Journal of Sports Sciences
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rjsp20

A comparison of time-motion performance between age groups in judo matches

Bianca Miarka [a], Valéria Leme Gonçalves Panissa [a], Ursula Ferreira Julio [a], Fabrício Boscolo Del Vecchio [b], Michel Calmet [c] & Emerson Franchini [a]

[a] University of São Paulo - School of Physical Education and Sport, Biodynamics, Av. Prof. Melo de Morais, 65 - Cidade Universitária, São Paulo, 05508-030, Brazil

[b] Federal University of Pelotas, Superior School of Physical Education, Pelotas, Brazil

[c] University of Montpellier, Faculty of Sport Sciences, Montpellier, France

Available online: 24 Apr 2012

To cite this article: Bianca Miarka, Valéria Leme Gonçalves Panissa, Ursula Ferreira Julio, Fabrício Boscolo Del Vecchio, Michel Calmet & Emerson Franchini (2012): A comparison of time-motion performance between age groups in judo matches, Journal of Sports Sciences, DOI:10.1080/02640414.2012.679675

To link to this article: http://dx.doi.org/10.1080/02640414.2012.679675

Journal of Sports Sciences, 2012; 1–7, i*First* article

Routledge
Taylor & Francis Group

A comparison of time-motion performance between age groups in judo matches

BIANCA MIARKA[1], VALÉRIA LEME GONÇALVES PANISSA[1], URSULA FERREIRA JULIO[1], FABRÍCIO BOSCOLO DEL VECCHIO[2], MICHEL CALMET[3], & EMERSON FRANCHINI[1]

[1]*University of São Paulo – School of Physical Education and Sport, Biodynamics, Av. Prof. Melo de Morais, 65 – Cidade Universitária, São Paulo, 05508-030 Brazil,* [2]*Federal University of Pelotas, Superior School of Physical Education, Pelotas, Brazil, and* [3]*University of Montpellier, Faculty of Sport Sciences, Montpellier, France*

(Accepted 22 March 2012)

Abstract
The aim of this study was to compare time-motion indicators during judo matches performed by athletes from different age groups. The following age groups were analysed: Pre-Juvenile (13–14 years, $n = 522$), Juvenile (15–16 years, $n = 353$); Junior (19 years, $n = 349$) and Senior (>20 years, $n = 587$). The time-motion indicators included: Total Combat Time, Standing Combat Time, Displacement Without Contact, Gripping Time, Groundwork Combat Time and Pause Time. Analysis of variance (ANOVA) one-way and the Tukey test, as well as the Kruskal-Wallis test and Mann-Whitney (for non-parametric data), were conducted, using $P < 0.05$ as significance level. The results showed that all analysed groups obtained a median of 7 (first quantile - 3, third quantile - 12) sequences of combat/pause cycles. In total time of combat, the result was: for Total Combat Time, Standing Combat Time and Gripping Time: Pre-Juvenile and Senior were significantly longer than Juvenile and Junior. Considering Displacement Without Contact, Junior was significantly longer than all other age groups. For Groundwork Combat Time, Senior was significantly longer than all other age groups and Pre-Juvenile was longer than Junior. These results can be used to improve the physiological performance in intermittent practices, as well as technical-tactical training during judo sessions.

Keywords: *judo, time-motion, performance analysis, combat sport, technique, tactic*

Introduction

The requirement to produce an accurate recording of an event and then to analyse and diagnose it, and afford feedback to an athlete/coach to increase performance is not new in sport (Atkinson & Nevill, 2001; Drust, 2010; Hughes, Cooper, & Nevill, 2004; Hughes & Franks, 2004; Nevill, Atkinson, & Hughes, 2008). Admirable accounts that outline the historical improvement of this field in a wide range of combat sports are available (Calmet, Miarka, & Franchini, 2010; Castarlenas & Planas, 1997; Franchini, Sterkowicz, Meira, Gomes, & Tani, 2008; Gutiérrez-Santiago, Prieto, Camerino, & Anguera, 2011; Matsushigue, Hartmann, & Franchini, 2009; Nilsson, Csergö, Gullstrand, Tveit, & Refsnes, 2002; Santos, Franchini, & Lima-Silva, 2011; Sikorski, Mickiewicz, Majle, & Laksa, 1987; Van Malderen et al., 2006; Vecchio, Hirata, & Franchini, 2011). However, there is limited information on time-motion (Gutiérrez-Santiago et al., 2011; Marcon, Franchini, Jardim, & Barros Neto, 2010) and match demands of judo athletes (Franchini, Matsushigue, Vecchio & Artioli, 2011). Previous investigations described the effort-pause ratio during high level judo combat. For example, Castarlenas and Planas (1997) observed that usually judo matches present 11 work sequences (eight standing and three on the ground) and seven pause sequences. They demonstrated that sequences of effort last for about 15 s to 30 s, with pause breaks of about 10 s. Descriptions of the Polish (Sikorski et al., 1987) and Belgian Championships (Van Malderen et al., 2006) reflect similar results regarding activity and pause times during combats, when compared to the analyses made in international competitions. Despite notational analysis having been commonly used within research and applied settings to investigate match demands of judo

Correspondence: Bianca Miarka, University of São Paulo – School of Physical Education and Sport, Biodynamics, Av. Prof. Melo de Morais, 65 – Cidade Universitária, São Paulo, 05508-030 Brazil. E-mail: miarkasport@hotmail.com

ISSN 0264-0414 print/ISSN 1466-447X online
http://dx.doi.org/10.1080/02640414.2012.679675

combats performance, effective evaluation of time-motion and match effort components requires knowledge of the contextual factors that can potentially affect the physiological and tactical performance in intermittent practices, such as judo (Gutiérrez-Santiago et al., 2011; Taylor, Mallalieu, James, & Shearer, 2008).

Combat sports are no longer considered the mere sum of two individual behaviours, but rather a complex system composed of different actions performed by athletes, which produce specific physical demands (Miarka, Julio, Vecchio, Calmet, & Franchini, 2010). This means there is also a growing need for a better understanding of these activities with inferences over physiological work profiles (Calmet et al., 2010; Gutiérrez-Santiago et al., 2011; Marcon et al., 2010; Miarka et al., 2010). Therefore, time-motion analysis can be used to quantify physical and technical movement patterns of different matches, providing important guidelines for training in a chosen sport (Duthie, Pyne, & Hooper, 2005; Sirotic, Coutts, Knowles, & Catterick, 2009). This approach has been largely used in different team sports (Dawson, Hopkinson, Appleby, & Stewart, 2004; Duthie et al., 2005; Sirotic et al., 2009; Taylor et al., 2008). Research on time-motion performance can also provide specific information for the physical and technical preparation of athletes at each group standard (e.g. Sirotic et al., 2009; Gutiérrez-Santiago et al., 2011). Furthermore, this knowledge could be employed in evaluations of specific skills, metabolic demands and analogue to real combat in terms of anaerobic and aerobic characteristics (Almansba, Franchini, & Sterkowicz, 2007; Franchini, Vecchio, & Sterkowicz, 2009).

Variations of intensity and constant interruptions during a judo match make intermittence the main characteristic of this combat sport (Franchini, Bertuzzi, Takito, & Kiss, 2009; Franchini, Matsushigue et al., 2011; Gutiérrez-Santiago et al., 2011). Officially, the total time of a judo combat consists of four minutes for Pre-Juvenile and Juvenile groups, and five minutes for Junior and Senior groups. This period can be reduced if one athlete obtains the maximum score (*ippon*). In the case of a tie, it can be complemented by an extra time of 3 min for Senior and Junior athletes and 2 min for Juvenile and Pre-Juvenile or until one of the athletes achieves any score in this period, called golden score (International Judo Federation, 2010). Therefore, the variation in the total match time and the combination of different activities in both athletes suggests that perhaps there is a difference in effort situations between age groups. However, available information on tactical aspects and match demands of different groups in judo combats are scarce. Based on this limitation of knowledge about time-motion and differences between age groups with large samples, the purpose of the current study was to: (1) quantify different phases in a judo match based on time-motion analysis; and (2) determine the extent to which differences occur between age groups (Pre-Juvenile, Juvenile, Junior and Senior) in judo matches of different championships.

Methods

Match sample

The sample was composed of 1811 performances of athletes, comprised of four groups according to age groups: Pre-Juvenile (13–14 years, $n = 522$), Juvenile (15–16 years, $n = 353$), Junior (17–19 years, $n = 349$) and Senior (> 20 years, $n = 587$). Each of these 1811 performances were matches performed by two different athletes. As these data were collected during real competition it was not possible to quantify precisely how many matches each athlete performed, but in any case each match was independent of each other as athletes never fought against the same adversary during the tournament (i.e., during judo competitions judo athletes do not fight against the same athlete in the same competition). All participants were informed about the procedures used in the record, and provided their informed consent. In addition, the procedures in this study were approved by the Research Ethics Committee of the School of Physical Education and Sport – University of São Paulo, Brazil.

Procedures

Different championships (three regional championships and one state championship of all categories in Pre-Juvenile, Juvenile, Junior and Senior age groups for males) were taped using four Sony cameras (model DCR-DVD508) during 2008. In order to guarantee ecological validity, in our study one camera was positioned in each match area, such as coaches and match analysts normally do during the analyses they conduct. After recording, the data were measured by one expert. Before the time motion measurements, the expert assessed the intra- and inter-observer agreement in order to verify the true score of the time-motion indicators (Hopkins, 2000; James, Taylor, & Stanley, 2007).

Measures: Identification of judo performance through time-motion indicators

A variables list obtained from previous studies (Calmet et al., 2010; Gorostiaga, 1988; Marcon et al., 2010; Miarka, Hayashida, Julio, Calmet, & Franchini, 2011) was used to formulate the list of

time-motion indicators used in the computerised match analysis. This group of variables was composed of: Total Combat Time; Standing Combat Time; Pause Time; Groundwork Combat Time; Displacement Without Contact and Gripping Time. Next, each variable was given operational definitions. In addition, the frequency of appearance of each time-motion indicator was collected in each match and expressed per second of playing time:

- Total Combat Time: the criterion of identification for combat time was the period between the order from the referee to initiate the combat (''*hajime''*), the order to stop the combat (''*matte''*) and the order to finish the fight (''*soremade''*), based on the protocol used on the analysis of combat time frame in Gorostiaga (1988).
- Standing Combat Time (*tachi-waza*): the time of standing fight is defined by the period in which one or both fighters executed standing combat, characterised by the intention to perform throwing techniques (*nage-waza*), according to the rules, such as Gorostiaga (1988).
- Displacement Without Contact: this variable is defined by the time between the signal from the referee announcing the beginning of combat (''*hajime''*) and the execution of the grip (*kumi-kata*). In this period, athletes do not have any physical contact between them, based on the protocol used on the analysis of combat time frame in Calmet et al. (2010).
- Gripping Time (*kumi-kata*): the gripping time for the match is defined by the time between the accomplishment of the grip (kumi-kata) and the lack of contact on the opponent judogi, based on the protocol used in the analysis of combat time frame in Calmet et al. (2010).
- Groundwork Combat Time (ne-waza time): the groundwork time is defined by the period where one or both fighters executed groundwork techniques (ne-waza), according to the rules, following the protocol used Gorostiaga (1988).
- Pause Time: the recovery time is defined by the period between the signal for combat interruption (''*matte''*) and the signal for restart of the combat (command voice ''*hajime''*). The present study did not observe ''*sono-mama*'' and ''*yoshi*'' commands (halt of fight and restart), which would also have been computed as recovery if they had had occurred, following the protocol of Gorostiaga (1988).

Reliability testing

The reliability measures were assessed through intra-observer and inter-observer testing procedures. This research involved two experts, with more than ten years of judo practice and graduated in Physical Education, who analysed judo matches with FRAMI software. Briefly, for inter-observer agreement, the first expert analysed 20 performances of athletes and the second expert analysed the same 20 athletes (Hopkins, 2000; James et al., 2007). After this procedure, the second expert performed the intra-observer agreement, with the selection of the 10 combats (20 athletes) in a randomised order, before performing the analysis on each one more time. The reliability of this software was examined using the Cohen's Kappa, as suggested by Landis and Koch (1977) and reported by Sim and Wright (2005). From the distribution for each variable, the following Kappa values and strength of agreement classification were used: 0.0 to 0.2, poor; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; 0.81 to 1.00, almost perfect (Landis & Koch, 1977). The index and classification of Kappa values of time-motion indicators data used in the present study is shown in Table I. The significance level of $P < 0.05$ was used.

Statistical analysis

The number of combat/pause and groundwork combat/pause sequences was shown by median (first quantile, third quantile). For this non-parametric data, the Kruskal-Wallis and Mann-Whitney tests were conducted to compare groups. Afterwards, the effect size measure for non-parametric analysis was calculated, defined as $r = Z/NV$, where r represents the effect size, Z is derived from the conversion of the Mann-Whitney test and N is the total number of observations. This analysis considers r-values as: to small effect size ($r = 0.10$), medium effect size ($r = 0.30$) or large effect size ($r = 0.50$) (Field, 2005). Time-motion data were presented as mean $\pm$ s. Analysis of variance (ANOVA) one-way was conducted to compare measured variables. When differences were detected, the Tukey test was used *post hoc* to identify specific differences between age groups. Eta squared ($\eta 2$) was calculated. The significance level of $P < 0.05$ was used. All analyses were conducted using SPSS 18.0 for Windows.

Table I. Kappa values and classification of time-motion indicators.

Time-motion indicator	Kappa	
	Values	Classification
Total Combat Time	0.95	Almost perfect
Standing Combat Time	0.91	Almost perfect
Displacement Without Contact	0.84	Almost perfect
Gripping Time	0.88	Almost perfect
Groundwork Combat Time	0.88	Almost perfect
Pause Time	0.87	Almost perfect

Results

Total time accumulated in the match for each time-motion indicator in Pre-Juvenile, Juvenile, Junior and Senior age groups are presented in Table II.

The ANOVA revealed a significant difference between Pre-Juvenile and Senior when compared with other age groups in Total Combat Time ($P < 0.001$, $\eta^2 = 0.047$), Standing Combat Time ($P < 0.001$, $\eta^2 = 0.070$) and in Gripping Time ($P < 0.001$, $\eta^2 = 0.067$). Regarding Groundwork Combat Time, Senior presented longer values than other age groups, Junior was lower than Pre-Juvenile ($P < 0.001$, $\eta^2 = 0.037$). Junior was longer than other age groups in comparison of Displacement Without Contact ($P < 0.001$, $\eta^2 = 0.010$). Figure 1 presents the total time as a percentage of maximal time permitted for each age group on each time-motion indicator.

Concerning Total Pause Time and Total Groundwork Time, when comparing the Total Combat Time as a percentage of the maximum time permitted by the rules for each age group on each time-motion indicator (including Golden Score by the corresponding Total Combat Time of the golden score from each age group) the ANOVA showed a significant difference between Juvenile and Junior and all other groups concerning Total Combat Time ($P < 0.001$, $\eta^2 = 0.033$), Standing Combat Time ($P < 0.001$, $\eta^2 = 0.058$) and Gripping Time ($P < 0.001$, $\eta^2 = 0.054$). Concerning Pause Time, Junior and Senior groups were different from Pre-Juvenile, and Junior was different from Juvenile ($P = 0.001$, $\eta^2 = 0.014$). Senior was lower than other groups when considering the Displacement Without Contact ($P < 0.001$, $\eta^2 = 0.013$). Regarding Groundwork Combat Time, Junior was lower than other age groups ($P = 0.001$, $\eta^2 = 0.040$).

Significant differences were found between Junior [median of 6 (3, 10), $P < 0.001$] and Pre-Juvenile, Juvenile and Senior age groups, with median of 7 (3, 12) and r-values of: $r = -0.08$, $r = -0.09$ and $r = -0.010$, respectively ($P < 0.001$) for cycles of combat/pause sequences. Concerning groundwork combat/pause sequences, Juvenile [median of 5 (2, 8), $P < 0.001$] was longer than Pre-Juvenile [median of 4 (2, 9), $r = -0.07$, $P < 0.001$], Senior [median of 3 (1, 6), $r = -0.07$, $P < 0.001$] and Junior [median of 4 (2, 6), $r = -0.07$, $P < 0.001$]. Table III shows the mean $\pm$ s of time for each performance indicator in each phase of the match separated by age groups.

When combat was separated in each combat/pause sequential time, there was a significant difference between Senior and Juvenile and other age groups regarding Total Combat Time ($P < 0.001$, $\eta^2 = 0.064$), Standing Combat Time ($P < 0.001$, $\eta^2 = 0.079$) and Gripping Time ($P < 0.001$, $\eta^2 = 0.091$). Juvenile and Junior groups were different from Senior and Pre-Juvenile in Pause Time ($P < 0.001$, $\eta^2 = 0.102$). The ANOVA showed that Senior and Pre-Juvenile groups had differences in Groundwork Combat Time ($P < 0.001$, $\eta^2 = 0.088$) and Pause Time ($P < 0.001$, $\eta^2 = 0.102$) compared to other age groups. Juvenile and Junior were lower than Senior and Pre-Juvenile when comparing Groundwork Time ($P < 0.001$, $\eta^2 = 0.088$) and Pause Time ($P < 0.001$, $\eta^2 = 0.102$). In addition, the Junior time of Displacement Without Contact was longer than other age groups ($P < 0.001$, $\eta^2 = 0.17$).

Discussion

The aim of the present study was to quantify different movement patterns in judo matches based on a time-motion analysis and to compare age groups (Pre-juvenile, Juvenile, Junior and Senior). In this research, about 10% of fights ended with only one cycle of combat/pause, without Pause Time (Tables II and III). Moreover, an analogous percentage did not show Groundwork Combat Time (Tables II and III). Meanwhile, 58% of pre-juvenile combats and 56% of senior combats ended before the full time allowed by the rules. Castarlenas and Planas (1997) reported similar results, with 58% of combats finishing before the regular time. In contrast, juniors fought an average of 44% of maximal combat time, and 49% of

Table II. Total time by mean $\pm$ s for each time-motion indicator of each age group, in seconds.

Groups	Total Combat Time	Standing Combat Time	Displacement Without Contact	Gripping Time	Groundwork Combat Time	Pause Time
Pre-Juvenile $n = 522$	155 ± 101⋆	121 ± 85⋆	32 ± 26	72 ± 56⋆	42 ± 33[a]	57 ± 63
Juvenile $n = 353$	124 ± 77[b]	93 ± 62[b]	30 ± 24	50 ± 40[b]	37 ± 26	50 ± 46
Junior $n = 349$	137 ± 92[b]	97 ± 72[b]	38 ± 33⋆	59 ± 51[b]	33 ± 26[b]	48 ± 48
Senior $n = 587$	182 ± 109⋆	148 ± 92⋆	32 ± 28	89 ± 63⋆	50 ± 37⋆	57 ± 58

⋆Age group significantly different from other groups ($P < 0.05$); [a]Age group significantly different from Senior and Junior groups ($P < 0.05$); [b]Age group significantly different from Senior and Pre-Juvenile groups ($P < 0.05$). The present study did not observe Pause Time and Groundwork Combat Time in: 48 and 52 combats of Pre-Juvenile, 36 and 40 combats of Juvenile, 50 and 60 combats of Junior and 52 and 65 combats of Senior, respectively.

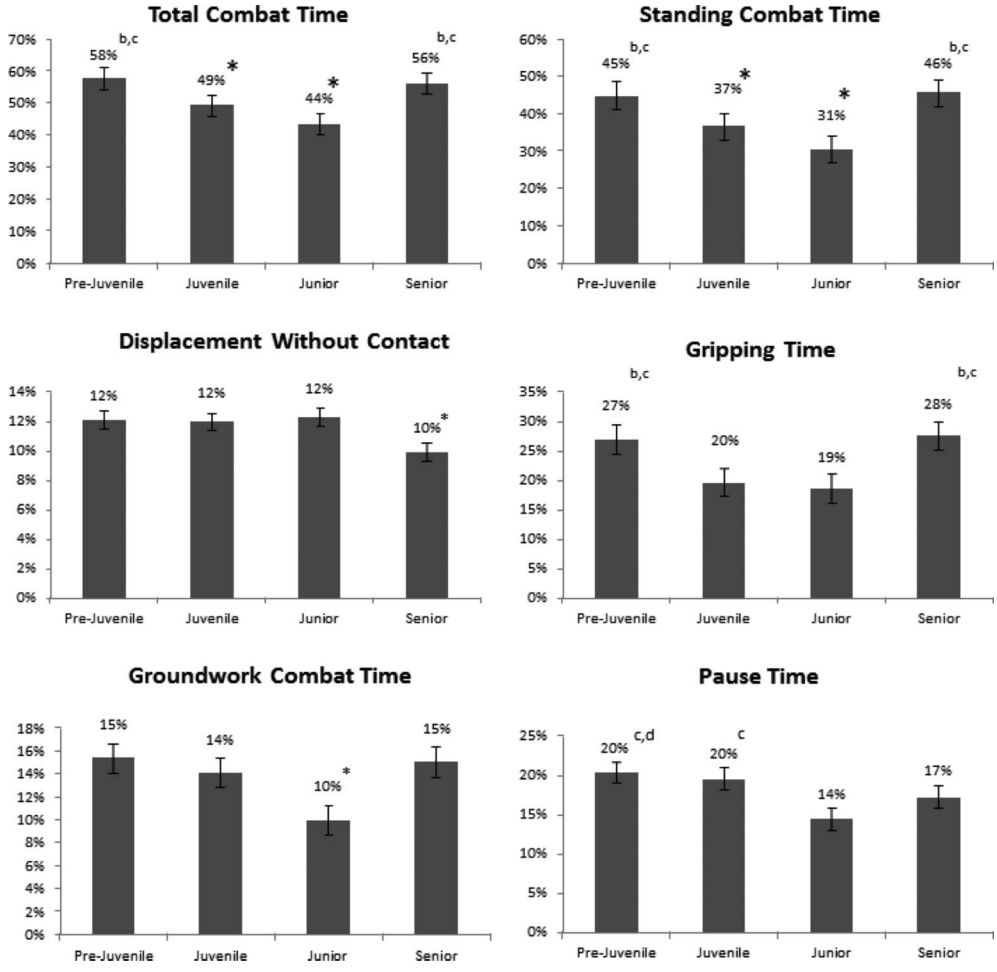

Figure 1. Mean of total time as a percentage of the maximal time permitted by rule for each age group on each time-motion indicator. ⋆Age group significantly different from other groups ($P < 0.05$); [b]Age group significantly different from Juvenile ($P < 0.05$); [c]Age group significantly different from Junior ($P < 0.05$); [d]Age group significantly different from Senior ($P < 0.05$). The present study observed golden score in: 43 combats of Pre-Juvenile, 11 combats of Juvenile, 29 combats of Junior and 145 combats of Senior.

Table III. Total time of each match phase showed by mean $\pm$ *s* for each time-motion indicator by each age group, in seconds.

Groups	Total Combat Time	Standing Combat Time	Displacement Without Contact	Gripping Time	Groundwork Combat Time	Pause Time
Pre-Juvenile $n = 522$	21 ± 8^{a}	16 ± 7^{a}	4 ± 5	10 ± 6^{a}	$10 \pm 8^{\star}$	$10 \pm 8^{\star}$
Juvenile $n = 353$	$16 \pm 6^{\star}$	$12 \pm 5^{\star}$	4 ± 4	$6 \pm 4^{\star}$	7 ± 4^{b}	7 ± 4^{b}
Junior $n = 349$	22 ± 10^{a}	16 ± 8^{a}	$6 \pm 6^{\star}$	10 ± 7^{a}	8 ± 6^{b}	7 ± 6^{b}
Senior $n = 587$	$30 \pm 33^{\star}$	$24 \pm 27^{\star}$	5 ± 8	$14 \pm 15^{\star}$	$15 \pm 14^{\star}$	$11 \pm 10^{\star}$

⋆Age group significantly different from other groups ($P < 0.05$); [a]Age group significantly different from Senior and Juvenile groups ($P < 0.05$); [b]Age group significantly different from Senior and Pre-Juvenile groups ($P < 0.05$). The present study did not observe Pause Time and Groundwork Combat Time in: 48 and 52 combats of Pre-Juvenile, 36 and 40 combats of Juvenile, 50 and 60 combats of Junior and 52 and 65 combats of Senior, respectively.

juvenile combats ended before the full time allowed.

Although the participation in judo championships is based primarily on chronological age groups, which span only two years, except for senior athletes, the comparison between groups and the analogous differences in Standing Combat Time, Gripping Time and Groundwork Combat Time are probably related to maturational aspects and have also been reported by previous studies with judokas and wrestlers (Calmet & Ahmaidi, 2004; Calmet, Trezel, & Ahmaidi, 2006; Calmet et al., 2010; Franchini, Matsushigue et al., 2011; Horswill, 1992; Little, 1991; Terbizan & Seljevold, 1996). Variations in size, function and skill associated with age and maturity status within two-year age groups can be

considerable (Figueiredo, Gonçales, Silva, & Malina, 2009). Therefore, senior and pre-juveniles are in an opposite situation compared to other age groups, given that both seem to be physiologically more homogeneous than juvenile and junior groups. Performance differences between groups are apparent by 13 years of age and tend to be greatest at 14 and 15 years old. (Malina, Bouchard, & Bar-O, 2004).

Senior judo athletes showed a Standing Combat Time of 148 ± 92 s, which was longer than in previous studies (Castarlenas & Planas, 1997; Van Malderen et al., 2006). On the other hand, Groundwork Combat Time and Pause Time analyses showed lower values compared to Castarlenas and Planas (1997), i.e., 54 ± 38 s and 101 ± 69 s, respectively. This can be explained by considering the modifications in the regulations that were introduced in order to make judo a more attractive sport to the public, which could show a decrease in groundwork activities. In addition, changes in rules over the years have aimed to produce a dynamic combat, which may have influenced tactical strategies and the pause periods (Boguszewski, 2011).

Concerning Gripping Time, the results clearly demonstrated differences between senior and other groups. As seniors have accumulated years of practice and more hours of training they could have made grip movements more complex and variable. For instance, Calmet et al. (2010) showed that gripping seems to be one essential characteristic determining expertise in judo matches, since research with children and youths and beginners and experts in judo, supports the notion that experts have a higher rate of technical and tactical gripping knowledge, regardless of age, but that more experienced athletes (i.e., senior judo athletes) spend more time on this specific action (Calmet & Ahmaidi, 2004; Calmet et al., 2006; Calmet et al., 2010; Franchini et al., 2008).

When Total Combat Time was separated by combat/pause cycles (Table III), Total Combat and Pause Time, senior results were longer than for other age groups. Therefore, the senior values obtained were similar to those of Sikorski et al. (1987), who analysed the 1986 Matsumae Cup and the 1985 European Championship and determined an effort-pause ratio of 30:13 per cycle. Therefore, the present results support previous studies, which have established a typical combat-pause time structure of 20–30 s per 5–10 s (Franchini et al., 2009; Sikorski et al., 1987; Van Malderen et al., 2006).

Regarding the time for patterns of combat movement analysed by cycle (Table III), the results demonstrated that seniors spent longer periods than all other age groups, except for Displacement Without Contact. Marcon et al. (2010), using three senior combat simulations, reported analogous Displacement Without Contact (4 ± 1 s) compared to those found in the present study in all groups. Calmet et al. (2010) associated this displacement time without contact with a tactical element with two different hypotheses: first, this time could be used by athletes to quickly analyse the opponent, attempting to perform interactions governed by gripping the judogi; second, athletes at this time try to grip and defend against the attempts of his/her opponent, as this is used to control space and to attain control of the opponent (Calmet et al., 2010; Franchini et al., 2008).

Conclusion

The present study is the first to show judo match demands in each time-motion situation and to make a comparison between four different age groups using a high number of matches. The Senior age group presented longer values of Total Combat Time, Standing Combat Time, Groundwork Combat Time and Gripping Time than all other groups. Junior had a Displacement Without Contact time longer than other age groups. However, this group presented lower Pause Time when compared with Senior and Pre-Juvenile. In this way, Pre-Juvenile had a combat time distribution similar to seniors, while Juvenile was the age group with lower values in most of the variables studied. These differences in movement patterns among groups need to be reflected in training practices. In summary, the results emphasise the importance of accounting the frequency of time-motion indicators and the singularities of each age group.

References

Almansba, R., Franchini, E., & Sterkowicz, S. (2007). Uchi-komi avec charge, une approche physiologique d un nouveau test spécifique au judo [An Uchi-komi with load, a physiological approach of a new special judo test proposal]. *Science & Sports*, *22*, 216–223.

Atkinson, G., & Nevill, A.M. (2001). Selected issues in the design and analysis of sport performance research. *Journal of Sports Sciences*, *19*, 811–827.

Boguszewski, D. (2011). Relationships between the rules and the way of struggle applied by top world male judoists. *Archives of Budo*, *7*, 27–32.

Calmet, M., & Ahmaidi, S. (2004). Survey of advantages obtained by judoka in competition by level of practice. *Perceptual and Motor Skills*, *99*, 284–290.

Calmet, M., Miarka, B., & Franchini, E. (2010). Modeling of grasps in judo contests. *International Journal of Performance Analysis in Sport*, *10*, 229–240.

Calmet, M., Trezel, N., & Ahmaidi, S. (2006). Survey of system of attacks by Judoka in regional and interregional matches. *Perceptual and Motor Skills*, *103*, 835–840.

Castarlenas, J.L., & Planas, A. (1997). Estudio de la estructura temporal del combate de judo [Study of the temporal structure of judo combat]. *Apunts - Educación Fisica y Deportes*, *47*, 32–39.

Dawson, B., Hopkinson, R., Appleby, B., & Stewart, G. (2004). Player movement patterns and game activities in the Australian Football League. *Journal of Science and Medicine in Sport*, *7*, 278–291.

Drust, B. (2010). Performance analysis research: Meeting the challenge. *Journal of Sports Sciences*, *28*, 921–922.

Duthie, G., Pyne, D., & Hooper, S. (2005). Time-motion analysis of 2001 and 2002 super 12 rugby. *Journal of Sports Sciences*, *23*, 523–530.

Field, A. (2005). *Discovering statistics using SPSS*. London: SAGE Publications.

Figueiredo, A.J., Gonçales, A.C., Silva, M.J.C., & Malina, R.M. (2009). Youth soccer players, 11–14 years: Maturity, size, function, skill and goal orientation. *Annals of Human Biology*, *36*, 60–73.

Franchini, E., Bertuzzi, R.C.M., Takito, M.Y., & Kiss, M.A.P.D. (2009). Effects of recovery type after a judo match on blood lactate and performance in specific and non-specific judo tasks. *European Journal of Applied Physiology*, *107*, 377–383.

Franchini, E., Matsushigue, K.A., Vecchio, F.B., & Artioli, G.G. (2011). Physiological profiles of elite judo athletes. *Sports Medicine*, *41*, 147–166.

Franchini, E., Miarka, B., Matheus, L., & Vecchio, F.B.D. (2011). Endurance in judo grip strength tests: Comparison between elite and non-elite judo players. *Archives of Budo*, *1*, 1–7.

Franchini, E., Sterkowicz, S., Meira, C.M.J., Gomes, F.R.F., & Tani, G. (2008). Technical variation in a sample of high level judo players. *Perceptual and Motor Skills*, *106*, 859–869.

Franchini, E., Vecchio, F.B., & Sterkowicz, S. (2009). A special judo fitness test classificatory table. *Archives of Budo*, *5*, 127–129.

Gorostiaga, E.M. (1988). Coste energético del combate de Judo [Energy cost of judo combat]. *APUNTS, Medicina de l' Esport*, *25*, 135–139.

Gutiérrez-Santiago, A., Prieto, I., Camerino, O., & Anguera, T. (2011). The temporal structure of judo bouts in visually impaired men and women. *Journal of Sports Sciences*, *29*, 1443–1451.

Hopkins, W.G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine*, *30*(1), 1–15.

Horswill, C.A. (1992). Applied physiology of amateur wrestling. *Sports Medicine*, *14*(2), 114–143.

Hughes, M., Cooper, S.M., & Nevill, A. (2004). Analysis of notation data: Reliability. In M. Hughes & I. M. Franks (Eds.), *Notational analysis of sport* (pp. 189–204). London: Routledge.

Hughes, M., & Franks, I.M. (2004). Notational analysis – a review of the literature. In M. Hughes & I. M. Franks (Eds.), *Notational analysis of sport* (pp. 59–106). London: Routledge.

International Judo Federation. (2010). Sports and organization rules of the International Judo Federation [Online]. Retrieved from www.ijf.org

James, N., Taylor, J.B., & Stanley, S. (2007). Reliability procedures for categorical data in performance analysis. *International Journal of Performance Analysis of Sport*, *7*, 1–11.

Landis J.R., & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*, 159–174.

Little, N.G. (1991). Physical performance attributes of junior and senior women, juvenile, junior and senior men judokas. *Journal of Sports Medicine and Physical Fitness*, *31*, 510–520.

Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Champaign, IL: Human Kinetics.

Marcon, G., Franchini, E., Jardim, J.R., & Barros Neto, T.L. (2010). Structural analysis of action and time in sports: Judo. *Journal of Quantitative Analysis in Sport*, *6*, 1–13.

Matsushigue, K., Hartmann, K., & Franchini, E. (2009). Taekwondo: Physiological responses and match analysis. *Journal of Strength and Conditioning Research*, *23*, 1112–1117.

Miarka, B., Hayashida, C.R., Julio, U.F., Calmet, M., & Franchini, E. (2011). Objectivity of FRAMI-software for judo match analysis. *International Journal of Performance Analysis in Sport*, *11*, 254–266.

Miarka, B., Julio, U.F., Vecchio, F.B.D., Calmet, M., & Franchini, E. (2010). Técnica y táctica en judo: Una revisión [Technique and tactics in judo: a review]. *Revista de Artes Marciales Asiáticas*, *5*, 427–431.

Nevill, A., Atkinson, G., & Hughes, M. (2008). Twenty-five years of sport performance research in the Journal of Sports Sciences. *Journal of Sports Sciences*, *26*, 413–426.

Nilsson, J., Csergö, S., Gullstrand, L., Tveit, P., & Refsnes, P.E. (2002). Work-time profile, blood lactate concentration and rating of perceived exertion in the 1998 Greco-Roman Wrestling Championship. *Journal of Sports Sciences*, *20*, 939–945.

Santos, V.G.F., Franchini, E., & Lima-Silva, A.E. (2011). Relationship between attack and skipping in taekwondo contests. *Journal of Strength and Conditioning Research*, *25*, 1743–1751.

Sikorski, W., Mickiewicz, G., Majle, B., & Laksa, C. (1987). Structure of the contest and work capacity of the judoist. Institute of Sport, Department of Theory of Sport, Department of Physiology, Data Base Center, and Polish Judo Association, 59–65.

Sim, J., & Wright, C.C. (2005). The kappa statistic in reliability studies: Use, interpretation, and sample size requirements. *Physical Therapy*, *85*, 257–268.

Sirotic, A.C., Coutts, A.J., Knowles, H., & Catterick, C. (2009). A comparison of match demands between elite and semi-elite rugby league competition. *Journal of Sports Sciences*, *27*(3), 203–211.

Taylor, J.B., Mallalieu, S.D., James, N., & Shearer, D.A. (2008). The influence of match location, quality of opposition, and match status on technical performance in professional association football. *Journal of Sport Sciences*, *26*, 885–895.

Terbizan, D., & Seljevold, P.J. (1996). Physiological profile of age-group wrestlers. *Journal of Sports Medicine and Physical Fitness*, *36*(3), 178–185.

Van Malderen, K., Jacobs, C., Ramon, K., Zinzen, E., Deriemaeker, P., & Clarys, P. (2006). Time and technique analysis of a judo fight: a comparison between males and females. In: H. Hoppeler, T. Reilly, E. Tsolakidis, L. Gfeller & S. Klossner et al. (Eds.), *Book of abstracts of the 11th annual congress of the European College of Sport Science* (p. 101). Lausanne: University of Bern.

Vecchio, F.B.D., Hirata S.M., & Franchini, E. (2011). A review of time-motion analysis and combat development in mixed martial arts matches at regional level tournaments. *Perceptual Motor Skills*, *112*, 639–648.