before starting the motor response.

DiCarlo and Maunsell (2005) informed that reaction time is short when the duration of the neural latency is short, the reaction time no can be trained, depends on the genetics of the karateka.

However, Ribeiro and Almeida (2005) evidenced that the intelligence of the person can reduce the reaction time, providing a faster movement. Yarrow, Brown and Krakauer (2009) explicated that the velocity of the reaction time and of the movement time during the fight depends on the experience of the karateka athlete that occurred in cortical changes (principally the motor cortex and the primary visual cortex). The experience of the athlete perform actions shorter not only because of a shorter reaction time, decision making is usually faster and better (Ablioti and collaborators, 2008; Beilock and collaborators, 2008).

Matias and Greco (2010) informed that an error of the decision making during the kumite can interfere in the actions of the karateka. Therefore, an error of the decision

making can delay the reaction time and later, the movement time to correct the inadequate action during the competition (Vaeyens and collaborators, 2007).

Tavares and Faria (1996) informed that during the sport, this study about the kumite of the shotokan karate, the athlete for practices an action needs of 75% of time for perform the decision making and 25% of time the karateka needs for practices the movement. Then, the encephalon delay to correct an inadequate decision making, the opponent can attack with speed because the chance of making a point is great (Afonso, Garganta and Mesquita, 2012).

For example, an inadequate decision making occur when a karateka change of guard and this action facilitates the opponent's attack because the karateka is in good distance for receive an offensive technique. The figure 11 to 13 illustrates inadequate decision making of the karateka during the fight.

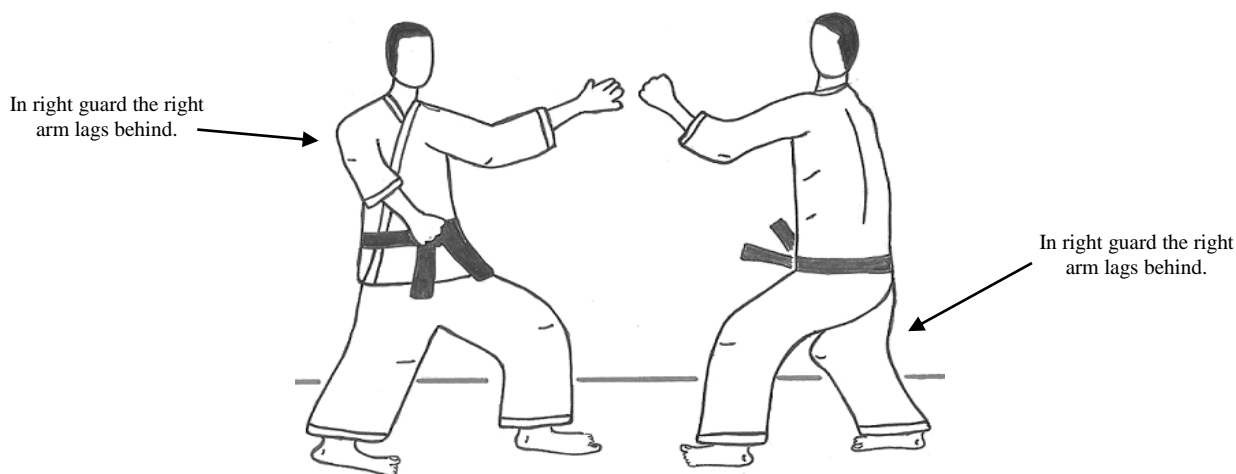


Figure 11 - The karatekas practicing tactical action in right guard.

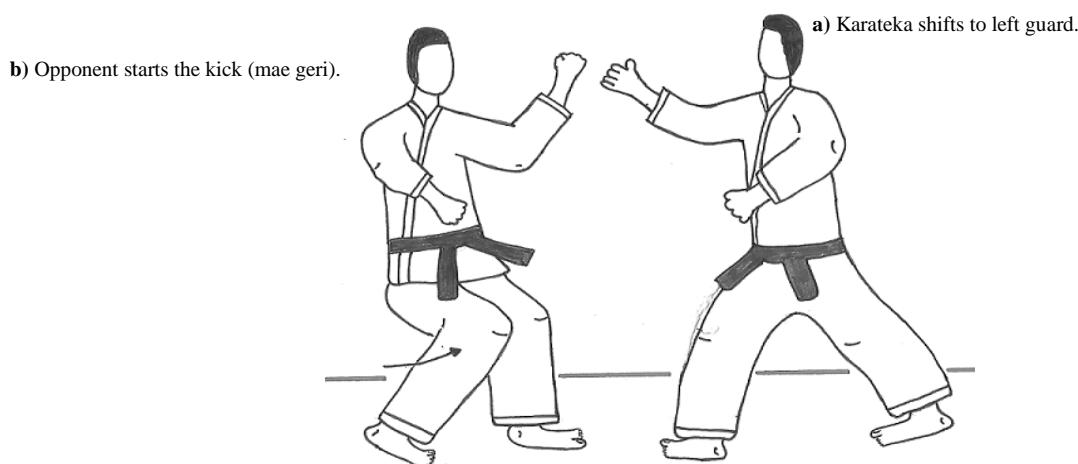


Figure 12 - The karateka of the right practiced (left guard) an inadequate decision making.

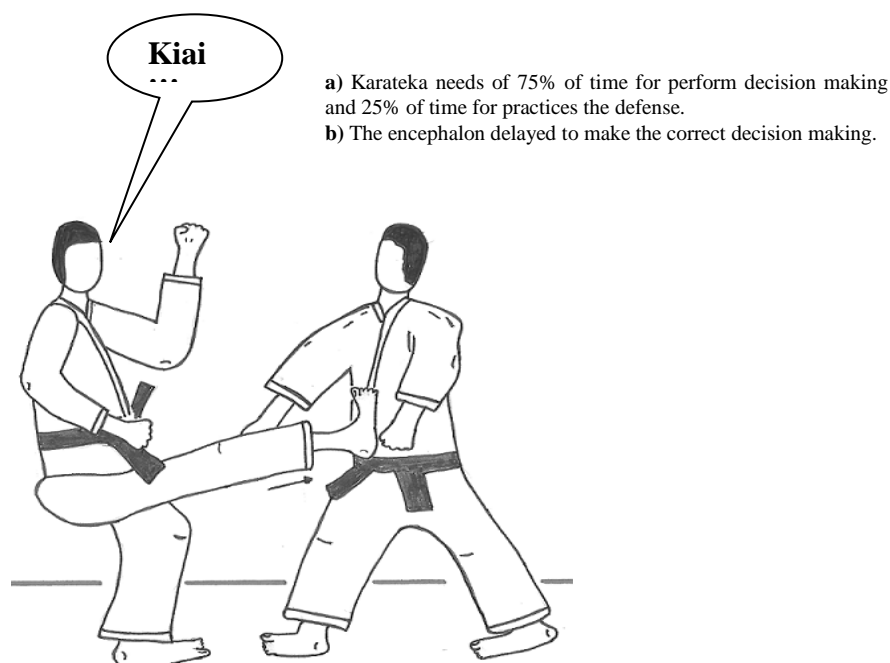


Figure 13 - The opponent practiced the kick with a perfect technique (ippon).

In conclusion, is important for the karate coach know about reaction time and decision making to orient the karateka during the fight.

CONCLUSION

The karateka during the fight practices effort and pause because the kumite of the shotokan karate is a sport intermittent. The

metabolic during the fight is aerobic or anaerobic (alactic or lactic) depends on the velocity of movement during the kumite and the time of pause determined by the referee. The results about the average heart rate during the fight (174,66 bpm) are classified with an effort high. Heart rate between 170 to 180 bpm corresponds to an effort aerobic and

anaerobic, usually the lactate accumulation is the range of 3 to 8 mmol/l.

The karateka practiced more points (waza-ari or ippon) of attack and with the anticipation. The offensive techniques that results in more points was the gyaku zuki, kizami zuki, oi zuki, mae geri, mawashi geri and ashi barai followed by gyaku zuki. The punch with more points was gyaku zuki because is the punch faster, the linear velocity is of $9,2 \pm 2,86$ m/s. The kick with more points of the female kumite was the mae geri because is the faster technique of the shotokan karate, the linear velocity is of $15,76 \pm 5,45$ m/s. The kick with more points of the male kumite was the mawashi geri because this kick has a semicircular trajectory and the opponent has little chance of defense when the technique is well executed (linear velocity of $8 \pm 3,24$ m/s). The central zone the karateka practiced more points during the fight because this zone of combat is where the kumite starts.

During the fight of the shotokan karate, occurs the simple reaction time or the choice reaction time. Reaction time is fastest when is only one possible response (simple reaction time) and becomes slower as additional response options are added (choice reaction time).

The velocity of the reaction time and of the movement time during the kumite depends on the experience of the karateka. The experience of the athlete perform actions shorter not only because of a shorter reaction time, decision making is usually faster and better.

In conclusion, is important the karate coach know the effort during the kumite for elaborates the physical training or work the karateka in technical training (called of kihon in Japanese) with the metabolic demands of the fight.

The attack techniques with the offensive actions that results in more points the karate coach needs of orients the athlete for a more use during the fight, in technical training and in situational training (called of kihon ippon kumite in Japanese).

However, the karateka needs to know that central zone needs more attention because it occur more points in the fight. Scientific knowledge of the karateka on the reaction time and the decision making can be useful in the fight.

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