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COACHING & KINESIOLOGY

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Frami® software protocol for Taekwondo: development, reliability and reproducibility

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Key words: performance analysis, taekwondo athletes, time-motion studies, athletic performance

Abstract

Background. The free combat software, called Frami®, has had its panel customized and adapted for Taekwondo analysis. Thus, the software is able to produce essential information from sequential combat actions and the functional demands of the combat. However, its protocol has not been validated for the sport of Taekwondo.

Aims. The present study aimed to verify the objectivity and reliability of a technical-tactical and motor actions analysis protocol for elite-level Taekwondo competition using the Frami® software by comparing results from experts and non-expert evaluators.

Methods. To determine if the Frami® software is suitable for Taekwondo competition, three evaluators (two experts and one non-expert) created a protocol, using displacement, attack, counterattack, defense, clinch, and pause phases, and selected 10 men's matches from the 2019 Taekwondo World Championships. A test-retest reliability was used to indicate the repeatability of test scores with the passage of time (test vs. retest after 24 hours). Cohen's Kappa and intraclass correlation coefficient were used to estimate and reflect the stability of the protocol measured by the Frami® software, $p \leq .05$.

Results. After conducting an intraclass correlation coefficient (ICC) analysis, this study indicated that for all combat phases, the evaluators showed "moderate" to "excellent" reliability (ICC=.64 to .99), except the third evaluator (non-expert) that presented "poor" for the clinch counterattack actions (ICC=.33). For objectivity, the obtained ICCs varied from "moderate" to "excellent" (ICC=.5 to .99). For penalties and scores, objectivity was rated "almost perfect" (ICC = .89 to .97).

Conclusion. The protocol proved to be reproducible and objective for the analysis of elite-level Taekwondo competition. This protocol was advantageous, since more motor actions were added (clinch, combat base, penalties, and scores) compared to the previously validated protocol, and it was developed under the current competitive rules in which electronic devices (chest, foot, and helmet) are used. However, the evaluation performed by a non-expert may not represent accurately the technical-tactical actions of the combat.

Introduction

Time-motion analysis studies in combat sports are effective for describing athlete's behavior, characterizing the bout phase, and understanding how specific actions can predict performance [Coswig *et al.* 2018a; Miarka *et al.* 2015; Miarka *et al.* 2016] as well as identify technical-tactical characteristics that can be crucial in a combat [Tabben *et al.* 2018]. Specifically, in Taekwondo, Tornello *et al.* [2014] analyzed the technical-tactical interactions of cadet athletes of both sexes and the winners showed less attack frequency and more defensive actions. Casolino *et al.* [2012] observed

similarly that winners performed a higher frequency of attacks, fewer defensive actions, and rear-legged kicks were more frequent compared to lead-leg kicks.

Preceding studies showed constant progress in the Taekwondo technical-tactical analysis, such as the development of combat-models [Menescardi *et al.* 2019], physiological and time-motion effects of rounds and combats [Hausen *et al.* 2017; Menescardi *et al.* 2015; Tornello *et al.* 2013], outcomes [Falco *et al.* 2014], age divisions [Menescardi *et al.* 2015; Tornello *et al.* 2013], electronic protective clothing [Dong *et al.* 2014], and weight [Bridge *et al.* 2011; Santos *et al.* 2011; Tornello *et al.* 2013]. These studies have identified essential indicators that can help predict international competitive success at Taekwondo; however, to the best of our knowledge, few studies have focused on the development of protocols and free software that seek to help coaches and researchers to conduct technical-tactical analysis.

Frami® is a free software, which was initially developed [Miarka *et al.* 2011] to validate Judo competitions [Miarka *et al.* 2015; Miarka *et al.* 2011]. The development of this software allowed advances to be made for combat sports, in which the research was developed with pacing strategies [Coswig *et al.* 2018b], home advantage [Brito *et al.* 2017], weight division comparisons [Sterkowicz-Przybycien *et al.* 2017], injuries frequency [Miarka *et al.* 2018], and gender differences [Miarka *et al.* 2018; Sterkowicz-Przybycien *et al.* 2017]. Due to these advances, new protocols were validated for other combat sports, such as mixed martial arts [Miarka *et al.* 2016] and Taekwondo [Formalioni *et al.* 2017].

A valid Frami® protocol for analyzing time and movement exists for Taekwondo [Formalioni *et al.* 2017]. However, this protocol validated only four combat actions (movement time, attack/defense, counterattack, and pause); thus, some specific actions important to scoring and therefore the match outcome may not be scored by the evaluator, such as the clinch, combat base, penalties, and scores. A more detailed protocol would allow the analyzer to be more accurate as to the noted actions and an efficient description of the combat phases [Miarka *et al.* 2015; Miarka *et al.* 2011], which, in turn, could expand the amplitude of interventions that can be performed by a coach to prepare their athlete. In addition, the validated protocol analyzed matches during the 2011 and 2013 Taekwondo World Championships before the addition of electronic sensors (foot, chest, and helmet) were used to score matches. In this sense, if there is a valid protocol with matches disputed in recent Taekwondo championships, it is possible to bring more up-to-date information about the athletes' behavior using electronic sensors. In this way, coaches will have contextualized information when establishing combat strategies. Therefore, the present study aimed to validate a technical-tactical analysis protocol in the Frami® software for Taekwondo competitions comparing expert and non-expert evaluators.

Methods

Experimental approach

This was an observational descriptive study. For that, three experts in Taekwondo analyzed 10 videos from the Manchester 2019 WT Championship and reanalyzed them 24 hours later. All evaluators had ≥9 years of experience and competed at the national level. Evaluator 1 and 2 were Taekwondo black belts (experts), and evaluator 3 was a Taekwondo brown belt (non-expert). The videos were downloaded from the public database of the World Taekwondo Channel (YouTube®). The inclusion criteria we adopted included: a) a landscape view of the whole competition area, b) visualization of the scoreboard during competition, c) sufficient quality image for analysis (standard definition 480/60i), and d) at least one of the athletes needed to be ranked in the top 5 of their weight class by World Taekwondo (the governing body for international Taekwondo competition). For video analysis, we used the Frami® software, which allows users to utilize slow motion by up to 8 times slower than regular speed; this software was previously validated for Taekwondo combats [Formalioni *et al.* 2017]. The evaluators trained on the software for 7 hours. The order of the analyzed matches as well as the reevaluations (time with or without displacement, attack, counterattack, defense, clinch, and pause) were randomized to guarantee impartiality as described by Miarka *et al.* [2015].

Technical-tactical indicators

The evaluators created the protocol based upon previously published studies [Casolino *et al.* 2012; Formalioni *et al.* 2017; Tornello *et al.* 2014] as described in Table 1.

After the protocol, the evaluators registered the software commands according to the chart described at Figure 1.

Frami® Software

This software was written with Delphi C++ (Borland Software Corporation, Austin, USA). The program was tested during its development and compared with the first version for Judo technical-tactical analysis [Miarka et al. 2015; Miarka et al. 2011]. The main change of the present version of Frami® is its ability to slow down the video speed up to eight times slower than normal speed. After that initial development, an analysis to find potential errors was performed early before the final version was released to ensure the adequacy of requirements and to generate functional test data. For design verification activities, there was an attempt to determine the consistency of design with requirements, adequacy of design, and to generate structural and functional test data. After that, the verification activities in the con-

Table 1. Technical-tactical actions used to create the protocol.

Action	Description
Open stance	When two athletes are standing face-to-face in fighting stances so that their trunks are facing the same direction.
Closed stance	When two athletes are standing face-to-face in fighting stances so that their trunks are facing opposite directions.
Attack	Application of a Taekwondo technique (punches or kicks) in the direction of the opponent in order to add points or score a knockout. Techniques are considered an attack when an approved attacking tool (e.g., the top of the foot or the fist) makes contact to an approved target (e.g., the chest or abdomen) on the opponent's body. They are subdivided into anterior, posterior, and clinch attacks.
Counterattack	An attack action performed after receiving an attack. These can occur simultaneously with the opponent's action or after dodging the attack. They are subdivided into anterior, posterior, and clinch counterattacks.
Defense	An action taken to prevent the opponent from scoring. These are subdivided into *Makgi* (blocks with hands and/or arms), *Cha-makgi* (blocks with legs and/or feet), and dodges (a change of direction of the body).
Clinch	When an athlete shortens their distance from their opponent, hugs them, and the central referee breaks the athletes apart to resume competition.
Pause	When the referee stops the match.

struction stage aimed to determine its consistency with design, adequacy of implementation, general structural and functional test data, and applying test data. The last verification activity was to check and commensurate the level of redevelopment in the operation and maintenance stages following indications of preceding reports [Miarka et al. 2011]. Figure 2 demonstrates the free Frami® software for Taekwondo.

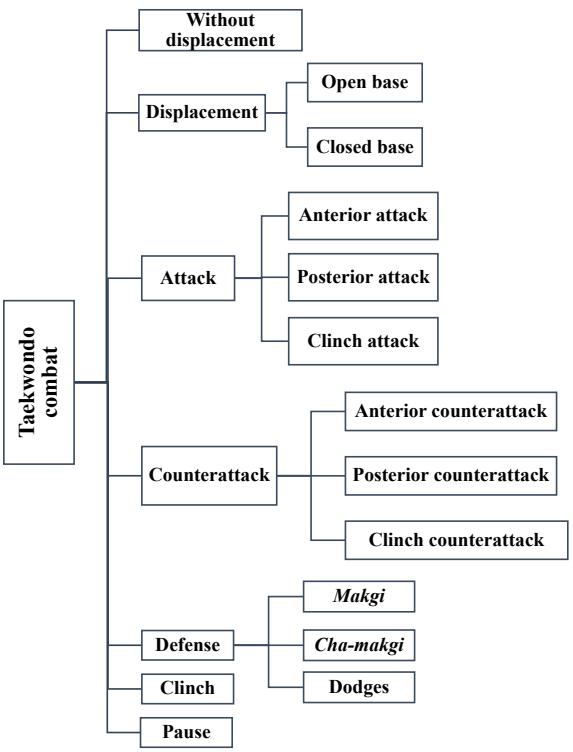

Figure 1. Organization of the Frami® protocol for Taekwondo competition analysis. *Makgi* = blocks with hands and/or arms, *Cha-makgi* = blocks with legs and/or feet.

Statistical analysis

Statistical analysis was performed using SPSS (22.0; SPSS, Inc., Chicago, IL, USA). Test and retest comparisons were made using the Cohen's Kappa agreement coefficient (K) and the intraclass correlation coefficient (ICC); $p \leq .05$ was considered significant in both cases. To classify the level of agreement between the inter- and intra-evaluator, we used the cut-points proposed by Koo Li [2016] for Cohen's Kappa (<.0 = poor; .0–.2 = slight; .21–.4 = fair; .4-.6 = moderate; .61–.8 = substantial; .81–.99 = almost perfect; 1 = perfect) and the classification suggested by Atkinson Nevill [1998] for ICC (<.5 = poor; .5–.75 = moderate; .76–.9 = good; >.91 = excellent).

Results

Table 2 shows the data of the ICC and its classification regarding the reliability (evaluator vs. same evaluator 24 hours later).

Except for the "clinch counterattack," reliability was rated from "moderate to excellent" in all proposed phases. Table 3 shows the scores for objectivity between evaluators.

Table 3. Objectivity in the analysis of phases of the taekwondo combat by time.

Combat phase	Objectivity (ICC 95%)	Classification
Without displacement	.92 (.83; .96)	Excellent
Displacement	.79 (.55; .9)	Good
Forward attack	.82 (.63; .91)	Good
Backward attack	.87 (.73; .94)	Good
Clinch attack	.9 (.8; .95)	Good
Total attack	.84 (.66; .92)	Good
Forward counterattack	.79 (.56; .9)	Good
Backward counterattack	.63 (.22; .82)	Moderate
Clinch counterattack	.5 (-.04; .76)	Moderate
Total counterattack	.76 (.5; .89)	Good
Defense	.77 (.52; .89)	Good
Clinch	.99 (.99; .99)	Excellent
Pause	.99 (.99; .99)	Excellent

Table 2. Reliability in the analysis of combat phases by time (sum of seconds).

Combat phase	Evaluator 1				Evaluator 2	Evaluator 3					
	Test (s)	Retest (s)	Reliability (ICC 95%) *	Classification	Test (s)	Retest (s)	Reliability (ICC 95%) *	Classification	Test (s)	Retest (s)	Reliability (ICC 95%) *
Without displacement	36.33 ± 14.5	35.13 ± 16.29	.95 (.89; .97)	Excellent	39.72 ± 19.74	39.43 ± 17.99	.98 (.95; .99)	Excellent	47.64 ± 28.74	49.1 ± 27.4	.99 (.99; .99)
Displacement	25.78 ± 12.05	27.30 ± 13.62	.99 (.97; .99)	Excellent	17.29 ± 8.98	18.14 ± 9.83	.96 (.92; .98)	Excellent	2.44 ± 2.07	1.71 ± 1.77	.8 (.58; .9)
Forward attack	6.26 ± 3.9	6.16 ± 3.77	.98 (.96; .99)	Excellent	6.43 ± 4.94	6.04 ± 3.75	.89 (.77; .95)	Good	8.6 ± 5.47	8.55 ± 5.41	.97 (.93; .98)
Backward attack	3.94 ± 3.05	4.29 ± 3.25	.93 (.86; .97)	Excellent	3.75 ± 3.18	3.99 ± 4.65	.86 (.7; .93)	Good	7.31 ± 5.52	6.9 ± 5.67	.92 (.84; .96)
Clinch attack	1.01 ± .84	1.08 ± 1.07	.92 (.84; .96)	Excellent	1.02 ± .96	.97 ± .84	.9 (.79; .95)	Good	1.51 ± 1.64	1.63 ± 1.77	.89 (.77; .95)
Total attack	11.21 ± 5.82	11.53 ± 5.94	.96 (.93; .98)	Excellent	11.19 ± 6.98	11 ± 6.84	.9 (.79; .95)	Good	17.42 ± 8.75	17.08 ± 8.84	.96 (.92; .98)
Forward counterattack	1.5 ± 1.21	1.31 ± 1.19	.92 (.83; .96)	Excellent	1.6 ± 1.23	1.81 ± 1.51	.78 (.54; .9)	Good	.97 ± 1.13	.71 ± .99	.7 (.36; .86)
Backward counterattack	1.12 ± 1.12	.99 ± .87	.88 (.74; .94)	Good	1.34 ± .86	1.35 ± 1.03	.79 (.56; .9)	Good	1.63 ± 2.25	1.56 ± 1.71	.64 (.25; .83)
Clinch counterattack	.13 ± .22	.22 ± .35	.77 (.52; .89)	Good	.38 ± .63	.38 ± .78	.86 (.7; .93)	Good	.74 ± .25	.11 ± .27	.33 (-.4; .68)
Total counterattack	2.75 ± 1.95	2.52 ± 1.73	.94 (.87; .97)	Excellent	3.32 ± 1.98	3.54 ± 2.16	.86 (.71; .93)	Good	2.68 ± 2.8	2.39 ± 2.29	.8 (.57; .9)
Defense	8.67 ± 4.19	8.94 ± 4.65	.97 (.93; .98)	Excellent	11.63 ± 5.8	1.71 ± 4.91	.92 (.82; .96)	Excellent	15.2 ± 7.21	14.93 ± 7.35	.98 (.96; .99)
Clinch	26.79 ± 19.28	27.09 ± 19.97	.99 (.99; .99)	Excellent	28.79 ± 2.92	29.91 ± 21.23	.99 (.99; .99)	Excellent	27.45 ± 18.94	27.52 ± 18.32	.99 (.99; .99)
Pause	28.17 ± 14.97	28.55 ± 15.07	.99 (.99; .99)	Excellent	28.35 ± 15.51	27.61 ± 14.97	.99 (.99; .99)	Excellent	27.36 ± 15.06	27.07 ± 15.08	.99 (.99; .99)

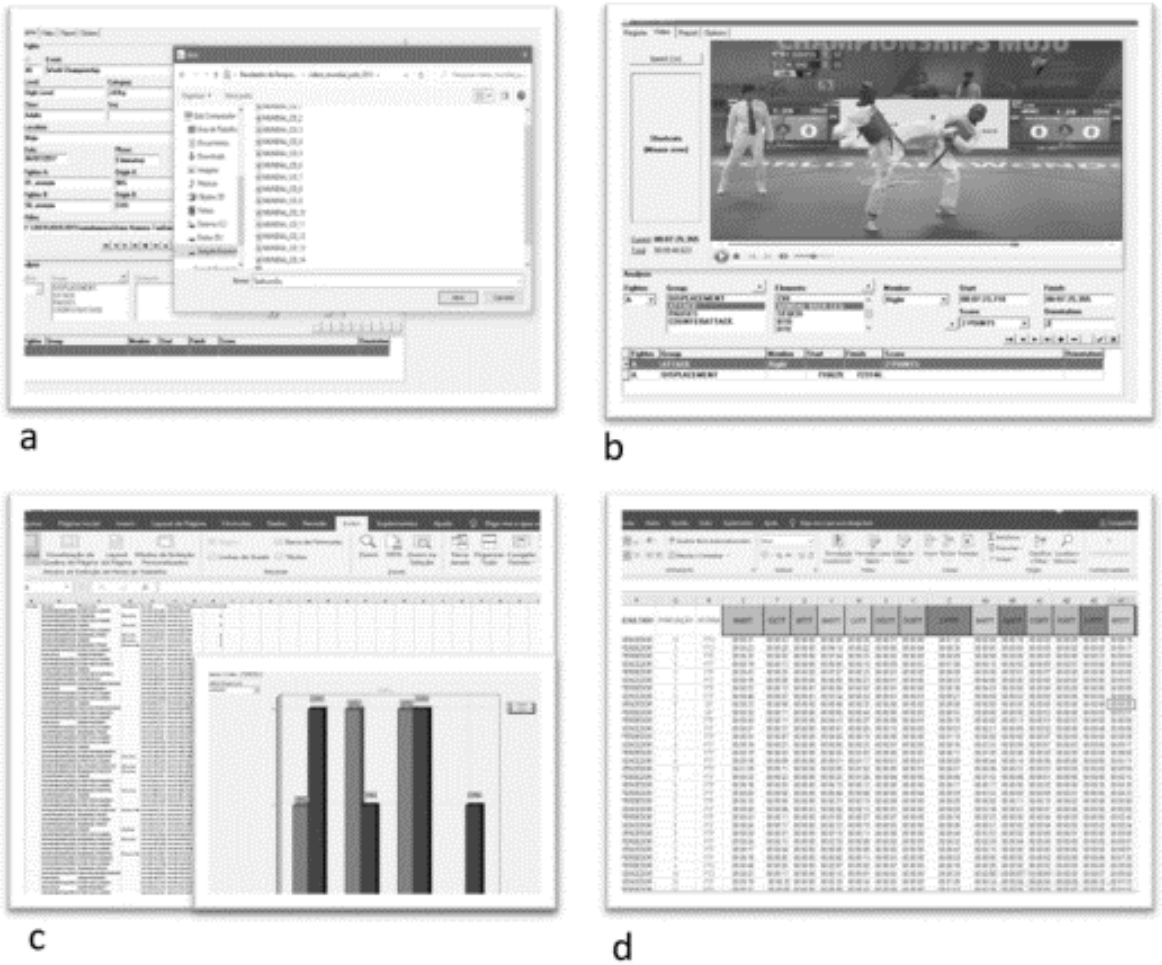

Figure 2. Frami® software analysis. a) video upload, b) record of time-motion and technical-tactical variables, c) sequential time-motion and technical-tactical collect data, with match demands graph, and d) results of each performance analysis per Taekwondo round.

There was objectivity from "moderate to excellent" for all evaluated actions. Figures 3, 4, and 5 show the analysis of the phases of the competition (evaluators 1, 2, and 3, respectively; test and retest).

Table 4 and Figure 6 show data related to objectivity in the analysis of penalties and scores. There was "almost perfect" objectivity in the analyzes.

Table 4. Objectivity by frequency of penalties and scores.

Variable	Median (Q1; Q3%) (evaluator 1/ 2/ 3)	Objectivity (95%) *	Classification
Penalties	1.1 (1; 2.2) / 1 (1; 3) / 1 (1; 3)	.89	Almost perfect
Scores	4.5 (3; 7) / 4.5 (2.7; 7) / 4.5 (3; 7)	.97	Almost perfect

* Cohen's Kappa concordance coefficient

Discussion

Contextualized technical-tactical analyses can assist coaches and athletes in preparing training sessions aimed at high-performance and to develop specific tactics for different weight divisions [Menescardi *et al.* 2019], gender [Miarka *et al.* 2014], and age [Dos Santos *et al.* 2019]. This study aimed to validate a technical-tactical analysis protocol for Taekwondo competition using the Frami® software.

The main results indicated that all evaluators showed "moderate" to "excellent" reliability for the time combat phases, except the third evaluator who presented "poor" for the clinch counterattack actions. For objectivity, the evaluators obtained ICCs varying from "moderate" to "excellent." For penalties and scores, objectivity was rated "almost perfect" by all evaluators. Together, these results show that the current protocol presents reliability and objectivity for videos analyzed in Frami® and can be more precise and contextualized, since actions were added that were not included in the previously validated protocol and in matches carried out by the current rules that use electronic devices to record scores [Dong *et al.* 2014]. The real impact of the use of electronic devices on technical-tactical actions is not known. However, Moenig [2017] states that the current rules, which include electronic scoring devices, should be improved, as they are difficult to understand by the public and made the

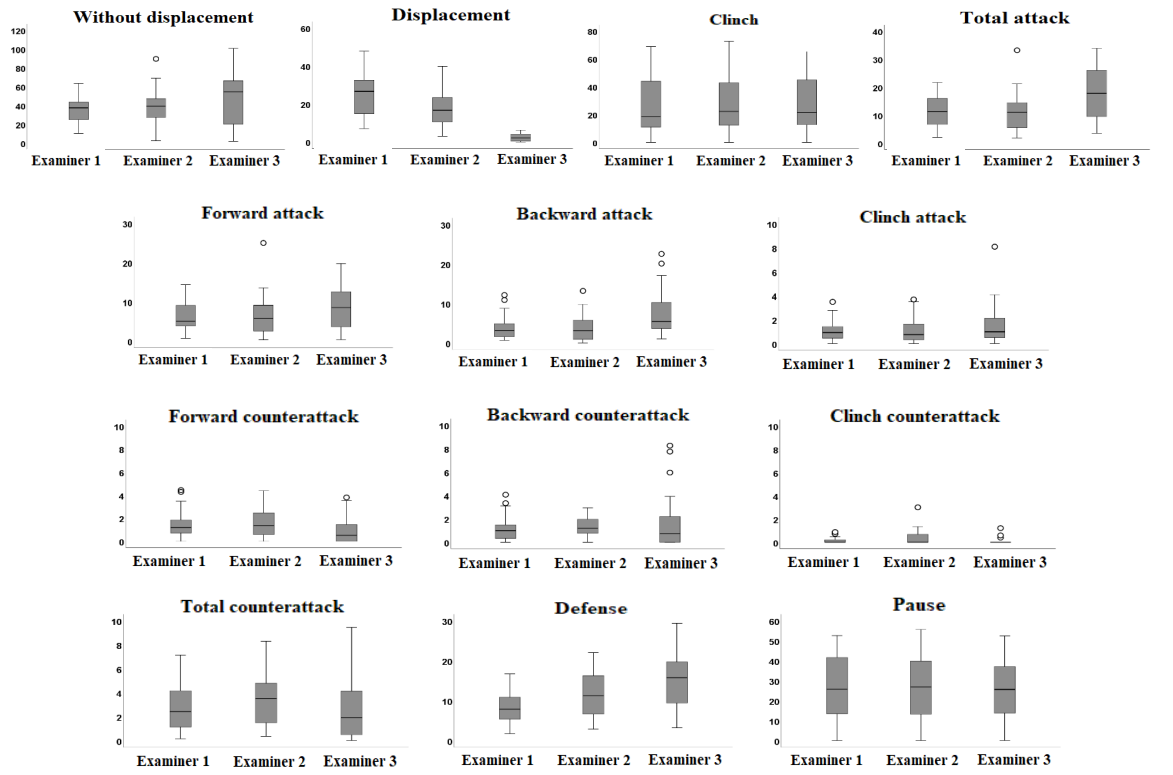

Figure 3. Analysis of time (seconds) in each combat phase.
º = outliers.

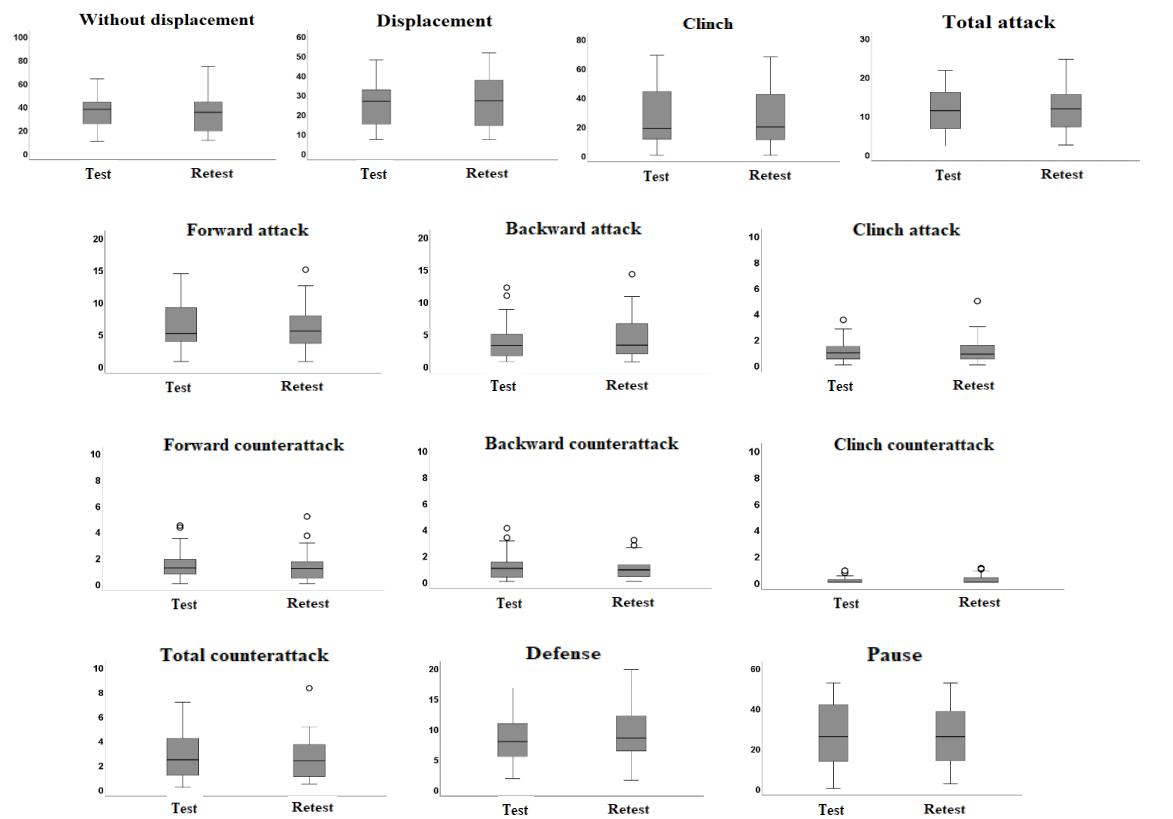

Figure 4. Analysis and reanalysis of each combat phase by evaluator 1.
º = outliers

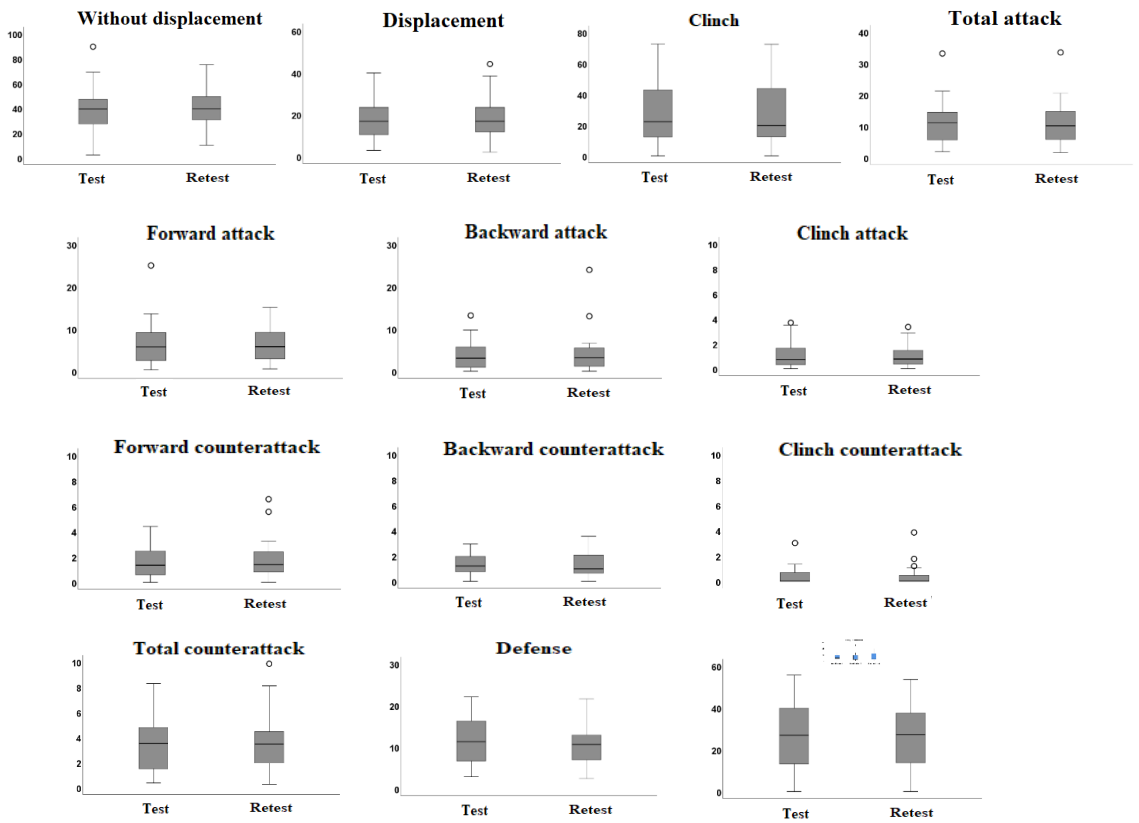

Figure 5. Analysis and reanalysis of each combat phase by evaluator 2.
º = outliers

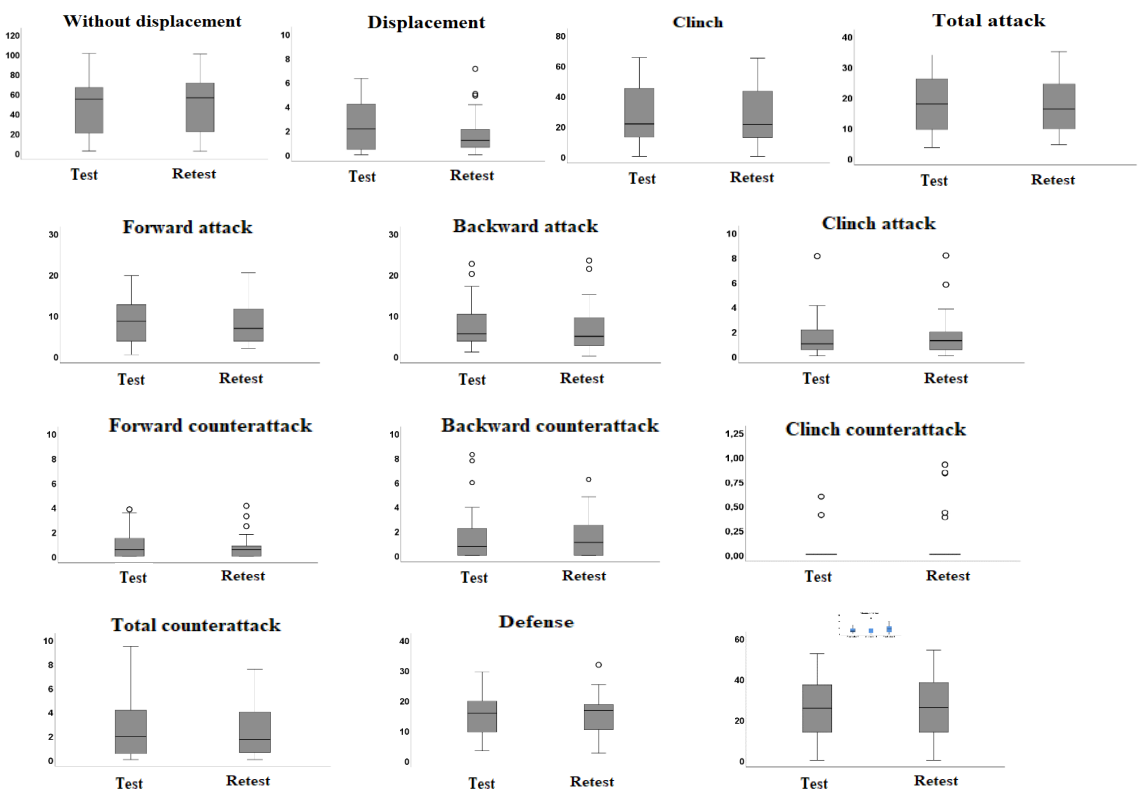

Figure 6. Analysis and reanalysis of each combat phase by evaluator 3.
º = outliers

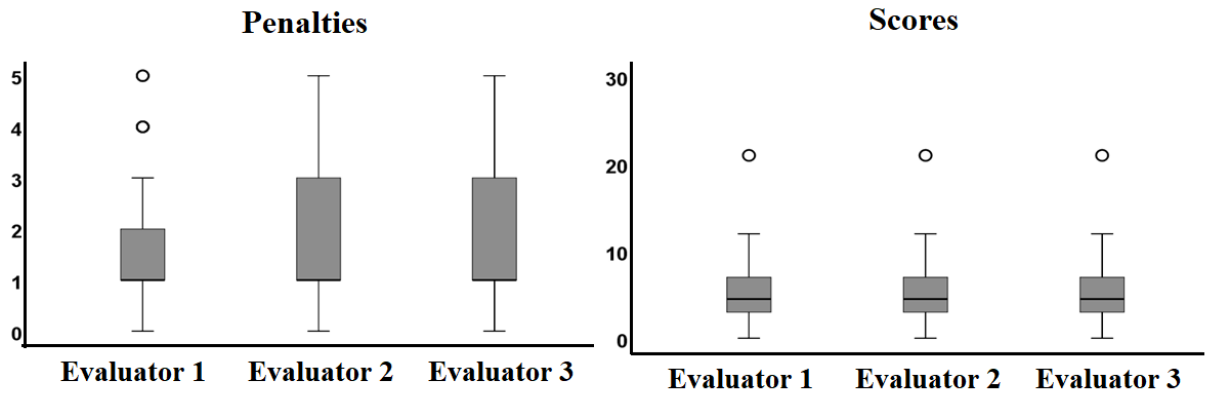

Figure 7. Analysis by frequency of punishments and scores.
° = outliers.

combat boring for spectators, and as a result, Taekwondo may lose space in the Olympic Games due to the future inclusion of Karate in the Tokyo. Preliminary studies have indicated that the use of electronic vests allows less powerful strokes to result in scoring [Ramazanoglu 2013], which may also have contributed to the lower prevalence of injuries and concussions [Viscogliosi 2013].

In view of the previously validated protocol, 13% of the variables had shown a weak correlation [Formalioni *et al.* 2017]. In our protocol, only one variable (counterattack in the clinch) showed "poor" (7.7%) reproducibility by evaluator 3. It is important to mention that this result was obtained probably due to the evaluator having less experience (brown belt) as compared to the other two evaluators (black belts). Future studies can confirm the data shown here; however, our protocol showed that experience can be a limiting factor when carrying out an accurate analysis. Along this same line, Miarka *et al.* [2015] observed objectivity in the analysis of 20 Judo videos by different experts levels, and the results of that study showed correlations classified as "almost perfect" for 87% of all analyzed actions. Thus, we believe that if there is a capacity for a technical understanding of combat sport, there will be agreement regardless of the level of expertise. In opposition to our results, Lopez-Gonzalez Miarka [2013] verified the objectivity of a new time-motion protocol based on technical-tactical interactions for the Olympic wrestling by two expert evaluators with different experience levels (one coach had 19 years of experience and one athlete); the results of that study demonstrated "almost perfect" agreement in the analysis of time performed actions.

The temporal and technical-tactical characteristics reported in this research, including the duration of a given effort (i.e., pausing matches and the accumulated time over the course of a Taekwondo match) provide a tool that can be used in both program design and the manipulation of Taekwondo training factors. Using the Taekwondo protocol provided in this study, trainers/coaches might choose to realize match analysis and develop training sessions aimed at improving both technical-tactical skills as well as sport-specific conditioning. Taekwondo time-motion phases and technical-tactical actions for an athlete within a given age [Casolino *et al.* 2012; Tornello *et al.* 2014], round [Menescardi *et al.* 2019], match outcome [Falco *et al.* 2014], weight [Bridge *et al.*, 2011], and level [Casolino *et al.* 2012; Formalioni *et al.* 2017; Tornello *et al.* 2014] would provide guidance for the selection of sequential Taekwondo-specific work periods interspersed by "realistic" pause or transition periods.

Taekwondo-specific work periods might include displacement patterns [Santos *et al.* 2011], specific to an athlete's preferred attacks [Dong *et al.* 2014], counterattacks [Casolino *et al.* 2012; Dong *et al.* 2014] and defenses, those that delay the attack of his/her opponent, or movement patterns that progress to subsequent combat phases. Potential limitations of performance analysis methods include the reliability of the data entry, or the researcher's ability to reproduce the observed value when the measurement is repeated [Miarka *et al.* 2011]. The present study demonstrated a large variation in the counterattack phase analysis in an inter-observer comparison with non-expert (evaluator 3). The frequency and duration of Taekwondo combat actions were measured using reliability analyses that can affect inter-observer consistency between experts and non-experts.

Our findings showed a practical implication for technical-tactical analysis by Taekwondo experts; which can offer advanced knowledge about the combination of different actions that determine the success of the combat. The main results indicated that the time-motion analysis, which are simple observations of combat situations, can be performed by non-experts, as they maintain their objectivity and replicability in the analyzes, enabling the increase of the labor market for analysts' non-experts in Taekwondo. On the other hand, in the technical-tactical analysis, the results indicated the need for expertise. The observational-descriptive approach implemented in the current investigation may limit extrapolation of the results. Furthermore, Taekwondo athletes are likely

to elicit different physiological responses [Hausen *et al.* 2017; Menescardi *et al.* 2015; Tornello *et al.* 2013] and motor demands for a specific action [Dong *et al.* 2014] and/or combat phase [Menescardi *et al.* 2019]; however, limited detailed data are available comparing the experts and non-experts analysis with a complex Taekwondo protocol [Menescardi *et al.* 2019]. This also indicates the need for future further research to verify how the use of this Taekwondo protocol could affect potential outcomes during the championship.

Our results are consistent with previously published studies in which attacks are preferably performed with the lead leg [Gutierrez-Santiago *et al.* 2020; Menescardi *et al.* 2019; Menescardi *et al.* 2015; Santos *et al.* 2011] and the side kick (called *bandal chagi*) being the most frequent [Gutierrez-Santiago *et al.* 2020; Santos *et al.* 2011]. Moenig [2017] states since the introduction of the electronic scoring system suspicions regarding arbitration errors have decreased; however, there has been a perceived negative effect on striking attempts, where the prevalence of the front leg kick, unconventional techniques and even bizarre kicks have caused Taekwondo to go from a full-contact to a light-contact sport. As our study evaluated elite athletes (ranked in the top 5 in the world), it was expected that there would be a high prevalence of techniques like the side kick. Previous studies show that athletes who were the winners obtained higher scores with the lead leg kicks [Falco *et al.* 2014; Gutierrez-Santiago *et al.* 2020]. The results of our study are limited to comparing elite adult male athletes, so they will have less applicability to other groups of athletes. However, future studies can apply our protocol to generate competitive data that can be used to improve athletes' technical level and to establish specific training models for different weight, gender, and age divisions.

Conclusion

After the applied methods and obtained results, we concluded that the developed and validated protocol proved to be advantageous for elite-level Taekwondo competitions since more actions were added (i.e., clinch, combat base, penalties, and scores) compared to the previously validated protocol. In addition, our protocol was developed under the current competitive rules in which electronics on the chest, foot, and helmet are used, thus differentiating and updating the Frami® software's applications to Taekwondo competition.

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Protokół oprogramowania Frami® dla Taekwondo: rozwój, niezawodność i odtwarzalność

Słowa kluczowe: analiza wydolności, zawodnicy taekwondo, badania czasowo-ruchowe, wydolność sportowa

Streszczenie.

Wprowadzenie. Darmowe oprogramowanie do analizy walki, zwane Frami®, miało swój panel dostosowany i zaadaptowany do analizy Taekwondo. Tak więc, oprogramowanie było w stanie wyprodukować istotne informacje z sekwencyjnych działań bojowych i funkcjonalnych wymagań walki. Jednakże, jego protokół nie został zatwierdzony dla sportu Taekwondo. Cele. Niniejsze badanie weryfikowało obiektywność i wiarygodność protokołu analizy techniczno-taktycznej i działań motorycznych dla zawodów Taekwondo na poziomie elitarnym przy użyciu oprogramowania Frami® poprzez porównanie wyników ustalonych przez ekspertów i osób nie będących ekspertami.

Metody. Aby ustalić, czy oprogramowanie Frami® jest odpowiednie do zawodów Taekwondo, trzech oceniających (dwóch ekspertów i jeden nie-ekspert) stworzyło protokół, używając faz przemieszczenia, ataku, kontrataku, obrony, klinczu oraz pauzy i wybrało 10 walk z udziałem mężczyzn z Mistrzostw Świata Taekwondo 2019. Zastosowano rzetelność test-retest, aby wskazać powtarzalność wyników testu z upływem czasu (test i retest po 24 godzinach). Cohen's Kappa i współczynnik korelacji wewnątrzklasowej zostały użyte do oszacowania i odzwierciedlenia stabilności protokołu mierzonego przez oprogramowanie Frami®, $p \leq .05$.

Wyniki. Po przeprowadzeniu analizy współczynnika korelacji wewnątrzklasowej (ICC), niniejsze badanie wykazało, że dla wszystkich faz walki, oceniający wykazali „umiarkowaną" do „doskonałej" wiarygodność (ICC=.64 do .99), z wyjątkiem trzeciego oceniającego (nie-eksperta), który wykazał „słabą"

wiarygodność dla działań kontrataku klinczu (ICC=.33). Dla obiektywności, uzyskane ICC wahało się od „umiarkowanego" do „doskonałego" (ICC=.5 do .99). Dla kar i wyników, obiektywność została oceniona jako „prawie doskonała" (ICC = .89 do .97).

Wnioski. Protokół okazał się być powtarzalny i obiektywny dla analizy w zawodach Taekwondo na poziomie elitarnym. Protokół ten był korzystny, ponieważ dodano więcej działań motorycznych (klincz, podstawa walki, kary i punktacja) w porównaniu do poprzednio walidowanego protokołu, a także został opracowany zgodnie z aktualnymi przepisami zawodniczymi, w których używane są urządzenia elektroniczne (klatka piersiowa, stopa i kask). Jednakże, ocena dokonana przez nie-eksperta może nie przedstawiać dokładnie techniczno-taktycznych działań w walce.