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Indización

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VELOCITY OF THE OFFENSIVE TECHNIQUE OF THE KARATE FOR THE MIXED MARTIAL ARTS FIGHTER: A SYSTEMATIC REVIEW

VELOCIDADE DA TÉCNICA OFENSIVA DO KARATÊ PARA O LUTADOR DE ARTES MARCIAIS MISTAS: UMA REVISÃO SISTEMÁTICA

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Abstract

The objective of the systematic review was to present the velocity of the offensive techniques of the karate. This study followed the systematic review methodology proposed in PRISMA statement. The studies were identified in electronic databases during January of 2012 to May of 2015. Inclusion criteria of the articles were evaluated under the following search strategies: (1) type of participants, (2) type of task and (3) type of result. The researcher selected 24 studies that were included in this systematic review. The results of the study were the following: the best linear velocity of the punch was the *gyaku zuki* (13 m/s), the 2nd best linear velocity was the *oi zuki* (10 m/s) and the last position was the *kizami zuki* (7,1±1,88 m/s). The best linear velocity of the kick was the *yoko geri kekomi* (41 m/s), the 2nd best linear velocity was the *mae geri keage* (19,3 m/s) and the 3rd position was the *mae geri kekomi* (15,76±5,45 m/s). The study determined the linear velocity and the angular velocity of some joints of the body during the karate attack. The linear velocity of the hip, knee and of the ankle during the *mawashi geri kekomi* attack was faster than the return of the leg. The *gyaku zuki tchudan* had a higher angular velocity of the elbow (1483±172,9°/s) than the same joint of the *kizami zuki tchudan* (164,79°/s). The systematic review determined that the punch velocity (0,166 to 0,095 s) was higher than the kick (0,68 to 0,12 s). The systematic review determined that the *kizami zuki tchudan* was the fastest punch (0,11 to 0,096 s) and the *mawashi geri tchudan* was the fastest kick (0,13 to 0,12 s). In conclusion, the study of the velocity of the karate attack is important for the coach guide the MMA fighter.

Keywords

Karate – Fight – Mixed Martial Arts – Velocity – Biomechanics

Resumo

O objetivo da revisão sistemática foi apresentar a velocidade da técnica ofensiva do karatê. A revisão sistemática utilizou a metodologia proposta pelo PRISMA. Os estudos foram identificados em base de dados eletrônicos durante janeiro de 2012 a maio de 2015. O critério de inclusão dos estudos aconteceu conforme as seguintes estratégias de busca: (1) tipo de participantes, (2) tipo de tarefa e (3) tipo de resultado. O pesquisador selecionou 24 estudos que foram incluídos nessa revisão sistemática. Os resultados do estudo foram os seguintes: a melhor velocidade linear do soco foi o *gyaku zuki* (13 m/s), a 2^a melhor velocidade linear foi o *oi zuki* (10 m/s) e a última posição foi o *kizami zuki* (7,1±1,88 m/s). A melhor velocidade linear do chute foi o *yoko geri kekomi* (41 m/s), a 2^a melhor velocidade linear foi o *mae geri keage* (19,3 m/s) e a 3^a posição foi o *mae geri kekomi* (15,76±5,45 m/s). O estudo determinou a velocidade linear e a velocidade angular de algumas articulações do corpo durante o ataque do karatê. A velocidade linear do quadril, joelho e do tornozelo durante o ataque do *mawashi geri kekomi* foi mais veloz do que o retorno da perna. O *gyaku zuki tchudan* teve uma maior velocidade angular do cotovelo (1483±172,9°/s) que a mesma articulação do *kizami zuki tchudan* (164,79°/s). A revisão sistemática determinou que a velocidade do soco (0,166 to 0,095 s) foi maior do que o chute (0,68 to 0,12 s). A revisão sistemática determinou que o *kizami zuki tchudan* foi o mais veloz soco (0,11 a 0,096 s) e o *mawashi geri tchudan* foi o mais veloz chute (0,13 a 0,12 s). Em conclusão, o estudo da velocidade do ataque do karatê é importante para o técnico orientar o lutador de MMA.

Palavras- Chaves

Karatê – Luta – Artes Marciais Mistas – Velocidade – Biomecânica

Introduction

The popularization of the mixed martial arts (MMA) in the world¹ was important for the researchers practiced more studies about the combat sports². The combat sports with best performance in MMA the researcher has studied more with the objective of understand the characteristics of these types of fights – muay thay³, taekwondo⁴, boxing⁵, kickboxing⁶, Brazilian jiu-jitsu⁷, wrestling⁸ and others.

The karate in MMA is other combat sport with success because the karateka performs the punch and the kick with velocity and strength during the fight⁹, the motive of the high quality of the offensive technique are the exercises practiced by the karateka - strength training, punch and kick in the *makiwara* (board in vertical fixed on the ground for the karateka apply attacks) and/or in the *sunatawara* (is the sandbag)¹⁰. The offensive techniques of the karate with more points during the fight of competition are the punches (*gyaku zuki* is the reverse punch, *kizami zuki* is the jab punch and *oi zuki* is the lunge punch).

¹ S. Bishop; P. La Bounty and M. Devlin, Mixed martial arts: a comprehensive review. *J Sport Human Perf* 1:1(2013):28-42.

² W. Mynarski; B. Królikowska; M. Rozpara; A. Nawrocka and D. Puciato. The caloric cost of combat sports and martial arts training in relation to health recommendations. *Arch Budo* 9:2(2013):127-133; G. Artioli; R. Bertuzzi; H. Roschel and S. Mendes; A. Lancha Junior and E. Franchini. Determining the contribution of the energy systems during exercise. *J Vis Exp* - :61(2012):1-5; F. Silva; R. Souza; W. Carvalho; R. Costa; D. Jerônimo and L. Júnior. Analysis of acute cardiovascular responses in experienced practitioners of capoeira: a Brazilian art. *JEPonline* 15:6(2012):112-119 and G. Artioli; B. Gualano; E. Franchini; R. Batista; V. Polacow and A. Lancha Junior. Physiological, performance, and nutritional profile of the Brazilian Olympic Wushu (kung-fu) team. *J Strength Cond Res* 23:1(2009):20-25.

³ A. Crisafulli; S. Vitelli; I. Cappai; R. Milia; F. Tocco; F. Melis and A. Concu. Physiological responses and energy cost during a simulation of a muay thay boxing match. *Appl Physiol Nutr Metab* 34:2(2009):143-150; J. Silva; F. Del Vecchio; L. Picanço; M. Takito and E. Franchini. Time-motion analysis in muay thai and kickboxing amateur matches. *J Hum Sport Exerc* 6:3(2011):490-496 and F. Del Vecchio; J. Silva and C. Farias. Análise temporal de combates de muay thay de nível nacional: efeitos da fase competitiva. *RAMA* 10:1(2015):34-41.

⁴ C. Bridge; L. McNaughton; G. Close and B. Drust. Taekwondo exercise protocols do not recreate the physiological of championship combat. *Int J Sports Med* 34:7(2013):573-581.

⁵ P. Davis; R. Leithäuser and R. Beneke. The energetics of semi-contact 3x2 min amateur boxing. *Int J Sports Physical Perform* 9:2(2014):233-239 and P. Davis; A. Wittekind and R. Beneke. Amateur boxing: activity profile of winners and losers. *Int J Sports Physiol Perform* 8:1(2013):84-91.

⁶ I. Ouergui; O. Hammouda; H. Chtourou; N. Gmada and E. Franchini. Effects of recovery type after a kickboxing match on blood lactate and performance in anaerobic tests. *Asian J Sports Med* 5:2(2014):99-107 and I. Ouergui; N. Hssin; M. Haddad; J. Padulo; E. Franchini; N. Gmada and E. Bouhlel. The effects of five weeks of kickboxing training on physical fitness. *Muscles Ligaments Tendons J* 4:2(2014):106-113.

⁷ L. Andreato; S. Moraes; J. Esteves; M. Miranda; J. Pastório; E. Pastório; B. Branco and E. Franchini. Psychological, physiological, performance and perceptive responses to Brazilian jiu-jitsu combats. *Kines* 46:1(2014):44-52 and C. Borges; R. Oliveira; R. Oliveira e P. Perfeito. Recuperação fisiológica aguda após lutas de solo e correlação com a potência aeróbica máxima. *Praxia* 1:1(2013):71-79.

⁸ H. Karnincic; S. Krstulovic and M. Baic. The influence of body weight on chosen physiological parameters in wrestling. *J Hum Kinet* 37(2013):119-127.

⁹ H. Chaabène; E. Franchini; S. Sterkowicz; M. Tabben; Y. Hachana and K. Chamari. Physiological responses to karate specific activities. *Sci Sports* 31:2(2015):-.

¹⁰ N. Marques Junior e J. Silva Filho. Treino de força para o karateca do estilo shotokan especialista no kumite. *Rev Bras Prescr Fisio Exerc* 7:41(2013):506-533.

and the kicks (*mae geri* is the front kick and *mawashi geri* is the semicircular kick)¹¹, but the punches the karateka practices more points because the fighter has the better ability with the arms¹². However, the karateka uses more these offensive techniques during the MMA fight¹³, the motive the MMA literature does not inform¹⁴, but Marques Junior¹⁵ determined that the offensive techniques are faster and the karateka practices the offensive techniques with the face directed toward for the opponent, permitting good vision.

Second Nakayama¹⁶, the velocity is the motor capacity more important for the karateka practices the offensive techniques because an attack with high speed is difficult of the opponent defend. Others authors consider the velocity the motor capacity more important for the karateka of the MMA and of the *shiai kumite* (fight of competition in Japanese)¹⁷. Then, a systematic review about velocity of the offensive techniques of the karate is important for the MMA fighter choose the best attack during the combat.

What is the velocity of the offensive techniques of the karate? There is little information on this theme¹⁸, but combat sports literature does not have study about velocity of the offensive techniques of the karate in a systematic review¹⁹.

The objective of the systematic review was to present the velocity of the offensive techniques of the karate.

¹¹ H. Chaabène; E. Franchini; B. Miarka; M. Selmi; B. Mkaouer and K. Chamari. Time-motion analysis and physiological responses to karate official combat sessions: is there a difference between winners and defeated karatekas? *Int J Sports Physiol Perform* 9:2(2014):302-308; N. Marques Junior. Karatê shotokan: pontos dos golpes durante o kumite de competição masculino. *Ulbra Mov* 2:1(2011):1-15; N. Marques Junior. Pontos dos golpes durante o kumite de competição do karatê shotokan masculino. *Lecturas: Educ Fís Dep* 17:169(2012):1-12 and N. Marques Junior. Shotokan karate: score of the techniques during the female kumite of competition. *Lecturas: Educ Fís Dep* 17:174(2012):1-8.

¹² N. Marques Junior. Porque o soco causa mais pontos do que o chute durante a luta de karatê? Conteúdo para prescrever o treino de karatê shotokan. *Rev Bras Prescr Físio Exerc* 7:40(2013):376-387.

¹³ J. Harding; D. Wacker; W. Berg; G. Rick and J. Lee. Promoting response variability and stimulus generalization in martial arts training. *J Appl Behav Analysis* 37:2(2004):185-195.

¹⁴ J. Amtmann; K. Amtmann and W. Spath. Lactate and rate of perceived exertion responses of athletes training for and competing in a mixed martial arts event. *J Strength Cond Res* 22:2(2008):645-647; F. Del Vecchio; S. Hirata and E. Franchini. A review of time-motion analysis and combat development in mixed martial arts matches at regional level tournaments. *Percept Motor Skill* 112:2(2011):639-648 and F. Del Vecchio and E. Franchini. Specificity of high-intensity intermittent action remains important to MMA athletes physical conditioning: response to Paillard (2011). *Percept Motor Skill* 116:1(2013):233-234.

¹⁵ N. Marques Junior. Scientific evidences about the fight of the shotokan karate of competition. *Rev Bras Prescr Físio Exerc* 8:47(2014):400-417.

¹⁶ M. Nakayma. O melhor do karate – fundamentos. vol. 2, 9ª ed. (São Paulo: Cultrix, 2012), p. 108-109.

¹⁷ V. Barbanti. Treinamento esportivo: as capacidades motoras dos esportistas. (Barueri: Manole, 2010) p. 104-143 e Y. Verkhoshansky. Preparação de força especial. (Rio de Janeiro: GPS, 1995), p. 9-12.

¹⁸ N. Marques Junior. Velocidade do soco e do chute do karatê: uma meta-análise. *Lecturas: Educ Fís Dep* 17:169(2012):1-12.

¹⁹ E. Franchini e F. Del Vecchio. Estudos em modalidades esportivas de combate: “estado da arte”. *Rev Bras Educ Fís Esp* 25:esp(2011):67-81 and F. Fernandes; R. Wichij; V. Silva; A. Ladeira; U. Eriilha. Biomechanical methods applied in martial arts studies. *J Morphol Sci* 28:3(2011):141-144.

Materials and methods

This study followed the systematic review methodology proposed in Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement²⁰.

The studies were identified in electronic databases during January of 2012 to May of 2015. Literature searches were conducted in Google Scholar, Research Gate and PubMed. In electronic databases were consulted using the following keywords: karate, *mae geri*, *gyaku zuki*, karate and punch, karate and kick.

Relevant articles were obtained in full, and assessed against the inclusion and exclusion criteria described below. Inclusion criteria of the articles were evaluated under the following search strategies: (1) type of participants (male karateka), (2) type of task (velocity of the punch and/or of the kick) and (3) type of result (determined the velocity of the punch and/or of the kick). The studies that were excluded are the articles that were not in accordance with the inclusion criteria of the systematic review.

In the first phase of analysis, 3976 studies were found using the keywords listed in the previous section. After the reading the title and the abstract of each study, the second phase of analysis the total was reduced to 89 studies about velocity of the offensive technique of the karate. The researcher was able to read the 89 studies in a period of 30 days and the total was reduced to 35 studies with chances of inclusion. Of these studies, 24 studies were included in this systematic review. The details for the full strategy were listed in a PRISMA flow diagram, as shown in figure 1.

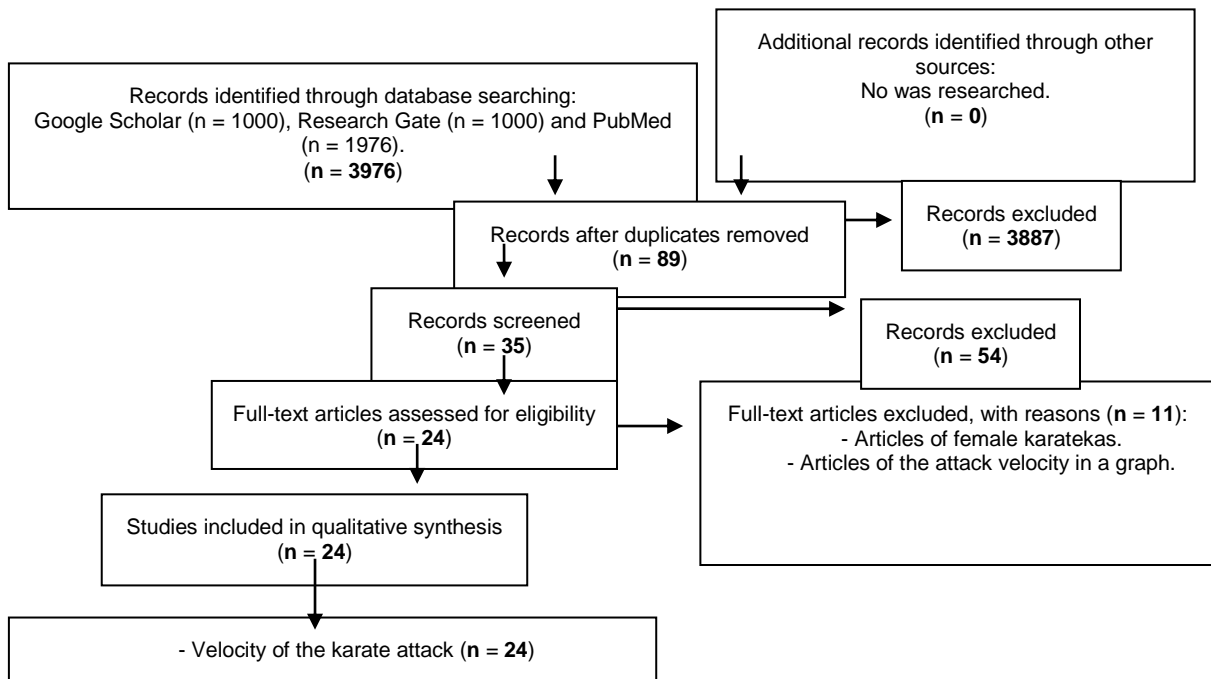


Figure 1
PRISMA flow diagram of the selection of articles

²⁰ D. Moher; A. Liberati; J. Tetzlaff and D. Altman. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLOS Med 6:7(2009):1-6.

The researcher used the scale of Galna et al.²¹ for the quality assessment of the studies. The scale of Galna et al.²² use questions (internal validity, external validity and others) about the article and the researcher determined the point of 0 to 1 of each item. The studies were considered low quality with an average below of 0,60 points, they were excluded from the systematic review. The use of the scale of Galna et al.²³ occurred in two moments with the objective to check the reliability and determine the level of agreement between the two scores on this instrument. The researcher determined the quality of the studies during an assessment, after 15 days, practiced new assessment of the studies²⁴ of velocity of the offensive technique of the karate.

The reliability of the quality of the studies by the scale of Galna et al.²⁵ was checked via intraclass correlation coeficiente ($p \leq 0,05$). Cohens's Kappa was calculated to determine the level of agreement between the two assessments of the studies ($p \leq 0,05$). Bland and Altman²⁶ method was applied to assess the level of agreement between the first and second quality assessment of the studies by the scale of Galna et al.²⁷. All these statistical treatments were performed according to the procedures of the GraphPad Prism, version 5.0.

Results and discussion

Intra-observer the level of agreement exhibited Cohen's Kappa values of 0,74, was a good agreement that is appointed by the literature²⁸, the result had significant difference ($p = 0,001$). The reliability of the quality of the studies by the scale of Galna et al.²⁹ was checked via intraclass correlation, the result was of 0,97 ($p = 0,0001$), this result was excellent³⁰.

Bland and Altman³¹ method was applied to assess the level of agreement between the first and second quality assessment of the studies by the scale of Galna et al.³². Although the difference between the assessment 1 and 2 was low (bias = 0,003), the limits of agreement (LA) ranged from - 0,07 (lower limit of agreement) to 0,08 (upper limit of agreement), the result was medium, suggesting a medium high agreement between the assessment 1 and 2 because the values of the bias stayed located near of the zero (increase the agreement) and the LA stayed located near of the zero (increase the agreement). The author calculated the 95% confidence interval (CI) recommended by

²¹ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older adults: a systematic review. *Gait Posture* 30:3(2009):270-275.

²² B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

²³ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

²⁴ N. Marques Junior. Vertical jump of the elite male volleyball players in relation the game position: a systematic review. *Rev Observatorio Dep* 1:3(2015):10-27.

²⁵ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

²⁶ J. Bland and D. Altman. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 8476:1(1986):307-310.

²⁷ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

²⁸ A. Gaya. *Ciências do movimento humano*. (Porto Alegre: Artmed, 2008), p. 286-287.

²⁹ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

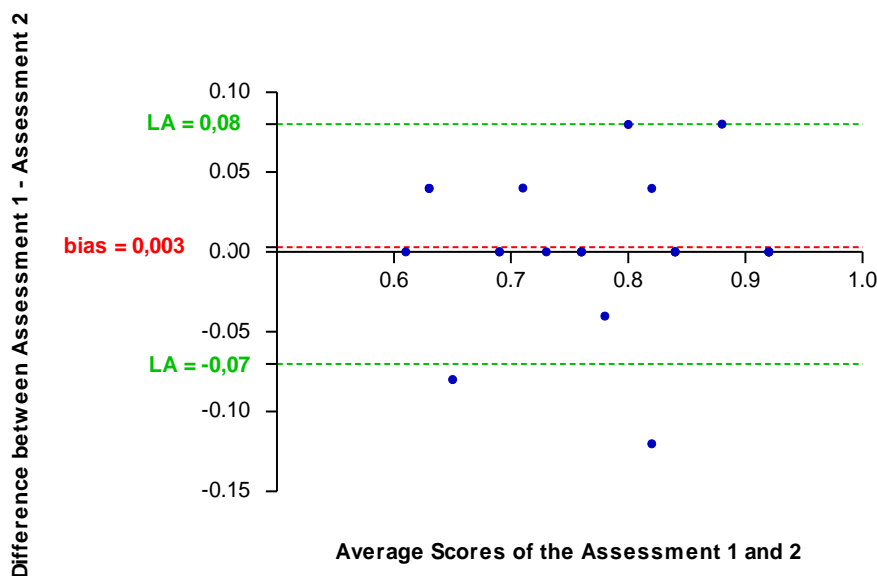
³⁰ P. Huijbregts. Spinal motion palpation: a review of reliability studies. *J Manual Manipul Therap* 10:1(2002):24-39.

³¹ J. Bland and D. Altman. Statistical methods for assessing agreement between...

³² B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

Marques Junior³³ about the Bland and Altman³⁴ method. The 95% CI of the bias was medium (lower CI = - 0,013 and upper CI = 0,019) and the 95% CI of the limit of agreement was high (lower CI = - 0,24 and upper CI = 0,39).

Therefore, a medium high agreement between the assessment 1 and 2 of the studies by scale of Galna et al.³⁵ was determined by Bland and Altman³⁶ method. The Bland and Altman³⁷ method shows in figure 2 the agreement between the assessments 1 and 2.



Graph 1

Bland and Altman plot the 95% limits of agreement (LA) between the assessment 1 and 2 by the scale of Galna et al.³⁸

The first assessment the researcher found a medium (thirteen studies, 0,61 to 0,76 points) to high scientific quality (eleven studies, 0,84 to 0,92 points). The second assessment the researcher found a medium (fourteen studies, 0,61 to 0,76 points) to high scientific quality (ten studies, 0,84 to 0,92 points).

The selected studies were medium to high quality because the number similar of studies was with these values. The table 1 shows the methodological quality of the studies.

³³ N. Marques Junior. Estatística aplicada ao esporte e a atividade física. Vol. 3. (Niterói: s.ed., 2014), p. 50-92.

³⁴ J. Bland and D. Altman. Statistical methods for assessing agreement between...

³⁵ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

³⁶ J. Bland and D. Altman. Statistical methods for assessing agreement between...

³⁷ J. Bland and D. Altman. Statistical methods for assessing agreement between...

³⁸ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

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Study	1	2	3	4	5	6	7	8	9	10	11	12	13	Average and Quality of each Study
Marques Junior ³⁹	1	0	0,5	0,5	0	1	1	1	0	0	1	1	1	0,61 (medium)
	1	0	1	1	0	1	1	1	0	0	1	1	1	0,69 (medium)
Diacu ⁴⁰	1	0	0,5	0,5	0	1	1	1	0	0	1	1	1	0,61 (medium)
	1	0	0,5	0,5	0	1	1	1	0	0	1	1	1	0,61 (medium)
Cynarski, Wajs and Vencesbrito ⁴¹	1	0	0,5	1	0	1	1	1	0	0	1	1	1	0,65 (medium)
	1	0	0,5	0,5	0	1	1	1	0	0	1	1	1	0,61 (medium)
Gianino ⁴²	1	0,5	0,5	0,5	0	1	1	1	0	0	1	1	1	0,65 (medium)
	0,5	0,5	0,5	0,5	0	1	1	1	0	0	1	1	1	0,61 (medium)
Mehanni ⁴³	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
Monteiro, Silva and Fernandes ⁴⁴	1	1	1	0,5	0	1	1	1	0	0	1	1	1	0,73 (medium)
	1	1	0,5	0,5	0	1	1	1	0	0	1	1	1	0,69 (medium)
McCann ⁴⁵	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
Rathee, Magnes and Davis ⁴⁶	0,5	1	0,5	0,5	1	1	1	1	0	0	1	1	1	0,73 (medium)
	0,5	1	0,5	0,5	1	1	1	1	0	0	1	1	1	0,73 (medium)
Hariri et al. ⁴⁷	0,5	1	1	0,5	0	1	1	1	0	0	1	1	1	0,69 (medium)
	1	1	0,5	0,5	0	1	1	1	0	0	1	1	1	0,69 (medium)
Vencesbrito et al. ⁴⁸	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
Sbriccoli et al. ⁴⁹	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
Pozo, Bastien and Dierick ⁵⁰	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
Vencesbrito et al. ⁵¹	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)
	1	1	1	1	1	1	1	1	0	1	1	1	1	0,92 (high)

³⁹ N. Marques Junior. Velocidade do soco e do chute do karatê: uma meta-análise. Lecturas: Educ Fís Dep 17:169(2012):1-12.

⁴⁰ F. Diacu. On the dynamics of karate. PIMS -(2003):9-11.

⁴¹ W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate techniques with the use of motion capture and mathematical modeling. The concept of a research project. J Martial Arts Anthropol 14:1(2014):39-53.

⁴² C. Gianino. Physics of karate: kinematics analysis of karate techniques by a digital movie camera. Lat Am J Phys Educ 4:1(2010):32-34.

⁴³ A. Mehanni. Kinematische und dynamische biomechanik des prellstosses kizami-zuki bein karate. (Doctoral thesis, Konstanz University, Physical Education, 2004), p. 67-118.

⁴⁴ H. Monteiro; C. Silva and T. Fernandes. Tempo de reação e velocidade do soco em caratecas graduados. FIEP 83:special(2013):-.

⁴⁵ S. McCann. Kinematics analysis of the gyaku zuki in zenkutsu dachi. (Doctoral thesis, San Jose State University, Master of Arts, 1992), p. 19-80.

⁴⁶ N. Rathee; J. Magnes and J. Davis. Kinematics of board breaking in karate using video physics and human performance. Eur Sci J 10:12(2014):338-348.

⁴⁷ S. Hariri; M. Rezaei; S. Nikokheslat and A. Sarshin. The study a relationship between the speed at the gyaku zuki kick contact time and the displacement of contact plate in elite karatekas men. Int J Sports Stud 4:12(2014):1513-1515.

⁴⁸ A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo e W. Cynarski. Avaliação eletromiográfica e cinemática do pontapé mae geri em karatecas de elite cinto negro não competidores. Rev UIIPS 2:3(2014):4-23.

⁴⁹ P. Sbriccoli; V. Camomilla; A. Mario; F. Quinzi; F. Figura and F. Felici. Neuromuscular control adaptations in elite athletes: the case of top level karatekas. Eur J Appl Physiol 108:6(2010):1269-1280.

⁵⁰ J. Pozo; G. Bastien and F. Dierick. Execution time, kinetics, and kinematics of the mae geri kick: comparison of national and international standard karate athletes. J Sports Sci 29:14(2011):1553-1561.

⁵¹ A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo and G. Branco. Characterization of kinesiological patterns of the frontal kick, *mae geri*, in karate experts and non-karate practitioners. RAMA 9:1(2014):20-31.

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Portela et al. ⁵²	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
Fernández et al. ⁵³	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0,92 (high)
	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0,84 (high)
Santos ⁵⁴	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
Ferreira et al. ⁵⁵	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0,92 (high)
	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0,92 (high)
Piemontez et al. ⁵⁶	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
	1	1	1	0,5	1	1	1	1	1	0	0	1	1	1	0,80 (medium)
Piemontez et al. ⁵⁷	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
	1	1	1	0,5	1	1	1	1	1	0	0	1	1	1	0,80 (medium)
Alsamad ⁵⁸	1	1	0,5	0,5	0	1	1	1	1	0	0	1	1	1	0,69 (medium)
	1	1	0,5	0,5	0	1	1	1	1	0	0	1	1	1	0,69 (medium)
Quinzi et al. ⁵⁹	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
	1	1	1	1	1	0,5	1	1	1	1	0	1	1	1	0,88 (high)
Mohamed and Halwish ⁶⁰	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0,84 (high)
	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
Pecoraioli ⁶¹	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
Emmermacher, Witte and Potenberg ⁶²	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0,76 (medium)
	1	1	0,5	0,5	1	1	1	1	1	0	0	1	1	1	0,76 (medium)

Table 1

Summary of the quality assessment of the studies selected

Obs.: The numbers in bold are the results of the 1st assessment and without this effect are of the 2nd assessment.

The numbers from 1 to 13 are the questions of the scale of Galna et al.⁶³: 1. Research aims or questions stated clearly (Scoring Criteria: 1 – yes; 0,5 – yes, lacking detail or clarity; 0 – no); 2. Participant detailed (number, age, sex, height, weight) (Scoring Criteria: 0 to 1); 3. Recruitment and sampling methods described (1 – yes; 0,5 – yes, lacking detail or clarity; 0 – no); 4. Inclusion and exclusion criteria detailed (1 – yes; 0,5 – yes, lacking detail or clarity; 0 – no); 5. Controlled co-variables (walking speed, age, gender) (0 to 1); 6. Key outcome variables clearly described (1 – yes; 0,5 – yes, lacking detail or clarity; 0 – no); 7. Adequate methodology able to repeat study (participant sampling, equipment, procedure, data processing, statistical) (0 to 1); 8. Methodology able to answer research question (participant sampling, equipment, procedure, data processing, statistical) (1 – yes; 0 – no). 9. Reliability of the methodology stated (1 – yes; 0 – no); 10. Interval validity of the methodology stated (1 – yes; 0 – no); 11. Research questions answered adequately in the discussion (1 – yes; 0 – no); 12. Key findings supported by the results (1 – yes; 0 – no); 13. Key findings interpreted in a logical manner which is supported by references (1 – yes; 0 – no). **Quality of the Studies:** 0 to 0,59 is low, 0,60 to 0,80 is medium and 0,81 to 1 is high.

⁵² B. Portela; M. Barbosa; T. Cavazzotto and M. Tartaruga. Kinematics analysis of the front kick with and without impact on traditional karate. Arch Budo Sci Martial Art Extreme Sport 10(2014):47-51.

⁵³ C. Fernández; V. Majolero; J. Rodríguez y C. González. Diferencias en el salto vertical y la velocidad de patada mae geri entre karatekas internacionales y nacionales. RAMA 8:1(2013):13-20.

⁵⁴ P. Santos. Análise biomecânica do chute frontal de karatê: implicações em lesões nos membros inferiores. (Dissertação de Mestrado, UNESP, Faculdade de Engenharia, Mestrado em Engenharia Mecânica, 2015), p. 40-54.

⁵⁵ L. Ferreira; A. Martins; G. Piemontez; S. Domenech; M. Gevaerd; A. Bonilla e N. Borges Junior. Influência das características antropométricas sobre o impulso e tempo de execução do chute giro dorsal do karatê. Rev Educ Fís/UEM 25:1(2014):33-43.

⁵⁶ G. Piemontez; A. Martins; N. Reis; L. Ferreira e S. Melo. Características cinemáticas do chute semicircular no karatê. Lecturas: Educ Fís Dep 16:163(2011):1-13.

⁵⁷ G. Piemontez; A. Martins; S. Melo; L. Ferreira e N. Reis. Cinemáticas do chute semicircular no karatê: comparação entre as fases de ataque e retorno. Rev Educ Fís/UEM 24:1(2013):51-59.

⁵⁸ T. Alsamad. The kinematics analysis of doubles kazami mawashi geri for heavy weight players under the maximum load in karate. World J Sport Sci 7:1(2012):16-19.

⁵⁹ F. Quinzi; V. Cammomilla; F. Felici; A. Di Mario and P. Sbriccoli. Differences in neuromuscular control between impact and no impact roundhouse kick in athletes of different skill levels. J. Electromyogr Knes 23:1(2013):140-150.

⁶⁰ A. Mohamed and T. Halwish. Kinematics of the mawashi shoudan kick as a parameter of designing a training program for karate juniors. World J Sport Sci 5:4(2011):237-244.

⁶¹ F. Pecoraioli. Analisis biomeccanica del mawashi geri jodan in cinture nere di karate: modelli tecnici a confronto. (Tesi di Dottorato, Università di Bologna, Attività Sportive, 2009), p. 25-48.

⁶² P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri. 25^o International Symposium on Biomechanics in Sport (Ouro Preto, MG, Brazil, 2007), p. 289-292.

⁶³ B. Galna; A. Peters; A. Murphy and M. Morris. Obstacle crossing deficits in older...

In table 2 was presented a summary of each study selected for the systematic review.

Study	Male Karatekas	Type of Study and Kinematic Acquisition	Attack Velocity
Marques Junior ⁶⁴	n = 7 studies.	Meta-analysis about linear velocity of the attack in the trunk (<i>tchudan</i> or <i>kekomi</i> in Japanese) with more points during the competition of Shotokan karate.	7,1±1,88 meters per second (m/s) of the <i>kizami zuki tchudan</i> , 9,2±2,86 m/s of the <i>gyaku zuki tchudan</i> , 5,83±2,54 m/s of the <i>oi zuki tchudan</i> , 15,76±5,45 of the <i>mae geri kekomi</i> and 8±3,24 m/s of the <i>mawashi geri kekomi</i> . Marques Junior and Silva Filho ⁶⁵ transformed the values of the linear velocity of these attacks for seconds, the results were the following: 0,11 seconds (s) of the <i>kizami zuki tchudan</i> , 0,15 s of the <i>gyaku zuki tchudan</i> , 0,097 s of the <i>oi zuki tchudan</i> , 0,26 s of the <i>mae geri kekomi</i> and 0,13 s of the <i>mawashi geri kekomi</i> .
Diacu ⁶⁶	n = 2 references.	Review article about the mathematics applied to the karate. The study presents the linear velocity of the attack, but does not determine the target of the attack, trunk (<i>tchudan</i> or <i>kekomi</i> in Japanese) and/or face (<i>jodan</i> or <i>keage</i> in Japanese).	5,7 to 9,8 m/s of the <i>kizami zuki</i> , 9,9 to 14,4 m/s of the <i>mae geri</i> , 9,5 to 11 m/s of the <i>mawashi geri</i> , 9,9 to 14,4 m/s of the <i>yoko geri</i> (side kick) and 10,6 to 12 m/s of the <i>ushiro geri</i> (back kick).
Cynarski et al. ⁶⁷	Group of karatekas of the traditional Shotokan karate.	The original article, the researchers used the software BTS SMART-D system for determine the linear velocity with three-dimensional (3D) analysis. The karatekas were filmed by cameras during various axes. The researchers studied the <i>mae geri</i> , but the study presented the velocity of others attacks.	The study presented the linear velocity of the <i>mae geri kekomi</i> through of a graphical. The velocity of others attacks the study presented and were the following: 14 m/s of the <i>gyaku zuki</i> , 5,52 to 12,64 m/s of the <i>oi zuki</i> , 14,4 m/s of the <i>mae geri</i> , 9,5 to 11 m/s of the <i>mawashi geri</i> and 9,9 to 14,4 m/s of the <i>yoko geri</i> .
Gianino ⁶⁸	Karatekas	The original article, the researcher practiced with a camera in the sagittal plane (with the fighter of side) the data collection of the karate attacks. The linear velocity with two-dimensional (2D) analysis was determined by software.	13 m/s of the <i>gyaku zuki tchudan</i> , 10 m/s <i>oi zuki tchudan</i> , 19 m/s of the <i>mae geri keage</i> , 2 m/s of the <i>yoko geri kekomi</i> and 41 m/s of the <i>yoko geri keage</i> .
Mehanni ⁶⁹	Black belt karatekas (n = 7).	The Doctoral thesis, the researcher used five Sony DCR-VX 100 cameras in the Panasonic tripod. The <i>kizami zuki</i> data were collected with two cameras in the left sagittal plane (left side), with two cameras in the right sagittal plane (right side) and a camera in the frontal plane (behind of the fighter). The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by APAS software (3D analysis) that determined the linear and angular velocity of the punch.	The linear velocity of the <i>kizami zuki tchudan</i> was of 5,8 m/s. The angular velocity of the punch was the following: 153,29 degrees per second (°/s) of the knee, 140,15 °/s of the hip (knee and hip occurred in the <i>zenkutsu dachi</i> – is the front stance), 111,81 °/s of the shoulder and 164,79 °/s of the elbow.
Monteiro et al. ⁷⁰	Male karatekas of 22±3,2 years and with 9,8±3,1 years of practice of the fight, all fighters were black belts (n = 10).	The original article, the researchers used a Samsung WB2000 camera in the tripod. The <i>gyaku zuki</i> data were collected with the camera in the sagittal plane of the punch, the camera stayed at a distance of 3 meters (m) and 1 m above of the ground. The karatekas practiced 3 punches with pause of 30 seconds between each repetition (the punch occurred in the <i>zenkutsu dachi</i>). The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Peak Motus software (3D analysis) of the Vicon that determined the linear and angular velocity of the punch.	The linear velocity of the wrist during the <i>gyaku zuki tchudan</i> was of 6±0,38 m/s. The angular velocity of the elbow during the punch was of 1483±172,9 °/s.

⁶⁴ N. Marques Junior. Velocidade do soco e do chute...

⁶⁵ N. Marques Junior e J. Silva Filho. Treino de força para o karateca do estilo shotokan especialista no kumite. Rev Bras Prescr Fisio Exerc 7:41(2013):506-533.

⁶⁶ F. Diacu. On the dynamics of karate...

⁶⁷ W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate techniques...

⁶⁸ C. Gianino. Physics of karate: kinematics analysis...

⁶⁹ A. Mehanni. Kinematische und dymamische biomechanik...

⁷⁰ H. Monteiro; C. Silva and T. Fernandes. Tempo de reação e velocidade do soco...

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McCann ⁷¹	Male black belts karatekas of the Shotokan style with 26 to 36 years (n = 5).	The Doctoral thesis, the researcher used two Panasonic D5000 cameras and each camera stayed in the 90° angle during the front plane (in front of fighter). The karateka practiced the <i>gyaku zuki tchudan</i> in <i>zenkutsu dachi</i> without a target and with impact into a target. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Peak Performance 3D Motion Measurement System software (3D analysis) that determined the linear velocity of the punch.	The linear velocity during the <i>gyaku zuki tchudan</i> without a target was the following: 1 m/s of the hip, 2,9 m/s of the shoulder and 7,6 m/s of the wrist. The linear velocity during the <i>gyaku zuki tchudan</i> with impact into a target was the following: 1,27 m/s of the hip, 3,56 m/s of the shoulder and 6 m/s of the wrist.
Rathee et al. ⁷²	Male black belt karateka (n = 1).	The original article, the researcher used a camera in the sagittal plane during the <i>gyaku zuki tchudan</i> in <i>zenkutsu dachi</i> at the moment that the fighter broke a board. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Kinematic software (2D analysis) that determined the linear velocity of the punch.	The linear velocity during the <i>gyaku zuki tchudan</i> that broke a board was of 6,58 m/s.
Hariri et al. ⁷³	Iran's karatekas team, all fighters were black belts (24,1±3,4 years, 73,6±6,6 kg and 176±4,6 cm, n = 16).	The original article, the researcher used a camera in the sagittal plane during the <i>gyaku zuki</i> . The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Skill Spector software (2D analysis) that determined the linear velocity of the wrist during the punch.	The linear velocity of the wrist during the <i>gyaku zuki</i> was of 4,3±0,39 to 5,91±0,57 m/s.
Vencesbrito et al. ⁷⁴	Male black belts karatekas of the Portugal team that were competitors of <i>kumite</i> (fight, 21±3 years, 175±7 cm, 72±10 kg, lower limb of 89±4 cm, n = 10).	The original article, the <i>mae geris</i> were collected with the Casio EX-FH20 camera in the sagittal plane of the kick, the camera stayed at a distance of 2 m. The karateka practiced the <i>mae geri kekomi</i> in <i>zenkutsu dachi</i> with impact into a target (3 repetitions with pause of 10 seconds between each repetition). The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by APAS software (2D analysis) that determined the linear velocity of the kick.	The linear velocity during the <i>mae geri kekomi</i> was the following: 1,7±0,5 m/s of the pelvis, 2,1±0,7 m/s of the hip, 5,5±1,7 m/s of the knee, 8,2±2,5 m/s of the ankle and 5,8±1,2 m/s of the foot.
Sbriccoli et al. ⁷⁵	Elite male karatekas with 15 years of karate practice, all the fighters were black belts (24,8±1 years, 178±0,03 cm, 73,8±4 kg, n = 6). Amateur male karatekas with 15 years of karate practice, all the fighters were black belts (27,8±1 years, 180±0,03 cm, 77±3,6 kg, n = 6).	The original article, the <i>mae geris</i> were collected with a camera in the sagittal plane of the kick. The karateka practiced the <i>mae geri</i> by 3 repetitions. The fastest kick was chosen for further analysis. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by kinematic software (2D analysis) that determined the angular velocity of the kick.	Elite karatekas practiced the angular velocity during the <i>mae geri</i> with the following results: 1,470±84°/s of the knee flexion and 543±43°/s of the hip flexion (preparatory phase of the kick). Amateur karatekas practiced the angular velocity during the <i>mae geri</i> with the following results: 1,110±26°/s of the knee flexion and 427±8°/s of the hip flexion (preparatory phase of the kick).
Pozo et al. ⁷⁶	Belgian national (37,9±9 years, 176,4±7,9 cm, 76±11,3 kg, lower limb of 82,2±4,7 cm, n = 8 males and 1 female) and international (24,2±10,6 years, 174,4±8,6 cm, 70,3±9,3 kg, lower limb of 79,9±5,8 cm, n = 7 males and 1 female) black belts karatekas of the Shotokan style.	The original article, the <i>mae geris</i> were collected with the Basler piA640-210gc camera in the sagittal plane of the kick. The karateka practiced the <i>mae geri</i> in <i>zenkutsu dachi</i> with impact into a target (6 repetitions with pause of 1 minute between each repetition) and returned to the reference position. The kick was performed with dominant lower limb and all 6 kicks were analyzed. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by kinematic software (2D analysis) that determined the angular velocity of the kick.	International karatekas practiced the angular velocity during the <i>mae geri</i> with the following results: 784°/s of the knee flexion and 721°/s of the hip flexion (preparatory phase of the kick), 1029°/s of the knee extension and 690°/s of the hip extension (attack phase). National karatekas practiced the angular velocity during the <i>mae geri</i> with the following results: 698°/s of the knee flexion and 605°/s of the hip flexion (preparatory phase of the kick), 961°/s of the knee extension and 638°/s of the hip extension (attack phase).

⁷¹ S. McCann. Kinematics analysis of the *gyaku zuki*...

⁷² N. Rathee; J. Magnes and J. Davis. Kinematics of board breaking in karate...

⁷³ S. Hariri; M. Rezaei; S. Nikokheslat and A. Sarshin. The study a relationship between the speed at the *gyaku zuki*...

⁷⁴ A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo e W. Cynarski. Avaliação eletromiográfica e cinemática do pontapé *mae geri*...

⁷⁵ P. Sbriccoli; V. Camomilla; A. Mario; F. Quinzi; F. Figura and F. Felici. Neuromuscular control adaptations in elite athletes: the case of top level karatekas...

⁷⁶ J. Pozo; G. Bastien and F. Dierick. Execution time, kinetics, and kinematics of the *mae geri* kick...

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Vencesbrito et al. ⁷⁷	Male black belts karatekas (24±7 years, 171±7 cm, 72±19 kg, lower limb of 89±6 cm, n = 14).	The original article, the <i>mae geris</i> were collected with the Casio EX-FH20 camera in the sagittal plane of the kick, the camera stayed at a distance of 2 m. The karateka practiced the <i>mae geri kekomi</i> in <i>zenkutsu dachi</i> with impact into a target (3 repetitions). The kick was with dominant leg, the right. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by APAS software (2D analysis) that determined the linear velocity of the kick.	The linear velocity during the <i>mae geri kekomi</i> was the following: 2,3±0,5 m/s of the hip, 5,8±0,7 m/s of the knee and 8,1±0,9 m/s of the ankle.
Portela et al. ⁷⁸	Male black belts karatekas of Guarapuava, Paraná state, Brazil. The fighters had 13,7±4,7 years of training and they were of the traditional Shotokan karate (n = 8).	The original article, the <i>mae geris</i> were collected with the Casio FH25 camera in the sagittal plane of the kick. The karateka practiced the <i>mae geri</i> without impact and with impact over a sandbag. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Skill Spector version 1.3.2. software (2D analysis) that determined the linear velocity of the kick.	The linear velocity during the <i>mae geri</i> without impact was the following: 3,18±2,43 m/s of the left ankle, 3,42±1,42 m/s of the right ankle, 3,74±3,41 m/s of the left foot and 3,88±2,23 m/s of the right foot. The linear velocity during the <i>mae geri</i> with impact over a sandbag as the following: 101,53±10,05 m/s of the left ankle, 105,11±10,07 m/s of the right ankle, 8,88±2,42 m/s of the left foot and 10,70±1,93 m/s of the right foot.
Fernández et al. ⁷⁹	Spanish national (21±3,4 years, 168,5±6,7 cm, 66,8±7,3 kg, n = 13 males) and international (17±3,5 years, 170,5±7,6 cm, 65,2±10,8 kg, n = 11 males) black belts karatekas expert in <i>kata</i> .	The original article, the <i>mae geris</i> were collected with the Casio EXFC-100 camera in the sagittal plane of the kick, the camera stayed at a distance of 2,5 m. The karateka practiced 3 <i>mae geris</i> with each leg. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Kinovea version 0.8.15. software (2D analysis) that determined the linear velocity of the kick.	19,3±1,49 m/s was the linear velocity of the <i>mae geri</i> of the international karatekas and 18,2±0,96 m/s was the linear velocity of the <i>mae geri</i> of the national karatekas.
Santos ⁸⁰	Male karatekas of several belts (black = 1, brown = 4 and purple = 1, n = 8, n = 7 males and 1 female, 17 to 24 years, 42 to 104 kg, 160 to 190 cm).	Master dissertation, the <i>mae geris kekomi</i> were collected with two Casio cameras in the tripod during the sagittal plane the kick, the camera stayed at a distance of 1 m and 0,5 m. The karateka practiced 5 <i>mae geris</i> in the target and after of each kick, practiced 1 minute of pause. The fighter practiced the kick in the fight stance with two actions: static and dynamic. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Kinovea software (2D analysis) that determined the velocity in seconds of the kick.	The karatekas practiced the <i>mae geri kekomi</i> with the time of 0,233±0,77 s in the fight stance during the static action. The karatekas practiced the <i>mae geri kekomi</i> with the time of 0,219±0,67 s in the fight stance during the dynamic action.
Ferreira et al. ⁸¹	Male black belts karatekas of Curitiba, Paraná state, Brazil. The fighters had 12,16±7,58 years of training and they were of the Shubu-Do karate. All athletes were of national level (27,66±7,58 years, 174±0,06 cm, 79,51±15,38 kg, lower limb of 87±0,03 cm, n = 12).	Original article, the <i>ushiro geris kekomi</i> were collected with a camera. The karateka practiced 7 kicks in the target and after of each kick, practiced 1 minute of pause. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (2D analysis) that determined the velocity in seconds of the kick.	The karatekas practiced the <i>ushiro geri kekomi</i> with the time of 0,34±0,05 s for the left lower limb and 0,35±0,04 s for the right lower limb.
Piemontez et al. ⁸²	Male black belts karatekas of the Shubu-Do style with 7±1,7 years of training (29,62±9,05 years, n = 8).	Original article, the <i>mawashi geris kekomi</i> were collected with 6 cameras. The karateka practiced 3 kicks in the sandbag. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (3D analysis) that determined the velocity of the kick.	The karatekas practiced the <i>mawashi geri kekomi</i> with the following times of the ankle: 0,48±0,11 s of attack, 0,98±0,09 s of return of the leg after the attack and 10,03±2,10 m/s of the attack. The <i>mawashi geri kekomi</i> had the following times of the hip: 4,76±1,74 m/s of the attack.

⁷⁷ A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo and G. Branco. Characterization of kinesiological patterns of the frontal kick, *mae geri*...

⁷⁸ B. Portela; M. Barbosa; T. Cavazzotto and M. Tartaruga. Kinematics analysis of the front kick...

⁷⁹ C. Fernández; V. Majolero; J. Rodríguez y C. González. Diferencias en el salto vertical y la velocidad de patada *mae geri*...

⁸⁰ P. Santos. Análise biomecânica do chute frontal de karatê...

⁸¹ L. Ferreira; A. Martins; G. Piemontez; S. Domenech; M. Gevaerd; A. Bonilla e N. Borges Junior. Influência das características antropométricas sobre o impulso e tempo de execução do chute...

⁸² G. Piemontez; A. Martins; N. Reis; L. Ferreira e S. Melo. Características cinemáticas do chute...

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Piemontez et al. ⁸³	Male black belts karatekas of the Shubu-Do style of Curitiba, Paraná state, Brazil (n = 20).	Original article, the <i>mawashi geris kekomi</i> were collected with 6 cameras. The karateka practiced 3 kicks in the sandbag. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (3D analysis) that determined the velocity of the kick.	The karatekas practiced the <i>mawashi geri kekomi</i> with the following times of the ankle: 0,48 s of attack, 0,81±0,07 s of return of the leg after the attack, 9,43±1,01 m/s of the attack and 2,04±0,07 m/s of the return of the leg after the attack. The <i>mawashi geri kekomi</i> had the following times of the knee: 5,22±0,26 m/s of the attack and 2,70±0,14 m/s of the return of the leg after the attack. The <i>mawashi geri kekomi</i> had the following times of the hip: 4,32±0,37 m/s of the attack and 1,32±0,13 m/s of the return of the leg after the attack.
Alsamad ⁸⁴	Male karateka (n = 1).	Original article, the kick was collected with a camera. The karateka practiced 2 <i>mawashi geris keages</i> (in the face), the first attack occurred with the front left leg (<i>kizami mawashi geri</i>) and the second kick occurred with the right leg back (<i>mawashi geri</i>). The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (2D analysis) that determined the velocity of the kick.	The <i>kizami mawashi geri keage</i> was practiced with a velocity of 0,211 s and the <i>mawashi geri keage</i> the karateka practiced in 0,254 s.
Quinzi et al. ⁸⁵	Elite male karatekas with 15 years of karate practice, all the fighters were black belts (24,8±1 years, 178±0,03 cm, 73,8±4 kg, n = 6).	The original article, the <i>mawashi geris</i> were collected with a camera in the sagittal plane of the kick. The karateka practiced the <i>mawashi geri</i> by 3 repetitions and all the data were analyzed. The kick with impact into a target was in the trunk (<i>kekomi</i>) and the kick without impact was in the face (<i>keage</i>). The type of kick (with impact and without) was equal the rules imposed by the World Karate Federation (WKF). The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by kinematic software (2D analysis) that determined the angular velocity of the kick.	Elite karatekas practiced the knee angular velocity during the <i>mawashi geri kekomi</i> of 1734±108°/s (with impact) and of the <i>mawashi geri keage</i> of 1633±102°/s (without impact). The same fighters practiced the hip extension during the attack phase during the <i>mawashi geri kekomi</i> of 608±62°/s (with impact) and of the <i>mawashi geri keage</i> of 375±60°/s (without impact).
Mohamed and Halwish ⁸⁶	Elite male karateka gold medal in 2011 of <i>kumite</i> (fight) during Asian Championship (18 years, 171 cm, 67 kg, lower limb of 96 cm, n = 1).	Original article, the <i>mawashi geri kekomi</i> was collected with a camera during the training. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by Skill Spector version 1.3.0. software (2D analysis) that determined the velocity of the kick.	The karateka practiced the <i>mawashi geri kekomi</i> with a time of 0,120 seconds.
Pecoraioli ⁸⁷	Male karatekas black belts of the WKF expert in <i>kumite</i> (18 years, n = 5)	The Doctoral thesis, the fighters were divided into 2 groups. The group 1 (n = 3) practiced the traditional <i>mawashi geri keage</i> described by Nakayama ⁸⁸ . The group 2 (n = 2) practiced the new <i>mawashi geri keage</i> with the following performance technique: the karateka practiced the kick in <i>zenkutsu dachi</i> , but during the preparatory phase practiced hip flexion and knee flexion, both actions were equal the <i>mae geri</i> and during attack phase, the fighter practiced the kick described by Nakayama ⁸⁹ . The kicks were collected with 6 cameras. The karatekas practiced 5 kicks with impact into a target, after each kick the fighter practiced a pause of 2 minutes. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (3D analysis) that determined the velocity of the kick.	The results of the traditional <i>mawashi geri keage</i> were the following: 0,58±0,01 s and 7,58±0,34 m/s. The results of the new <i>mawashi geri keage</i> were the following: 0,58±0,01 s and 7,95±0,27 m/s.

⁸³ G. Piemontez; A. Martins; S. Melo; L. Ferreira e N. Reis. Cinemáticas do chute semicircular...

⁸⁴ T. Alsamad. The kinematics analysis of doubles kazami mawashi geri...

⁸⁵ F. Quinzi; V. Cammomilla; F. Felici; A. Di Mario and P. Sbriccoli. Differences in neuromuscular control between impact and no impact roundhouse kick...

⁸⁶ A. Mohamed and T. Halwish. Kinematics of the mawashi shoudan kick...

⁸⁷ F. Pecoraioli. Analisis biomeccanica del mawashi geri jodan in cintura nere di karate...

⁸⁸ M. Nakayama. O melhor do karate – fundamentos. vol. 2, 9ª ed. (São Paulo: Cultrix, 2012) p. 104-105, 132-135.

⁸⁹ M. Nakayama. O melhor do karate – fundamentos. vol. 2...

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Emmermacher, Witte and Potenberg ⁹⁰	Male karatekas with good skill in kick. The fighters were of 1 orange belt and 2 black belts (n = 3).	Original article. The karatekas practiced 6 kicks and after each type of kick, the athlete practiced a pause of 3 minutes. The kicks were performed in the following order: 1 st the <i>kizami mawashi geri kekomi</i> (kick with the front leg and in the trunk), 2 nd the <i>kizami mawashi geri keage</i> (kick in the face), 3 rd <i>mawashi geri kekomi</i> (kick with the back leg) and 4 th <i>mawashi geri keage</i> . The researcher collected with a VICON system 8MX40 camera the in the sagittal plane. The data obtained by the camera were uploaded to a computer and the researcher practiced analysis by software (2D analysis) that determined the velocity of the kick.	The results of the linear velocity were the following: 2,19±0,27 m/s, 2,26±0,08 m/s and 2,54±0,29 m/s of the <i>kizami mawashi geri kekomi</i> , 3,05±0,21 m/s, 3,34±0,48 m/s and 3,50±0,13 m/s of the <i>mawashi geri kekomi</i> , 2,36±0,17 m/s, 2,38±0,11 m/s and 2,55±0,25 m/s of the <i>kizami mawashi geri keage</i> , 3,05±0,21 m/s, 3,34±0,19 m/s and 3,49±0,14 m/s of the <i>mawashi geri keage</i> . The time in seconds was the following: 0,68±0,06 of the <i>kizami mawashi geri keage</i> .
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Table 2
Summary of the studies selected

The systematic review had limitations, the researcher found 24 studies on velocity of the offensive techniques of the karate for the mixed martial arts (MMA) fighter. The studies presented the velocity of the punches (3 studies of the *kizami zuki*, 8 studies of the *gyaku zuki* and 3 studies of the *oi zuki*) and of the kicks (11 studies of the *mae geri*, 10 studies of the *mawashi geri*, 3 studies of the *yoko geri* and 2 studies of the *ushiro geri*), of offensive techniques often used Shotokan karate JKA (Japan Karate Association), traditional and WKF (World Karate Federation)⁹¹. Some of these studies of the table 2 did not present the target of the attack, in the trunk (*tchudan* or *kekomi* in Japanese) and/or in the face (*jodan* or *keage* in Japanese). The reader can know the biomechanics of these attacks in the study of Marques Junior⁹².

However, the studies did not investigate the velocity of some effective karate attacks, for example, the *ura mawashi geri* (inside roundhouse kick) is a kick that practices more points in the competition of the WKF Shotokan karate⁹³, but the studies did not determine the velocity this kick. Others attacks karate literature did not measure the velocity of the offensive techniques that cause many points during the competition of the JKA and traditional karate (both of the Shotokan style), the attacks are the following: *mae geri* followed by *kizami zuki* or *oi zuki*, *mawashi geri* followed by *kizami zuki* or *oi zuki*, *kizami ashi barai* (front foot sweep) followed by *gyaku zuki* and *mae tobi geri* (front kick with jump)⁹⁴. The systematic review did not find the velocity of 3 kicks that cause many knockouts during the Kyokushin karate combat, the attacks are the following: the *ushiro mawashi geri* (reverse roundhouse kick), the *ushiro mawashi tobi geri* (reverse roundhouse kick with jump) and the *kakato geri* (descendant kick or axe kick).

⁹⁰ P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri...

⁹¹ N. Marques Junior. Campeonato Mundial de kumite do karate shotokan de 1972: pontos dos golpes, ações ofensivas e zona dos pontos do brasileiro Luiz Tasuke Watanabe. Lecturas: Educ Fís Dep 17:178(2013):1-7; N. Marques Junior. Fight zone with points of the Shotokan karate female competition. Rev Bras Precr Fisio Exerc 8:44(2014):137-148; H. Sertic; I. Segedi and T. Vidranski. Situational efficiency of arm leg techniques in a karate fight of top level female karate competitors. J Martial Art Anthropol 12:2(2012):44-49 and J. Horrillo y J. Rubio. Análisis técnico de karatecas de nivel nacional durante la competición de kumite. Rev Ci Dep 9:1(2013):17-26.

⁹² N. Marques Junior. Karatê shotokan: biomecânica dos golpes do kumite de competição. Lecturas: Educ Fís Dep 16:158(2011):1-28.

⁹³ A. Nishimura. Análise dos golpes efetivos de karatê da categoria sub-21 na competição USA Open 2011. (Monografia de Graduação, UEL, Educação Física, 2011), p. 21-22.

⁹⁴ M. Nakayama. O melhor do karatê 3 – kumite 1. 7ª ed. (São Paulo: Cultrix, 2012), p. 30-145; N. Marques Junior. Pontos dos golpes durante o kumite de competição do karatê shotokan masculino. Lecturas: Educ Fís Dep 17:169(2012):1-12 and N. Marques Junior. Shotokan karate: score of the techniques during the female kumite of competition. Lecturas: Educ Fís Dep 17:174(2012):1-8.

All these attacks can be used by MMA fighter practitioner of karate⁹⁵, but the systematic review did not find the velocity of some attacks in the literature.

The linear and/or angular velocity of the kicks was presented in most attack studies of the back leg, and few studies on the front leg (*kizami geri* in Japanese)⁹⁶. Other problem of the studies, were the times of the attacks, the most offensive techniques were through of the linear and/or angular velocity, these results difficult the MMA coach of evaluate the attack velocity of the MMA fighter. Then, this is the reason to be presented few attacks in seconds. Marques Junior⁹⁷ recommended for the karate coach or for the MMA coach, use the Kinovea software and/or Skill Spector software for determine the linear velocity, the angular velocity and the time of the attack in seconds. The two softwares are free on the Internet. The linear velocity is defined as the displacement that occurs in an interval of time⁹⁸. The linear velocity of the offensive techniques of the karate is important for the coach to know this biomechanical factor that influences the quality of the attack velocity⁹⁹.

The linear velocity of the *kizam zuki tchudan* (jab punch in the trunk) was of 5,8 to 7,1±1,88 m/s¹⁰⁰, the *kizami zuki* without information about the target of the attack was of 5,7 to 9,8 m/s¹⁰¹, the *gyaku zuki tchudan* (reverse punch) had linear velocity of 6,58 to 13 m/s¹⁰², but the *gyaku zuki* without information about the target of the attack was of 14 m/s¹⁰³. The *oi zuki* (lunge punch) was the last punch that the researcher detected the linear velocity. The *oi zuki tchudan* had linear velocity of 5,83±2,54 to 10 m/s¹⁰⁴, but the *oi zuki* without information about the target of the attack was of 5,52 to 12,64 m/s¹⁰⁵. The best linear velocity was the *gyaku zuki tchudan*, the 2nd best linear velocity was the *oi zuki tchudan* and the last position was the *kizami zuki tchudan*.

⁹⁵ L. Paiva. É possível prever os resultados das lutas? Olhar clínico nas lutas, artes marciais e modalidades de combate. (Manaus: OMP Editora, 2015), p. 50-57.

⁹⁶ P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri. 25^o International Symposium on Biomechanics in Sport (Ouro Preto, MG, Brazil, 2007), 289-292 and T. Alsamad. The kinematics analysis of doubles kazami mawashi geri for heavy weight players under the maximum load in karate. World J Sport Sci 7:1(2012):16-19.

⁹⁷ N. Marques Junior. Scientific evidences about the fight of the Shotokan karate of competition. Rev Bras Prescr Fisio Exerc 8:47(2014):400-417.

⁹⁸ N. Marques Junior. Manual do software skill spector (versão 1.2.3., Dinamarca) para análise bidimensional em biomecânica. 2^a ed., ampliada e revisada (Niterói: s.ed., 2013), p. 5-7.

⁹⁹ A. Amadio e J. Serrão. A biomecânica em educação física e esporte. Rev Bras Educ Fís Esp 25:esp(2011):15-24. and J. Chow and D. Knudson. Use of deterministic models in sports and exercise biomechanics research. Sports Biomech10:3(2011):219-233.

¹⁰⁰ N. Marques Junior. Velocidade do soco e do chute do karatê: uma meta-análise. Lecturas: Educ Fís Dep 17:169(2012):1-12 and A. Mehanni. Kinematische und dynamische biomechanik des prellstosses kizami-zuki bein karate. (Doctoral thesis, Konstanz University, Physical Education, 2004), 67-118.

¹⁰¹ F. Diacu. On the dynamics of karate. PIMS -(2003):9-11.

¹⁰² N. Marques Junior. Velocidade do soco e do chute do karatê...; C. Gianino. Physics of karate: kinematics analysis of karate techniques by a digital movie camera. Lat Am J Phys Educ 4:1(2010):32-34 and N. Rathee; J. Magnes and J. Davis. Kinematics of board breaking in karate using video physics and human performance. Eur Sci J 10:12(2014):338-348.

¹⁰³ W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate techniques with the use of motion capture and mathematical modeling. The concept of a research project. J Martial Arts Anthropol 14:1(2014):39-53.

¹⁰⁴ N. Marques Junior. Velocidade do soco e do chute do karatê... and C. Gianino. Physics of karate...

¹⁰⁵ W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate...

Some kicks had a higher linear velocity than the punch. The *mae geri kekomi* (front kick in the trunk) was of $15,76\pm 5,45$ m/s¹⁰⁶, but the *mae geri keage* (in the face) was faster, with 19 m/s¹⁰⁷. The *mae geri* without information about the target of the attack was of $9,9$ to $19,3\pm 1,49$ m/s¹⁰⁸. The *mawashi geri kekomi* (semicircular kick with back leg in the trunk) had linear velocity of $3,05\pm 0,21$ to $8\pm 3,24$ m/s¹⁰⁹, but the *mawashi geri keage* (back leg in the face) the linear velocity was of $3,05\pm 0,21$ to $7,58\pm 0,34$ m/s¹¹⁰. However, the *mawashi geri keage* with preparatory phase of the kick equal to the *mae geri*, had the best linear velocity ($7,95\pm 0,27$ m/s) than the traditional *mawashi geri keage* ($7,58\pm 0,34$ m/s)¹¹¹ described by Nakayama¹¹².

For Marques Junior¹¹³, the *mawashi geri keage* with preparatory phase equal to the *mae geri* has explication of the biomechanics (is the new *mawashi geri keage*). For this author hip flexion performed by new *mawashi geri keage* has more torque than the hip internal rotation performed by traditional *mawashi geri keage*, then, the movement is faster. However, studies are needed to corroborate these affirmations.

The *kizami mawashi geri kekomi* (kick with the front leg, $2,19\pm 0,27$ to $2,54\pm 0,29$ m/s) and the *kizami mawashi geri keage* ($2,36\pm 0,17$ to $2,55\pm 0,25$ m/s)¹¹⁴ had linear velocity worse than the *mawashi geri kekomi* (kick with back leg, $3,05\pm 0,21$ to $8\pm 3,24$ m/s)¹¹⁵ and the *mawashi geri keage* ($3,05\pm 0,21$ to $7,58\pm 0,34$ m/s)¹¹⁶. The motive for the higher linear velocity of the *mawashi geri* is the greater angular acceleration¹¹⁷.

The *mawashi geri* without information about the target of the attack was of $9,5$ to 11 m/s¹¹⁸.

¹⁰⁶ N. Marques Junior. Velocidade do soco e do chute do karatê...

¹⁰⁷ C. Gianino. Physics of karate...

¹⁰⁸ F. Diacu. On the dynamics of karate...; W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate... and C. Fernández; V. Majolero; J. Rodríguez y C. González. Diferencias en el salto vertical y la velocidad de patada mae geri entre karatekas internacionales y nacionales. RAMA 8:1(2013):13-20.

¹⁰⁹ N. Marques Junior. Velocidade do soco e do chute do karatê... and P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri. 25^o International Symposium on Biomechanics in Sport (Ouro Preto, MG, Brazil, 2007), p. 289-292.

¹¹⁰ P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate... and F. Pecoraioli. Analisis biomeccanica del mawashi geri jodan in cinture nere di karate: modelli tecnici a confronto. (Tesi di Dottorato, Università di Bologna, Attività Sportive, 2009), 25-48.

¹¹¹ F. Pecoraioli. Analisis biomeccanica del mawashi geri...

¹¹² M. Nakayma. O melhor do karatê – fundamentos. vol. 2, 9^a ed. (São Paulo: Cultrix, 2012), p. 104-105, 132-135.

¹¹³ N. Marques Junior. Sugestão do mawashi geri do karatê shotokan com embasamento da biomecânica. Rev Mov 4:1(2011):66-72.

¹¹⁴ P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate...

¹¹⁵ N. Marques Junior. Velocidade do soco e do chute do karatê... and P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate....

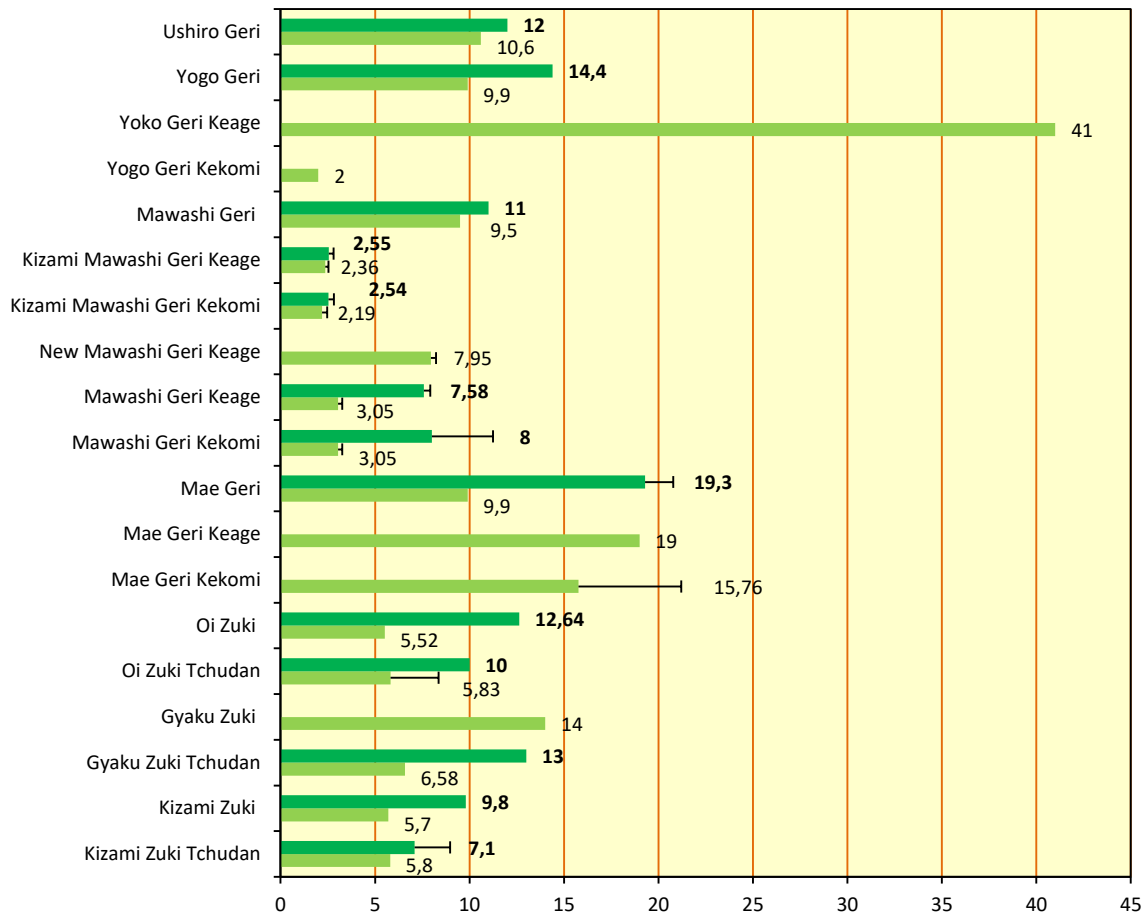
¹¹⁶ P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate... and F. Pecoraioli. Analisis biomeccanica del mawashi geri...

¹¹⁷ N. Marques Junior. Karatê shotokan: biomecânica dos golpes do kumite de competição. Lecturas: Educ Fís Dep 16:158(2011):1-28.

¹¹⁸ F. Diacu. On the dynamics of karate... and W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate...

Others kicks the karate literature determined the linear velocity, the results were the following: 9,9 to 14,4 m/s of the *yoko geri* (side kick)¹¹⁹, 2 m/s of the *yoko geri kekomi*, 41 m/s of the *yoko geri keage*¹²⁰ and 10,6 to 12 m/s of the *ushiro geri* (back kick)¹²¹.

The graph 2 illustrates these results of the linear velocity of the karate attack for mixed martial arts (MMA) fighter. The graph 2 shows the worst and the best linear velocity of each type karate attack.



Graph 2
Results of the linear velocity in meters per second of the offensive techniques of the karate for the MMA fighter that practices karate

The linear velocity of the punches (*kizami zuki*, *gyaku zuki* and *oi zuki*) this systematic review was of 5,52 to 14 m/s. Second Ning et al.¹²², the karate punch is very fast because this type of combat needs this motor capacity. The kung fu attack with technique similar to the punch, but with the open hand (*yau-man* in Chinese), the linear

¹¹⁹ F. Diacu. On the dynamics of karate... and W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate...

¹²⁰ C. Gianino. Physics of karate...

¹²¹ F. Diacu. On the dynamics of karate...

¹²² Y-L. Ning; J-D. Li; W-C. Lo; C-H. Huang; C-F. Chang; F-H. Hsieh and T-W. Lu. Patterns and consistency of muscle recruitment for a karate jab. Biomed Eng Appl Basis Communic 23:1(2011):75-82.

velocity was of 5,3 to 8,33 m/s¹²³. Then, the result of the karate punch was better than the *yau-man*. The motive is the characteristics of the karate fight, in a few seconds the combat can finish with a precise attack¹²⁴. For example, Nakayama¹²⁵ informed that the Shotokan karate has the objective of finish the fight with an attack (*ikken hissatsu* in Japanese). Therefore, the karateka usually trains the precision of the attack¹²⁶.

The linear velocity of the kick (*mae geri*, *mawashi geri*, *yoko geri* and *ushiro geri*) was of 2 to 41 m/s. All the karate kicks are performed at high velocity with the objective of hit the target¹²⁷. The *yoko geri kekomi* of the study the linear velocity was of 2 to 41 m/s. The side kick of the taekwondo, Wasik¹²⁸ detected this kick with a linear velocity of 5,63 m/s, results lower than the systematic review. In another study of taekwondo, Pieter and Pieter¹²⁹ determined the linear velocity of the side kick (6,37±1,54 m/s of the left leg and 6,87±0,43 m/s of the right leg), of the semicircular kick (16,26±1,32 m/s of the left leg and 15,51±2,27 m/s of the right leg) and of the back kick (8,73±1,72 m/s of the left leg and 9,14±1,49 m/s of the right leg). The results of Pieter and Pieter¹³⁰ about the side kick and the back kick were lowers than the same karate kicks this study (41 m/s of the *yoko geri keage* and 10,6 to 12 m/s of the *ushiro geri*). However, the semicircular kick of the study of Pieter and Pieter¹³¹ had more velocity than the *mawashi geri* of the systematic review (2,19±0,27 to 8±3,24 m/s). Perhaps, the reason for this is that the semicircular kick tends to be more practiced during the taekwondo combat¹³².

The study of the linear velocity and of the angular velocity (angular velocity is defined as: it is the rotation of a lever around of an axis which occurs a time interval¹³³) of some joints of the body of a technique of a sport is important for the coach know how the athletes performs the sport skill, this knowledge for the coach is important for prescribe the training and improve the athlete`s technique¹³⁴.

The linear velocity of some joints of the body during the karate attack the researchers practiced few studies on this theme. The *gyaku zuki tchudan* (reverse punch

¹²³ O. Pinto Neto; M. Magini and M. Saba. The role of effective mass and hand speed in the performance of kung fu athletes compared with nonpractitioners. J Appl Biomech 23:2(2007):139-148.

¹²⁴ M. Tabben; J. Coquart; H. Chaabène; E. Franchini; N. Ghoul and C. Tourny. Time-motion, tactical and technical analysis in top-level karatekas according to gender, match outcome and weight categories. J Sport Sci 33:8(2015):841-849.

¹²⁵ M. Nakayama. O melhor do karatê 3 – kumite 1. 7ª ed. (São Paulo: Cultrix, 2012), p. 11-12.

¹²⁶ J. Stevens. Três mestres do budo: Kano (judô), Funakoshi (karatê) e Ueshiba (aikido). 10ª ed. (São Paulo: Cultrix, 2013), p. 80-81.

¹²⁷ C. Sforza; M. Turci; G. Grassi; Y. Shirai; G. Pizzini and V. Ferrario. Repeatability of mae geri keage in traditional karate: a three-dimensional analysis with black belt karateka. Percept Motor Skil 95:2(2002):433-444.

¹²⁸ J. Wasik. Kinematic analysis of the side kick in taekwon-do. Acta Bioeng Biomech 13:4(2011):71-75.

¹²⁹ F. Pieter and W. Pieter. Speed and force in selected taekwondo techniques. Biol Sport 12:4(1995):257-266.

¹³⁰ F. Pieter and W. Pieter. Speed and force in selected taekwondo techniques...

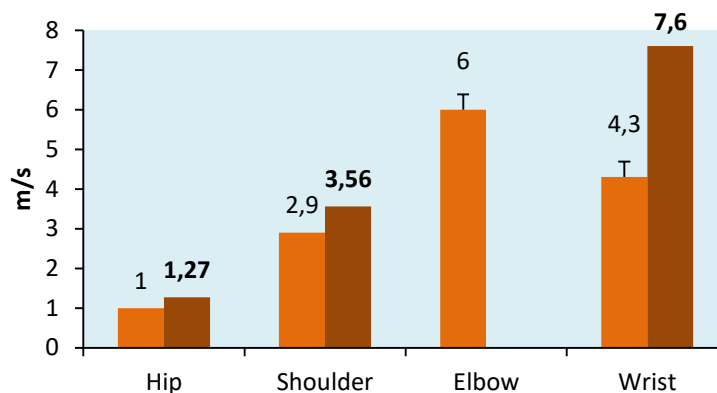
¹³¹ F. Pieter and W. Pieter. Speed and force in selected taekwondo techniques...

¹³² N. Marques Junior. Respostas fisiológicas e análise do perfil físico da luta do taekwondo: uma revisão sistemática. Rev Bras Prescr Fisio Exer -:(aceito para publicação em 2015):-.

¹³³ N. Marques Junior. Manual do software skill spector...

¹³⁴ V. Zatsiorsky. Biomecânica no esporte: performance do desempenho e prevenção de lesão. (Rio de Janeiro: Guanabara, 2004), p. 110-394.

in the trunk) in *zenkutsu dachi* (is the front stance) had linear velocity of 1 to 1,27 m/s of the hip, 2,9 to 3,56 m/s of the shoulder, $6\pm 0,38$ m/s of the elbow, $4,3\pm 0,39$ to 7,6 m/s of the wrist¹³⁵. The *gyaku zuki* or other karate attack, whole the body is involved in the action, the researchers did not measure the linear velocity of the pelvis, of the knee, of the ankle and of the foot¹³⁶. The graph 3 illustrates these results of the linear velocity of the *gyaku zuki tchudan*. The graph 3 shows the worst and the best linear velocity of the punch.



Graph 3

Results of the linear velocity in meters per second of some joints of the body during the *gyaku zuki tchudan*

The linear velocity of the *mae geri kekomi* (front kick in the trunk) in *zenkutsu dachi* was of $1,7\pm 0,5$ m/s of the pelvis, $2,1\pm 0,7$ to $2,3\pm 0,5$ m/s of the hip, $5,5\pm 1,7$ to $5,8\pm 0,7$ m/s of the knee, $3,18\pm 2,43$ to $105,11\pm 10,07$ m/s of the ankle and $3,74\pm 3,41$ to $10,70\pm 1,93$ m/s of the foot¹³⁷.

However, the researchers did not measure the linear velocity of the lower limb that is on the ground, this leg participates during the execution of the kick with an impulse¹³⁸. The graph 4 illustrates these results of the linear velocity of the *mae geri kekomi*. The graph 4 shows the worst and the best linear velocity of the kick.

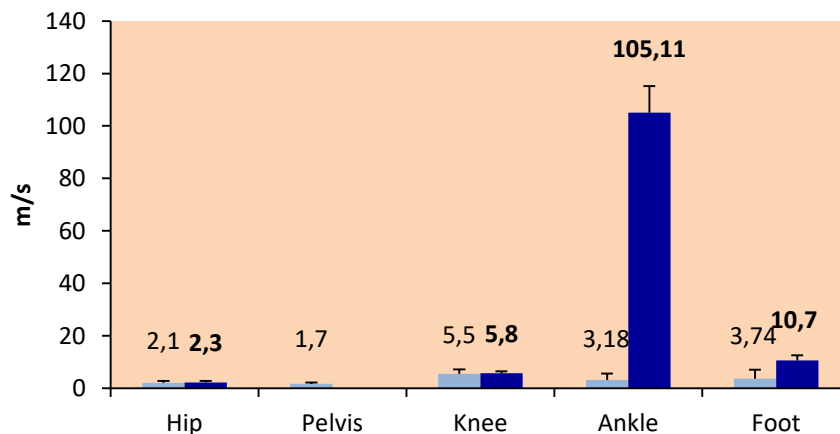
¹³⁵ S. Hariri; M. Rezaei; S. Nikokheslat and A. Sarshin. The study a relationship between the speed at the *gyaku zuki* kick contact time and the displacement of contact plate in elite karatekas men. Int J Sports Stud 4:12(2014):1513-1515; S. McCann. Kinematics analysis of the *gyaku zuki* in *zenkutsu dachi*. (Doctoral thesis, San Jose State University, Master of Arts, 1992), 19-80 and H. Monteiro; C. Silva and T. Fernandes. Tempo de reação e velocidade do soco em caratecas graduados. FIEP 83:special(2013):-.

¹³⁶ N. Marques Junior. Karatê shotokan: biomecânica dos golpes do kumite de competição. Lecturas: Educ Fís Dep 16:158(2011):1-28.

¹³⁷ A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo and G. Branco. Characterization of kinesiological patterns of the frontal kick, *mae geri*, in karate experts and non-karate practitioners. RAMA 9:1(2014):20-31; A. Vencesbrito; M. Branco; R. Fernandes; M. Ferreira; O. Fernandes; A. Figueiredo e W. Cynarski. Avaliação eletromiográfica e cinemática do pontapé *mae geri* em karatecas de elite cinto negro não competidores. Rev UIIPS 2:3(2014):4-23 and B. Portela; M. Barbosa; T. Cavazzotto and M. Tartaruga. Kinematics analysis of the front kick with and without impact on traditional karate. Arch Budo Sci Martial Art Extreme Sport 10(2014):47-51.

¹³⁸ M. Nakayma. O melhor do karatê – fundamentos. vol. 2, 9ª ed. (São Paulo: Cultrix, 2012), p. 104-105, 132-135.

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Graph 4

Results of the linear velocity in meters per second of some joints of the body during the *mae geri kekomi*

The *mawashi geri kekomi* (semicircular kick in the trunk) in fight stance had linear velocity during the attack of $4,32\pm 0,37$ to $4,76\pm 1,74$ m/s of the hip, $5,22\pm 0,26$ m/s of the knee and $9,43\pm 1,01$ to $10,03\pm 2,10$ m/s of the ankle¹³⁹. The same researchers studied the return of the lower limb after the attack, the results determined $1,32\pm 0,13$ m/s of the hip, $2,70\pm 0,14$ m/s of the knee and $2,04\pm 0,07$ m/s of the ankle¹⁴⁰.

The two studies detected that the attack leg was faster than the return of the leg. Piemontez et al.¹⁴¹ evidenced that until the velocity of the attack leg in seconds (s) ($0,48\pm 0,11$ to $0,48$ s) was faster than the return leg ($0,98\pm 0,09$ to $0,81\pm 0,07$ s).

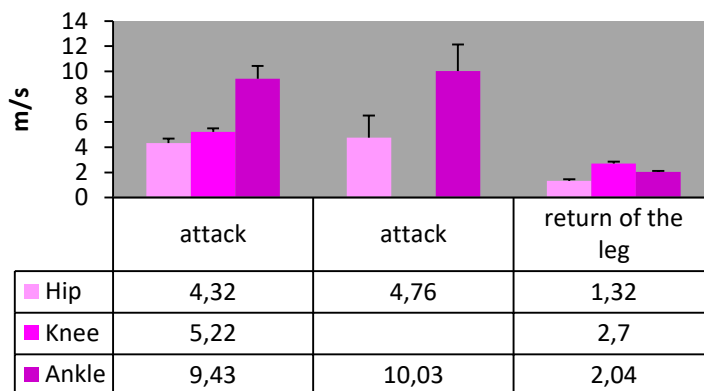
However, the studies about the *mawashi geri kekomi* did not measure the linear velocity of the pelvis and of the foot during the execution of the attack and after this task, the return leg. The studies of the *mawashi geri kekomi* had the same problem of the *mae geri kekomi*, lower limb that is on the ground the authors did not measure the linear velocity. The graph 5 illustrates these results of the linear velocity of the *mawashi geri kekomi*. The graph 5 shows the worst and the best linear velocity of the kick.

¹³⁹ G. Piemontez; A. Martins; N. Reis; L. Ferreira e S. Melo. Características cinemáticas do chute semicircular no karatê. Lecturas: Educ Fís Dep 16:163(2011):1-13 and G. Piemontez; A. Martins; S. Melo; L. Ferreira e N. Reis. Cinemáticas do chute semicircular no karatê: comparação entre as fases de ataque e retorno. Rev Educ Fís/UEM 24:1(2013):51-59.

¹⁴⁰ G. Piemontez; A. Martins; S. Melo; L. Ferreira e N. Reis. Cinemáticas do chute semicircular no karatê...

¹⁴¹ G. Piemontez; A. Martins; N. Reis; L. Ferreira e S. Melo. Características cinemáticas do chute semicircular no karatê... and G. Piemontez; A. Martins; S. Melo; L. Ferreira e N. Reis. Cinemáticas do chute semicircular no karatê...

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Graph 5

Results of the linear velocity in meters per second of some joints of the body during the *mawashi geri kekomi*

The *gyaku zuki tchudan*, the *mae geri keomi* and the *mawashi geri kekomi* are the attacks very practiced during the *kumite* (fight in Japanese) of the *Shotokan karate*¹⁴². However, the MMA fighter that karate fight, the literature of this type of combat has no data about the attack more used by this fighter¹⁴³. But, karate literature informed that the *kumite* has short duration because the attack of the karateka is very fast¹⁴⁴, with predominance of the alactic anaerobic metabolism¹⁴⁵.

The study of Ionete et al.¹⁴⁶ about *gyaku zuki tchudan* had linear velocity of 0,91 m/s of the hip, 1,70 m/s of the shoulder and 5,12 m/s of the wrist. These results were lower than the systematic review (1 to 1,27 m/s of the hip, 2,9 to 3,56 m/s of the shoulder, 6±0,38 m/s of the elbow and 4,3±0,39 to 7,6 m/s of the wrist)¹⁴⁷, the motive was that the study of Ionete et al.¹⁴⁸ had a female karateka. In another study about *gyaku zuki tchudan*, was determined a linear velocity of 1,04±0,45 m/s of the hip, 1,79±0,74 m/s of the shoulder, 5,81±1,02 m/s of the elbow and 5,63±0,87 m/s of the wrist¹⁴⁹. But the systematic

¹⁴² G. Paz-Y-Miño. Predicting kumite strategies: a quantitative approach to karate. *J Asian Martial Art* 9:4(2000):23-35.

¹⁴³ T. Paillard. Physiological profile of fighters influences training organization in combat sports: response to Del Vecchio, Hirata, and Franchini (2011). *Percept Motor Skill* 113:3(2011):803-804.

¹⁴⁴ N. Marques Junior. Fight zone with points of the shotokan karate male competition. *Lecturas: Educ Fís Dep* 18:180(2013):1-9.

¹⁴⁵ N. Marques Junior. Effort during the shotokan karate kumite in 13th Brazilian championship JKA, 2012. *Lecturas: Educ Fís Dep* 17:172(2012):1-10.

¹⁴⁶ G. Ionete; E. Mereuta; C. Mereuta; M. Tudoran and D. Ganeca. Linear kinematics analysis of gyaku tsuki karate technique. *The Annals of "Dunarea de Jos" University of Galati* 15:1(2011):99-102.

¹⁴⁷ S. Hariri; M. Rezaei; S. Nikokheslat and A. Sarshin. The study a relationship between the speed at the gyaku zuki kick contact time and the displacement of contact plate in elite karatekas men. *Int J Sports Stud* 4:12(2014):1513-1515; S. McCann. Kinematics analysis of the gyaku zuki in zenkutsu dachi. (Doctoral thesis, San Jose State University, Master of Arts, 1992), 19-80 and H. Monteiro; C. Silva and T. Fernandes. Tempo de reação e velocidade do soco em caratecas graduados. *FIEP* 83:special (2013):-.

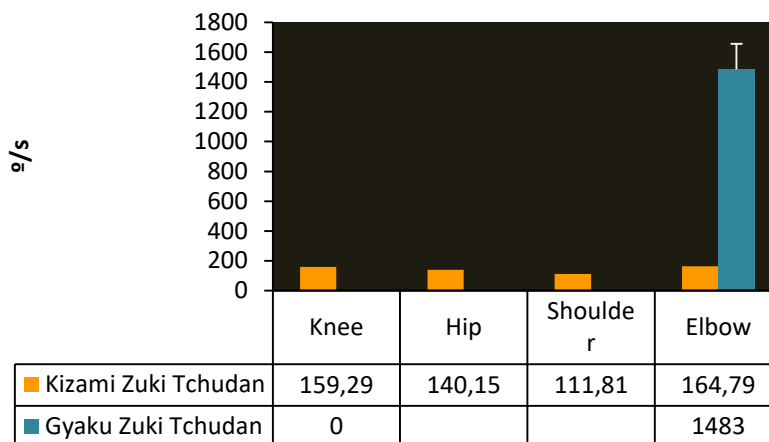
¹⁴⁸ G. Ionete; E. Mereuta; C. Mereuta; M. Tudoran and D. Ganeca. Linear kinematics analysis of gyaku tsuki karate technique...

¹⁴⁹ D. Gallaher. 3D analysis of punching technique: reverse vs. lead (gyaku tsuki vs. oi tsuki). (Thesis, California State University, Masters of Arts in Kinesiology, 2013), p. 28-37.

review had a higher linear velocity of the *gyaku zuki tchudan*. Then, perhaps the motive for the higher linear velocity of the punch were the subjects of the systematic review, the karatekas were more trained fighters. However, expert fighter in punch, Iranian international amateur boxers, had a better linear velocity (2,1 to 3,8 m/s of the shoulder and $6,7 \pm 1,5$ m/s of the elbow)¹⁵⁰ than the karatekas of the systematic review (2,9 to 3,56 m/s of the shoulder and $6 \pm 0,38$ m/s of the elbow).

The Doctoral thesis of Sidthilaw¹⁵¹ about the semicircular kick in the trunk of the Muay Thai had a linear velocity of $6,8 \pm 1,2$ to $10,3 \pm 0,6$ m/s of the ankle and $6,7 \pm 1,2$ to $7,3 \pm 1,2$ m/s of the knee. These results were similar the linear velocity of the ankle ($9,43 \pm 1,01$ to $10,03 \pm 2,10$ m/s) during the *mawashi geri kekomi* this systematic review and better than the linear velocity of the knee ($5,22 \pm 0,26$ m/s) of the same attack. In other study about taekwondo, the linear velocity of the ankle was of $9,5 \pm 9$ to $10 \pm 1,2$ m/s¹⁵², this result was similar to of the systematic review. The linear velocity of the *mae geri kekomi* was not compared with the literature because the author did not find study on this theme.

The angular velocity of some joints of the body during the karate attack the researchers practiced few studies on this theme. The angular velocity of the *kizami zuki tchudan* (jab punch) in *zenkutsu dachi* (front stance) had 159,29 degrees per second (°/s) of the knee, 140,15°/s of the hip, 111,81°/s of the shoulder and 164,79 °/s of the elbow¹⁵³. The *gyaku zuki tchudan* had $1483 \pm 172,9$ °/s of the elbow¹⁵⁴. The graph 6 illustrates these results of the angular velocity of the *kizami zuki tchudan* and of the *gyaku zuki tchudan*.



Graph 6

Results of the angular velocity in degrees per second of some joints of the body during the punch

¹⁵⁰ M. Cheraghi; H. Alinejad; A. Arshi and E. Shirzad. Kinematics of straight right punch in boxing. *Annals Appl Sport Sci* 2:2(2014):39-50.

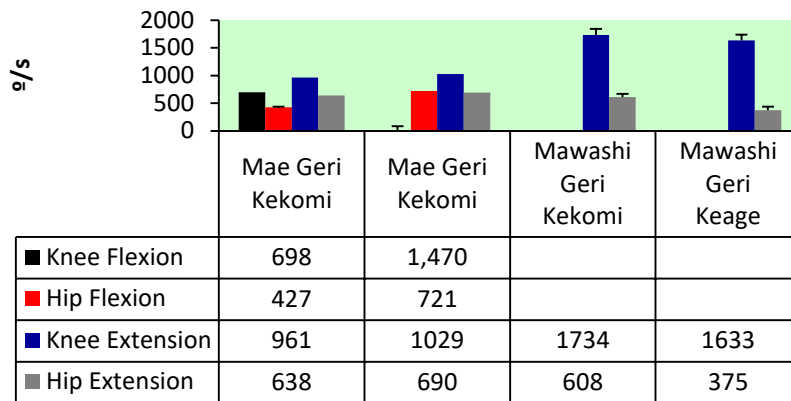
¹⁵¹ S. Sidthilaw. Kinetic and kinematic analysis of Thai Boxing roundhouse kicks. (Doctoral thesis, Oregon State University, Doctor of Philosophy, 1997), p. 23-60.

¹⁵² A. Hsieh; C-H. Huang and C-C. Huang. The biomechanical analysis of roundhouse kick in taekwondo. 30th Annual Conference Biomech Sport (Melbourne, 2012), p. 196-199.

¹⁵³ A. Mehanni. Kinematische und dynamische biomechanik des prellstosses kizami-zuki beim karate. (Doctoral thesis, Konstanz University, Physical Education, 2004), 67-118.

¹⁵⁴ H. Monteiro; C. Silva and T. Fernandes. Tempo de reação e velocidade do soco em caratecas graduados. *FIEP* 83:special(2013):-.

The angular velocity of the *mae geri kekomi* in *zenkutsu dachi* during the preparatory phase was of 698 to 1,470±84°/s of the knee flexion and 427±8 to 721°/s of the hip flexion¹⁵⁵. The attack phase had angular velocity of 961 to 1029°/s of the knee extension and 638 to 690°/s of the hip extension¹⁵⁶. The *mawashi geri* was practiced equal the rules imposed by the World Karate Federation (WKF)¹⁵⁷. The *mawashi geri kekomi* with impact into a target was in the trunk (attack phase: 1734±108°/s of the knee extension and 608±62°/s of the hip extension) and the *mawashi geri keage* without impact in the face (attack phase: 1633±102°/s of the knee extension and 375±60°/s of the hip extension). The kick with impact had higher angular velocity than the kick without impact. The graph 7 illustrates these results of the angular of the *mae geri kekomi*, of the *mawashi geri kekomi* and of the *mawashi geri keage*.



Graph 7

Results of the angular velocity in degrees per second of some joints of the body during the kick

The angular velocity of the elbow during the *gyaku zuki tchudan* (1483±172,9°/s) was higher than the elbow of the *kizami zuki tchudan* (164,79°/s). Perhaps this is related with the angular velocity of the pelvis and of the upper limb that practiced the force couple. In karate this force has the named of *hiki te*¹⁵⁸. The *mawashi geri kekomi* (1734±108°/s) and the *mawashi geri keage* (1633±102°/s) had a higher angular velocity of the knee extension than the knee extension of the *mae geri kekomi* (961 to 1029°/s). The researchers need to study this higher angular velocity of knee extension during the *mawashi geri* with the objective of determine this knee action is responsible of the *mawashi geri* be the kick with higher velocity of the karate (Note: the time in seconds this was determined).

¹⁵⁵ P. Sbriccoli; V. Camomilla; A. Mario; F. Quinzi; F. Figura and F. Felici. Neuromuscular control adaptations in elite athletes: the case of top level karatekas. Eur J Appl Physiol 108:6(2010):1269-1280 and J. Pozo; G. Bastien and F. Dierick. Execution time, kinetics, and kinematics of the mae geri kick: comparison of national and international standard karate athletes. J Sports Sci 29:14(2011):1553-1561.

¹⁵⁶ J. Pozo; G. Bastien and F. Dierick. Execution time, kinetics, and kinematics of the mae geri...

¹⁵⁷ F. Quinzi; V. Cammomilla; F. Felici; A. Di Mario and P. Sbriccoli. Differences in neuromuscular control between impact and no impact roundhouse kick in athletes of different skill levels. J. Electromyogr Knes 23:1(2013):140-150.

¹⁵⁸ M. Nakayma. O melhor do karatê – fundamentos. vol. 2, 9ª ed. (São Paulo: Cultrix, 2012), p. 84-85.

The velocity of the offensive technique of the karateka is in few seconds, with predominance of the alactic anaerobic metabolism and of the explosive strength¹⁵⁹. The karate coach and/or mixed martial arts (MMA) coach needs to know the time in seconds of the attack with the objective of determine the offensive technique of the karate for the MMA fighter with more and less velocity. This is important for the offensive technique fighter because the karateka can choose the best attack with the objective of cause a knockout in the opponent.

However, Marques Junior¹⁶⁰ in three articles determined the attacks with more and less velocity through of the linear velocity. This unit of measurement is no better way to determine the attack more and less fast of the karate. The studies with linear velocity¹⁶¹ were transformed for seconds based on Marques Junior and Silva Filho¹⁶² (Seconds = linear velocity : 60 = ? seconds). But the studies in seconds were immediately used in the systematic review¹⁶³.

¹⁵⁹ H. Chaabène; Y. Hachana; E. Franchini; B. Mkaouer and K. Chamari. Physical and physiological profile of elite karate athletes. *Sports Med* 42:10(2012):829-843 and C. Doria; A. Veicsteinas; E. Limonta; M. Maggioni; P. Aschieri; F. Eusebi; G. Fanò and T. Pietrangelo. Energetics of karate (kata and kumite techniques) in top-level. *Eur J Appl Physiol* 107:5(2009):603-610.

¹⁶⁰ N. Marques Junior. Velocidade do soco e do chute do karatê: uma meta-análise. *Lecturas: Educ Fís Dep* 17:169(2012):1-12; N. Marques Junior. Scientific evidences about the fight of the Shotokan karate of competition. *Rev Bras Prescr Físio Exerc* 8:47(2014):400-417 and N. Marques Junior. Porque o soco causa mais pontos do que o chute durante a luta de karatê? Conteúdo para prescrever o treino de karatê shotokan. *Rev Bras Prescr Físio Exerc* 7:40(2013):376-387.

¹⁶¹ N. Marques Junior. Velocidade do soco e do chute do karatê...; F. Diacu. On the dynamics of karate. *PIMS* -(2003):9-11; W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate techniques with the use of motion capture and mathematical modeling. The concept of a research project. *J Martial Arts Anthropol* 14:1(2014):39-53; A. Mehanni. Kinematische und dynamische biomechanik des prellstosses kizami-zuki bein karate. (Doctoral thesis, Konstanz University, Physical Education, 2004), 67-118; N. Rathee; J. Magnes and J. Davis. Kinematics of board breaking in karate using video physics and human performance. *Eur Sci J* 10:12(2014):338-348; C. Fernández; V. Majolero; J. Rodríguez y C. González. Diferencias en el salto vertical y la velocidad de patada mae geri entre karatekas internacionales y nacionales. *RAMA* 8:1(2013):13-20 and C. Gianino. Physics of karate: kinematics analysis of karate techniques by a digital movie camera. *Lat Am J Phys Educ* 4:1(2010):32-34.

¹⁶² N. Marques Junior e J. Silva Filho. Treino de força para o karateca do estilo shotokan especialista no kumite. *Rev Bras Prescr Físio Exerc* 7:41(2013):506-533.

¹⁶³ P. Santos. Análise biomecânica do chute frontal de karatê: implicações em lesões nos membros inferiores. (Dissertação de Mestrado, UNESP, Faculdade de Engenharia, Mestrado em Engenharia Mecânica, 2015), 40-54; T. Alsamad. The kinematics analysis of doubles kazami mawashi geri for heavy weight players under the maximum load in karate. *World J Sport Sci* 7:1(2012):16-19; A. Mohamed and T. Halwish. Kinematics of the mawashi shoudan kick as a parameter of designing a training program for karate juniors. *World J Sport Sci* 5:4(2011):237-244; L. Ferreira; A. Martins; G. Piemontez; S. Domenech; M. Gevaerd; A. Bonilla e N. Borges Junior. Influência das características antropométricas sobre o impulso e tempo de execução do chute giro dorsal do karatê. *Rev Educ Fís/UEM* 25:1(2014):33-43; F. Pecoraioli. Analisis biomeccanica del mawashi geri jodan in cintura nere di karate: modelli tecnici a confronto. (Tesi di Dottorato, Università di Bologna, Attività Sportive, 2009), 25-48 and P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri. 25^o International Symposium on Biomechanics in Sport (Ouro Preto, MG, Brazil, 2007), 289-292.

The punches had the following times: 0,11 to 0,096 seconds (s) of the *kizami zuki tchudan*¹⁶⁴, 0,163 to 0,095 s of the *kizami zuki* without information about the target of the attack¹⁶⁵, 0,15 to 0,10 s of the *gyaku zuki tchudan*¹⁶⁶ and 0,166 to 0,097 of the *oi zuki tchudan*¹⁶⁷. The *kizami zuki tchudan* and *kizami zuki* were the fastest punches. In second place the *gyaku zuki tchudan* and the *oi zuki tchudan* had velocity in seconds similar. However, karate literature informed that the *gyaku zuki tchudan* practiced many points during the karate championships and the *oi zuki tchudan* practiced fewer points¹⁶⁸. The MMA literature does not have this information¹⁶⁹. Therefore, the punch had a velocity of 0,166 to 0,095 s.

The kicks had the following times: 0,26 to 0,21±0,67 s of the *mae geri kekomi*¹⁷⁰, 0,31 s of the *mae geri keage*¹⁷¹, 0,32 to 0,16 s of the *mae geri* without information about the target of the attack¹⁷², 0,13 to 0,12 s of the *mawashi geri kekomi*¹⁷³, 0,58±0,01 to 0,25 s of the *mawashi geri keage*¹⁷⁴, 0,68±0,06 to 0,21 s of the *kizami mawashi geri keage*¹⁷⁵, 0,18 to 0,15 of the *mawashi geri* without information about the target of the attack¹⁷⁶, 0,68 s of the *yoko geri keage*¹⁷⁷, 0,24 to 0,16 s of the *yoko geri* without information about the target of the attack¹⁷⁸, 0,35±0,04 to 0,34±0,05 s of the *ushiro geri kekomi*¹⁷⁹ and 0,20 to

¹⁶⁴ N. Marques Junior. Velocidade do soco e do chute do karatê... and A. Mehanni. Kinematische und dynamische biomechanik des prellstosses kizami-zuki

¹⁶⁵ F. Diacu. On the dynamics of karate...

¹⁶⁶ N. Marques Junior. Velocidade do soco e do chute do karatê... and N. Rathee; J. Magnes and J. Davis. Kinematics of board breaking in karate...

¹⁶⁷ N. Marques Junior. Velocidade do soco e do chute do karatê... and C. Gianino. Physics of karate...

¹⁶⁸ Marques Junior. Karatê shotokan: pontos dos golpes durante o kumite de competição masculino. *Ulbra Mov* 2:1(2011):1-15; N. Marques Junior. Pontos dos golpes durante o kumite de competição do karatê shotokan masculino. *Lecturas: Educ Fis Dep* 17:169(2012):1-12 and N. Marques Junior. Shotokan karate: score of the techniques during the female kumite of competition. *Lecturas: Educ Fis Dep* 17:174(2012):1-8.

¹⁶⁹ C. Kirk; H. Hurst and S. Atkins. Measuring workload of mixed martial arts using accelerometry, time motion analysis and lactate. *Int J Perf Analysis Sport* 15:1(2015):359-370 and Z. Bujak; M. Muntean and D. Grerczuk. The hierarchy of professional activities of martial arts and mixed arts coaches. *J Martial Art Anthropol* 14:2(2014):29-35.

¹⁷⁰ N. Marques Junior. Velocidade do soco e do chute do karatê... and P. Santos. Análise biomecânica do chute frontal de karatê...

¹⁷¹ C. Gianino. Physics of karate: kinematics analysis of karate techniques...

¹⁷² Diacu. On the dynamics of karate... and C. Fernández; V. Majolero; J. Rodríguez y C. González. Diferencias en el salto vertical y la velocidad de patada mae geri

¹⁷³ N. Marques Junior. Velocidade do soco e do chute do karatê... and A. Mohamed and T. Halwish. Kinematics of the mawashi shoudan kick...

¹⁷⁴ T. Alsamad. The kinematics analysis of doubles kazami mawashi... and F. Pecoraioli. Analisis biomeccanica del mawashi geri jodan...

¹⁷⁵ T. Alsamad. The kinematics analysis of doubles kazami mawashi... and P. Emmermacher; K. Witte and J. Potenberg. Different variations of the karate technique mawashi geri...

¹⁷⁶ Diacu. On the dynamics of karate... and W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate...

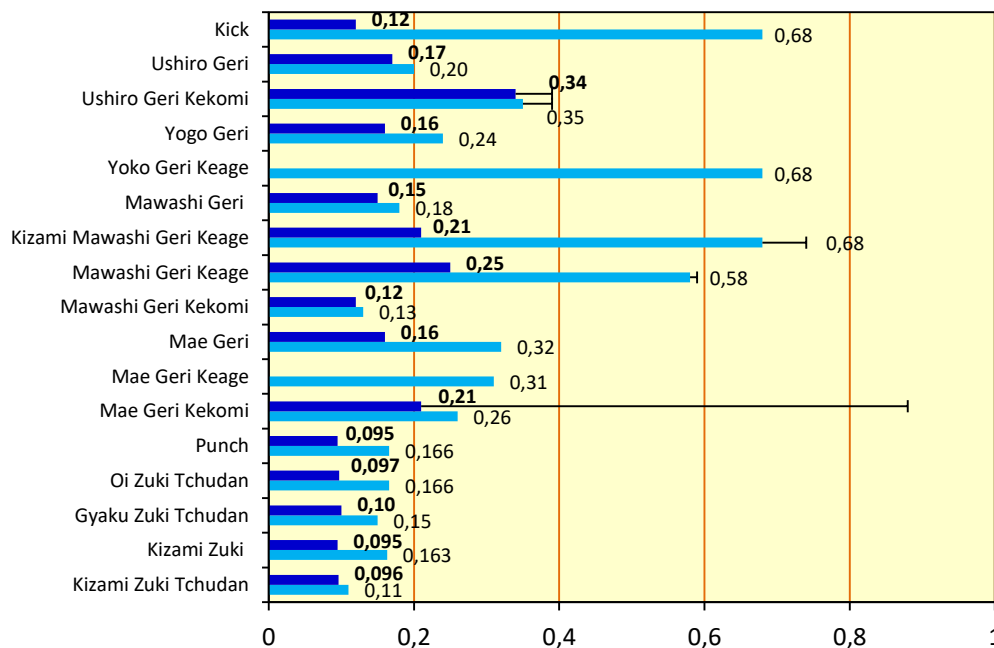
¹⁷⁷ C. Gianino. Physics of karate: kinematics analysis of karate techniques...

¹⁷⁸ Diacu. On the dynamics of karate... and W. Cynarski; W. Wajs and A. Vencesbrito. Improving the movements of basic karate...

¹⁷⁹ L. Ferreira; A. Martins; G. Piemontez; S. Domenech; M. Gevaerd; A. Bonilla e N. Borges Junior. Influência das características antropométricas sobre o impulso e tempo de execução do chute giro dorsal do karatê...

0,17 s of the *ushiro geri* without information about the target of the attack¹⁸⁰. The *mawashi geri kekomi* was the kick with higher velocity in seconds, in second place was the *mae geri kekomi*, in third was the *mawashi geri keage* and the *kizami mawashi geri keage*, in fourth was the *mae geri keage*, in fifth was the *ushiro geri kekomi* and in sixth was the *yoko geri keage*. The kicks without information about the target of the attack were not part of this list. Therefore, the kick had a velocity of 0,68 to 0,12 s.

The graph 8 illustrates the results in seconds of the karate attack for the MMA fighter. The graph 8 shows the worst and the best in seconds of each type karate attack.



Graph 8

Results of the velocity in seconds of the offensive techniques of the karate for the MMA fighter that practices karate

The results of the systematic review were similar to the study of Chaabène et al.¹⁸¹. The studies these researchers determined the *kizami zuki* was the fastest punch (0,11 s) and the *mawashi geri* was the fastest kick (0,177 s). However, the *kizami zuki tchudan* of the systematic review was faster (0,11 to 0,096 s), and the same occurred with the *mawashi geri tchudan* (0,13 to 0,12 s).

Chaabène et al.¹⁸² informed that the *gyaku zuki* has a duration of 0,15 s. This result was equal to the worst time of the *gyaku zuki tchudan* of the systematic review. The best time of the *gyaku zuki tchudan* was of 0,10 s.

¹⁸⁰ Diacu. On the dynamics of karate...

¹⁸¹ H. Chaabène; B. Mkaouer; E. Franchini; N. Souissi; M. Selmi; Y. Nagra and K. Chamari. Physiological responses and performance analysis difference between official and simulated karate combat conditions. *Asian J Sport Med* 5:1(2014):21-29.

¹⁸² H. Chaabène; B. Mkaouer; E. Franchini; N. Souissi; M. Selmi; Y. Nagra and K. Chamari. Physiological responses and performance analysis...

In another study of Chaabène et al.¹⁸³, the results of the *mae geri* (0,243 s), of the *yoko geri* (0,293 s) and of the *ushiro geri* (0,293 s) were similar to the values of the systematic review (0,26 to 0,21 s of the *mae geri kekomi*, 0,24 to 0,16 s of the *yoko geri* and 0,20 to 0,17 s of the *ushiro geri*). The study of Cullings¹⁸⁴ about the *ushiro geri kekomi* had a velocity of $0,25 \pm 0,04$ s, this result was better than the systematic review ($0,35 \pm 0,04$ to $0,34 \pm 0,05$ s of the *ushiro geri kekomi*). Chaabène et al.¹⁸⁵ determined the velocity of other kick not presented in this systematic review, 0,272 s of the *ushiro mawashi geri* (reverse roundhouse kick).

Chaabène et al.¹⁸⁶ informed that the punch was performed with a duration of 0,15 to 0,101 s. However, the systematic review detected a faster punch (0,166 to 0,095 s). The systematic review determined that the punch velocity (0,166 to 0,095 s) was higher than the kick (0,68 to 0,12 s). This happens because the trajectory of the punch is short, but of the kick is long¹⁸⁷. Other motive of the high velocity of the punch is that lever arms are smaller than the legs¹⁸⁸.

Conclusions

The systematic review determined the velocity of the punch and of the kick of the karate with the objective of auxiliary the training of the MMA fighter. The study provided the linear velocity, the angular velocity and the velocity in seconds of some karate attacks. The systematic review evidenced that the punch in seconds was faster than the kick. The best velocity of the punch in seconds was the *kizami zuki* (jab punch) and of the kick was the *mawashi geri* (semicircular kick). In conclusion, the study of the velocity of the karate attack is important for the coach guide the MMA fighter.

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¹⁸⁷ H. Chaabène; E. Franchini; B. Miarka; M. Selmi; B. Mkaouer; and K. Chamari. Time-motion analysis and physiological responses to karate official combat sessions: is there a difference between winners and defeated karatekas? *Int J Sport Physiol Perform* 9:2(2014):302-308.

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