
# The temporal structure of judo in visually impaired men and women

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| Journal: | *Journal of Sports Sciences* |
| Manuscript ID: | RJSP-2010-0492 |
| Manuscript Type: | Original Manuscript |
| Keywords: | Observation of judo, Visually impaired, T-patterns |
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## ABSTRACT

The aim of this study was to determine the temporal structure of judo in visually impaired men and women ($n$ = 117; 92 men and 25 women). We developed a data recording system based on the temporal parameters of judo and applied it to a broad sample of international bouts ($n$ = 219; 184 between men and 35 between women). The descriptive analysis of frequency of occurrence revealed that most of the bouts ended before the time-up bell sounded (81% men/74% women). Other defining features are shown in the following mean values (for men/women): the total bout time was 266/242 s; the total time paused was 158/172 s; the total time spent in standing combat was 82/54 s ($p$ = .008), while that of floor combat was 60/84 s ($p$ = .021); each bout had 6.88/5.66 paused sequences with a duration of 19.65/21.11 s, and 12.39/11.69 active sequences with a duration of 21.99/19.68 s. The sequential analysis by means of T-patterns (THEME) confirmed that the temporal structure of judo is not the same for men and women, thereby highlighting the need for a range of training methods matched to the needs of visually impaired competitors.


***Key words***: Observation, judo, visually impaired, T-patterns.

## INTRODUCTION

Over the last decade numerous studies have sought to understand sport performance in terms of physiological parameters (Drust, 2010; Nevill, Atkinson & Hughes, 2008; Pyne, Mujika & Reilly, 2009). One thing that has become apparent from such research is that the behaviour of physiological variables ($VO_2$ max, maximum isometric force, etc.) is much easier to isolate and quantify in individual sports (cycling, rowing, athletics, etc.), in contrast to the multifaceted nature of the physiological demands, training and performance that are characteristic of team and combat sports (Mujika, 2007). However, new approaches based on an understanding of temporal structure and consideration of the time factor with respect to a given action have enabled researchers to model the performance demands of team sports (Lonsdale & Tam, 2008; Platanou & Geladas, 2006), individual sports (Cabello & González-Badillo, 2003; Christmass, Richmond, Cable, Arthur & Hartmann, 1998) and combat sports (Sanderson, 1983). By their very nature, combat sports feature a number of parameters that were not readily addressed by traditional research, and it was this which gave rise to the new trend: quantification of the work done during combat by means of videographic analysis of its temporal structure (Jackson, 2003; Spencer et al., 2004; Tan, Polglaze & Dawson, 2009). This type of study, which takes the time factor into account, has enabled researchers to establish the most suitable training load for each individual sportsman or woman.

Although research into judo has suffered from a number of important methodological drawbacks, several researchers have sought to apply the abovementioned modelling approach (Artioli et al., 2010; Degoutte, Jouanel & Filaire, 2003; Umeda et al., 2008). The internal logic of a judo bout can be understood by considering the temporal variable

and how it determines and defines the type of work required and its distribution (work time/pause time). Indeed, work is not continuous because the actions of the judokas are generally followed by pauses during which they return to their starting position. Therefore, there is a series of variables that reveal the internal logic of the judo bout (Castarlenas & Planas, 1997), specifically: the number of pauses produced during the bout, the duration of these pauses, how long the bout continues without interruptions, the real distribution of the five minutes of the bout, and the time spent in standing as opposed to floor combat, etc.

The results of the abovementioned studies were obtained from judokas without any sensory deficits, and research has yet to address the dynamics of judo bouts involving judokas with some form of impairment. Consequently, the present study sought to determine the temporal structure of judo bouts involving visually impaired men and women. Specifically, the aim was to demonstrate the need for a range of training methods when working with visually impaired sportsmen and women, as well as the utmost importance of adapting the training load to their specific characteristics.

## METHOD

The study used observational methodology (Anguera & Jonsson, 2003), an approach which offers the rigor and flexibility required to elucidate the temporal characteristics of judo bouts involving visually impaired people. In accordance with Borrie, Jonsson and Magnusson (2001, 2002), the type of observation conducted can be said to be systematic, open and non-participant.

### *Design*

The observational design (Anguera, Blanco-Villaseñor & Losada, 2001) is nomothetic (various participants/bouts), based on within-session monitoring (of the behaviours engaged in throughout the judo bout), and multidimensional (the dimensions correspond to the criteria of the observation instrument). On the basis of this N-M-M (nomothetic-monitoring-multidimensional) design it is possible to derive a series of decisions about the participants, the observation and recording instruments, and the procedure of analysis.

### *Participants*

Participants were visually impaired judokas (B1, B2 and B3) who had taken part in international competition ($n$ = 117; 92 men and 25 women). Given that the unit of analysis of this study is the judo bout it should be noted that a total of 219 bouts were analysed ($n$ = 219; 184 between men and 35 between women). The International Blind Sports Federation (IBSA) gave its consent for all the bouts to be filmed and the study was approved by the Research Ethics Committee of the University of Vigo

The bouts were filmed in the competitive arena, without interruptions and from start to finish. Data were collected by means of two digital video cameras (JVC GZ-MG21E). The recordings of the different bouts were then edited using the video editing software Pinnacle Studio v. 12.

### *Observation instrument*

The observation instrument used in this study, the *Observed Temporal System for Judo Combat* (OTSJUDO), combines field formats with category systems and was developed

by creating a system of exhaustive and mutually exclusive categories for each temporal criterion (Fernández, Camerino, Anguera & Jonsson, 2009; Jonsson et al., 2006). The OTSJUDO (see Table 1) is consistent with the proposed observational design, it being multidimensional and based on the following criteria structure: Combat Start-End and Combat Parameters. Each of these criteria comprises a series of categories that fulfil the requirements of exhaustiveness and mutual exclusivity (E/ME). The first criterion gives rise to two categories designated Combat Start (CS) and Combat End (CE), while the second criterion consists of three categories referred to as First Pause Sequence (PSQ1), First Work Sequence in Standing Combat (WSQS1) and First Work Sequence in Floor Combat (WSQF1), which will increase in number up to the maximum number of sequences that appear in a given bout (PSQ2, WSQS2 and WSQF2; PSQ3, WSQS3 and WSQF3, and so on).

Table 1 near here

***Recording instrument***

The recording instrument used for the observation was the software package *Match Vision Studio Premium v. 1.0* (Castellano, Perea, Alday & Hernández-Mendo, 2008). This is an interactive multimedia program that enables the user to visualise and register digitalised video recordings on the same computer screen (see figure 1). The program is highly flexible and allowed us to introduce all the codes corresponding to the criteria and categories (see Table 1), which in turn correspond to the succession and sequentiality of the start and end of each of the actions involving standing and floor combat.

Figure 1 near here

***Procedure***

After recording the 219 judo bouts we obtained an Excel file containing a range of data, whose duration was established in frames (25 frames is equivalent to 1 s). From these data it was possible to calculate the different sequential and temporal parameters that comprise the temporal structure of judo involving visually impaired men and women. These parameters were as follows (see table 2):

- Total Times for the Judo Bouts Studied:
  - Total Bout Time (TBT).
  - Total Pause Time (TPT).
  - Total Work Time (TWT): Total Work Time in Standing Combat (TWTS) and Total Work Time in Floor Combat (TWTF).
- Number of Sequences (seq.):
  - Number of Pause Sequences (PSQ).
  - Total Number of Work Sequences (WSQ): Number of Work Sequences in Standing Combat (WSQS) and Number of Work Sequences in Floor Combat (WSQF).
- Sequence Times:
  - Pause Sequence Time (PSQT).
  - Work Sequence Time (WSQT): Work Sequence Time in Standing Combat (WSQTS) and Work Sequence Time in Floor Combat (WSQTF).

Table 2 near here

The quality of the data produced by the two observers was assessed by means of the SDIS-GSEG program (v 5.0 for Windows; Bakeman & Quera, 1992, 2001), as well as by calculating the corresponding kappa value (Cohen, 1968), which was above 0.8

The objective of the descriptive analysis was to reveal the occurrence of the abovementioned parameters and the relationship between variables. The SPSS software package (Version 15 for Windows, SPSS Inc., USA) was used to present descriptive statistics (mean ± SD) and to perform chi-square tests of the relationship between variables (Brace, Kemp & Snelgar, 2003). Statistical significance was set at $P < 0.05$ for all analyses.

In order to conduct the sequential analysis the Excel files were exported to the THEME software (Magnusson, 1996, 2000, 2005) in order to detect any temporal patterns (T-patterns). T-patterns, which were obtained by means of the algorithm incorporated within THEME v.5 (Magnusson, 2000), can help to reveal hidden structures and unobservable aspects of judo. Specifically, they enabled us to identify and determine the sequential and temporal structure of the judo bouts involving visually impaired sportsmen and women. The application of this software has proved to be highly effective for studying team sports (Borrie, Jonsson & Magnusson, 2002), individual sports (Louro et al., 2010) and combat sports (Gutiérrez, Prieto & Cancela, 2009).

## RESULTS

The results show the different temporal structures that appear in the judo bouts studied.

### *Time limit of bouts*

Of the 219 bouts analysed only a minority lasted the full five minutes allowed: 34 bouts (19%) involving male judokas and 9 (26%) between female judokas. Hence, the majority of bouts ended before the time-up bell: 150 (81%) bouts involving men and 26 (74%) between women (see table 3). The statistical analysis indicated no significant differences between men and women in this regard ($\chi^2 = 0.976$, $p = .323$).

Table 3 near here

### *Sequential and temporal parameters of judo bouts*

The values displayed in Table 4 show that the mean total duration of bouts including pauses (TBT) was 266 s for men and 242 s for women. If we subtract the total pause time (TPT, means of 158 s for men and 172 s for women) then the mean total work time (TWT) is 130 s for men and 119 s for women. It can therefore be deduced that of the total bout time the proportion of actual combat time is only 45.14% for men and 40.90% for women.

With respect to the total work time (TWT), a further distinction can be made between the total work time in standing combat (TWTS) and the total work time in floor combat (TWTF), which have mean values of 82 s (men)/54 s (women) and 60 s (men)/84 s (women), respectively. Therefore, 57.74% (men)/39.13% (women) of the work time corresponds to standing combat and 42.25% (men)/60.87% (women) to floor combat.

In order to determine whether there were any significant differences between men and women as regards the total times obtained, a *t* test for independent samples was applied to the results in Table 4. It can be seen that there were significant differences between men and women as regards the total time spent in standing combat (TWTS) and floor combat (TWTF).

Table 4 near here

As regards the number and duration of the sequences produced throughout the bouts the results showed a mean number of 12.39 (men) and 11.69 (women) work sequences (WSQ), with a mean duration (WSQT) of 21.99 s (men) and 19.68 s (women). The breakdown of these figures shows that 7.88 (men) and 6.66 (women) sequences corresponded to standing combat, with a mean duration (WSQTS) of 11.66 s (men) and 7.84 s (women), while for floor combat there were 4.46 (men) and 5.03 (women) sequences with a mean duration (WSQTF) of 12.93 s (men) and 15.34 s (women). In terms of pauses the mean number of pause sequences (PSQ) was 6.88 (men) and 5.66 (women), with a mean duration (PSQT) of 19.65 s (men) and 21.11 s (women).

The statistical analysis of the number of sequences obtained (PSQ, WSQ, WSQS and WSQF) and their corresponding times (PSQT, WSQT, WSQTS and WSQTF) revealed no significant differences between men and women for the majority of temporal parameters. Specifically, there was only a significant gender difference for the work sequence time in standing combat (WSQTS).

***Detecting temporal patterns***

Having identified the different temporal parameters that comprise judo bouts with visually impaired competitors, and prior to determining the temporal structure of such bouts, it is necessary to establish the exact distribution of these parameters across a bout, in other words, to describe their sequential structure. This can be done by interpreting the T-patterns that are derived from the THEME 5.0 software (Magnusson, 1996, 2000) and represented in the form of dendograms (see Figures 2 and 3). These dendograms show the relationship between different configurations of actions formed by concurrent codes, where the temporal distance between them is not the result of chance but, rather, falls within the critical interval of their occurrence (Anguera, 2005).

Figure 1 and 2 near here

Figures 2 and 3 show (from top to bottom) the exact sequence of a judo bout for visually impaired men and women, respectively.

**DISCUSSION**

Once analysed, the above results (descriptive statistics and T-patterns) can be used to define a 'representative' temporal structure (see Table 5) for judo bouts involving visually impaired men and women, which in turn constitutes a new tool that professional performance coaches could use to develop precise and appropriate training regimes for such competitors. The representative temporal structure was developed by taking into account the following parameters: *Temporal* (the TBT, the TWT [distinguishing between the TWTS and the TWTF], the TPT, the WSQT [distinguishing between the WSQTS and the WSQTF], and the PSQT) and *Sequential* (the number and distribution of the WSQ

[distinguishing between the WSQS and WSQF] and the PSQ).

Table 5 near here

In this study 81% (men) and 74% (women) of the judo bouts involving visually impaired sportsmen and women ended before the time-up bell. These data are consistent with those of Carmeni (1997), who reported that 81.5% of judo bouts between visually impaired men ended before the regulation five minutes of combat. Comparison of the data obtained from visually impaired judokas for this variable with those from visually able competitors reveals a wide range of findings. In some cases (Sáenz, Clavel, Dopico & Iglesias, 2002) there are barely any differences, with 78.58% of bouts involving visually able men ending before the full five minutes allowed. By contrast, the study by Castarlenas and Planas (1997) reported marked differences: 42% in visually able men vs. 81% and 74% in visually impaired men and women, respectively.

With respect to the total bout time (TBT) for visually able men, research consistently reports a figure of around seven minutes (Castarlenas & Planas, 1997; Degoutte, Jouanel & Filaire, 2003), which differs considerably from the 4 min 26 s observed here for visually impaired men. This difference is less marked among women, with reported values of 5 min 32 s in visually able female judokas (Sterkowicz, 1998) vs. the 4 min 2 s obtained in the present study with visually impaired women.

The total work time (TWT) reported for visually able judokas is very similar (around

three minutes) for both genders (Castarlenas & Planas, 1997; Sterkowicz, 1998), this being considerably longer than the figures obtained here for visually impaired men (2 min 10 s) and women (1 min 59 s). These differences illustrate that the actual combat time for visually impaired women is around 30% less than that for their visually able counterparts.

The total pause time (TPT) in judo with visually able men varies, ranging from the 1 min 41 s reported by Castarlenas and Planas (1997) to the 2 min 18 s of Sáenz et al. (2002). At all events, the highest values are those obtained in the present study, which found total pause times of 2 min 38 s and 2 min 52 s for visually impaired men and women, respectively. In fact, comparison of bouts involving visually able judokas with those between visually impaired men and women reveals a number of marked differences. As regards the TBT for visually able judokas, between 63% and 68.5% corresponds to actual combat (between 37% and 31.5% accounted for by pauses), and in all cases the work time is superior to the pause time. By contrast, with visually impaired judokas the pause time (54.86% men/59.10% women) is greater than the actual combat time (45.14% men /40.90% women), thereby highlighting the differences between visually able and impaired competitors.

With respect to standing and floor work (TWTS and TWTF, respectively) in visually able male judokas, Castarlenas and Planas (1997) reported that around 70% of the time was spent standing, with the remainder corresponding to floor work. These data reveal clear differences between visually able and impaired judokas, with the most marked differences being for women: the present study found a TWTS of 39.13% and a TWTF of 60.87% for

visually impaired women.

One aspect in which there are clearly no differences between visually able and impaired male judokas is the sequential parameters themselves, with around 7 PSQ and 8 WSQS in both previous research (Castarlenas & Planas, 1997) and the present study. The greatest differences are observed for the WSQF, with reported values of 2.98 in visually able men (Castarlenas & Planas, 1997) and 4.46/5.03 (men/women) in our visually impaired sportsmen and women.

The work sequence time (WSQT) for judo involving visually able men ranges widely from the 18 s reported by Castarlenas and Planas (1997) to the 27.87 s of Ribeiro, Vecchio, Carratalá and De Oliveira (2004). The results obtained here with visually impaired men and women (21.99 s and 19.68 s, respectively) are in line with these figures.

If we focus specifically on the work sequence time in standing combat (WSQTS) the variation among visually able judokas is less than for the WSQT as a whole: the highest reported value of WSQTS is 17 s (Castarlenas & Planas, 1997) and the lowest 11.54 s (Sáenz et al., 2002). Comparing these figures with the present results in visually impaired judokas we can see that the WSQTS (11.66 s in men/7.84 s in women) is considerably lower than that reported by Castarlenas and Planas (1997), although the figure for visually impaired men is very similar to that described by Sáenz et al. (2002).

The work sequence time in floor combat (WSQTF) for judo involving visually able men is again fairly heterogeneous, with reported figures of 7.38 s (Sáenz et al., 2002), 11.54 s (Ribeiro et al., 2004) and 18 s (Castarlenas & Planas, 1997). The present results for visually impaired men and women (12.93 s and 15.34 s, respectively) are in line with these figures.

Finally, with respect to the pause sequence time (PSQT) for judo involving visually able men, previous studies are relatively consistent and report values of 12 s (Castarlenas & Planas, 1997), 8.99 s (Sáenz et al., 2002) and 7.18 s (Ribeiro et al., 2004). In comparison, the PSQT obtained here for visually impaired men and women (19.65 s and 21.11 s, respectively) are much higher.

## CONCLUSIONS

The results of this study suggest that judo coaches will need to reconsider their training methods, since the temporal structure of judo bouts involving visually impaired judokas is not the same as that for their visually able counterparts. Specifically, there are differences in the work time spent in standing combat (TWTS), which is greater among visually able sportsmen and women, and the total pause time (TPT), which is considerably longer for visually impaired judokas. Visually impaired women also spend longer engaged in floor combat (TWTF).

The majority of judo bouts involving visually impaired men and women end before the maximum of five minutes combat allowed by the rules, there being no gender differences

in this regard. However, there are differences in the behaviour of visually impaired judokas that imply the need for different training approaches in men and women. Specifically, the results of the present study show significant gender differences in the total work time in floor combat (TWTF), which was considerably longer among women, the total work time in standing combat (TWTS), which was greater for men, and the work sequence time in standing combat (WSQTS), which was also longer among men.

The present study has examined the sequential and temporal parameters of judo bouts. This kind of analysis constitutes a tool that could help professional performance coaches to develop precise and appropriate training regimes that are adapted to the needs of visually impaired sportsmen and women.

***Authors' Note***

We gratefully acknowledge the support of the Spanish government project *Avances tecnológicos y metodológicos en la automatización de estudios observacionales en deporte* (Dirección General de Investigación, Ministerio de Ciencia e Innovación), Grant PSI2008-01179. Correspondence concerning this article should be addressed to O. Camerino, INEFC Lleida, University of Lleida, Lleida, Spain (e-mail: ocamerino@inefc.udl.cat).

We are grateful to all the judokas who took part in this study, and would also like to thank the International Blind Sports Federation (IBSA) and the Spanish Blind Sports Federation (FEDC) for allowing us to record the bouts.

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**Table 1.** The observation instrument OTSJUDO.

| Combat Start-End | Combat parameters | | |
|---|---|---|---|
| Combat Start (CS) | First Pause Sequence (PSQ1) | First Work Sequence in Standing Combat (WSQS1) | First Work Sequence in Floor Combat (WSQF1) |
| Combat End (CE) | Second Pause Sequence (PSQ2) | Second Work Sequence in Standing Combat (WSQS2) | Second Work Sequence in Floor Combat (WSQF2) |
| | | As before | |
| | | As before | |
| | And so on, up to the maximum number reached during a given bout (Pause, Standing Combat and Floor Combat) | | |

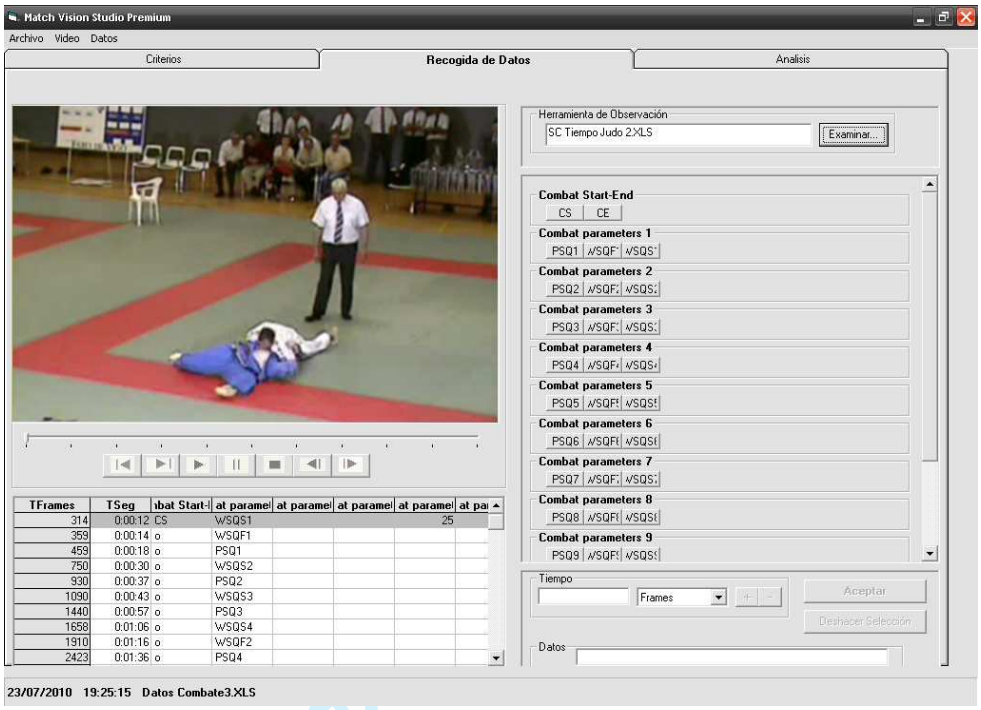


**Figure 1.** The recording instrument Match Vision Studio Premium v. 1.0.

**Table 2.** Sequential and temporal parameter of judo.

| TBT | | | Number of Sequences | | | Sequence Times | | |
|---|---|---|---|---|---|---|---|---|
| TPT | TWT | | PSQ | WSQ | | PSQT | WSQT | |
| | TWTS | TWTF | | WSQS | WSQF | | WSQTS | WSQTF |

**Table 3.** End points of bouts involving visually impaired male and female judokas.

| | Full 5 min of combat | < 5 min of combat | Total number of combats |
|---|---|---|---|
| ***Men (nº)*** | 34 (19%) | 150 (81%) | 184 |
| ***Women (nº)*** | 9 (26%) | 26 (74%) | 35 |
| ***Total*** | 43 | 176 | 219 |

**Table 4.** Values (means, *t* test and significance (p)) obtained for the sequential and temporal parameters studied in judo bouts involving visually impaired sportsmen and women.

| | ***TBT*** | ***TPT*** | ***TWT*** | ***TWTS*** | ***TWTF*** |
|---|---|---|---|---|---|
| ***Men (s)*** | 266 | 158 | 130 | 82 | 60 |
| ***Women (s)*** | 242 | 172 | 119 | 54 | 84 |
| ***t*** | 0.539 | -0.460 | 0.583 | 2.736 | -2.330 |
| ***p*** | .590 | .646 | .561 | ***.008*** | ***.021*** |
| | ***PSQ*** | ***WSQ*** | ***WSQS*** | ***WSQF*** | |
| ***Men (seq.)*** | 6.88 | 12.39 | 7.88 | 4.46 | |
| ***Women (seq.)*** | 5.66 | 11.69 | 6.66 | 5.03 | |
| ***t*** | 0.930 | 0.330 | 0.931 | -0.634 | |
| ***p*** | .354 | .741 | .353 | .527 | |
| | ***PSQT*** | ***WSQT*** | ***WSQTS*** | ***WSQTF*** | |
| ***Men (s)*** | 19.65 | 21.99 | 11.66 | 12.93 | |
| ***Women (s)*** | 21.11 | 19.68 | 7.84 | 15.34 | |
| ***t*** | -0.936 | 1.207 | 4.915 | -1.382 | |
| ***p*** | .350 | .229 | ***.001*** | .169 | |

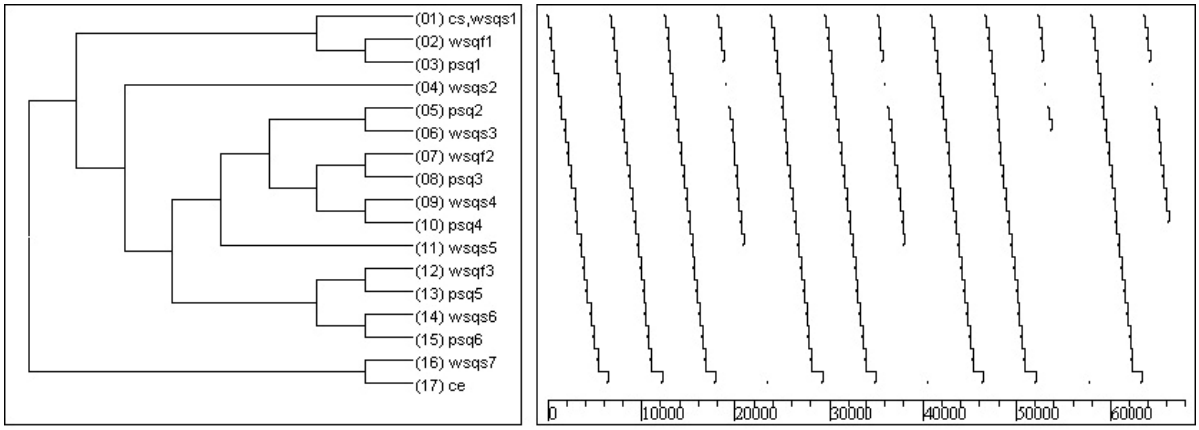


**Figure 2.** Dendogram representing the sequential structure of a T-pattern for judo with visually impaired men.

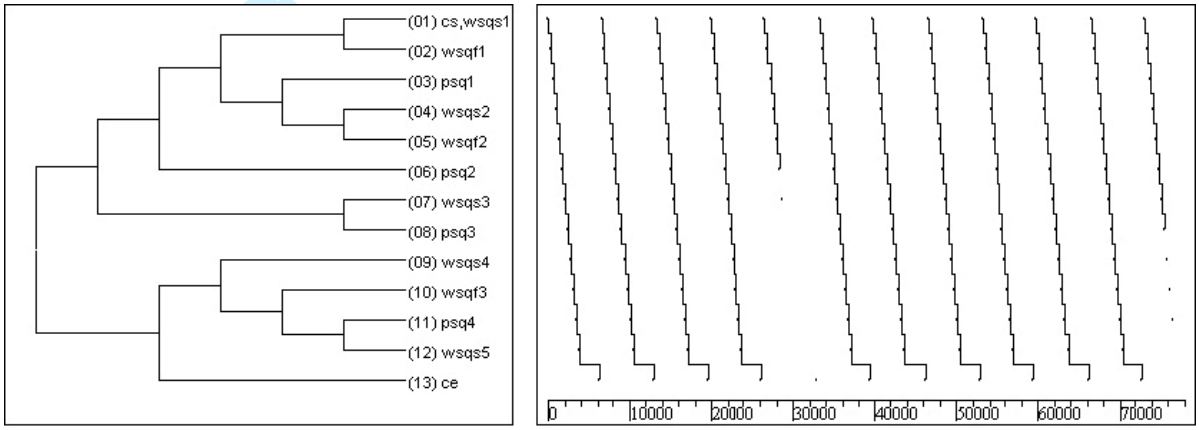


**Figure 3.** Dendogram representing the sequential structure of a T-pattern for judo with visually impaired women.

**Table 5.** Representative temporal structure for judo involving visually impaired sportsmen and women.

| *Women* | *Men* | Mean values |
|---|---|---|
| | | **Sequences—women:** 12 WSQ: 7 WSQS and 5 WSQF 6 PSQ |
| **Combat Start** | **Combat Start** | **Sequences—men:** 12 WSQ: 8 WSQS and 4 WSQF 7 PSQ |
| 1ª WSQS | 1ª WSQS | **Time—women:** TBT 4 min 2 s/bout |
| 1ª WSQF | 1ª WSQF | TWT: 1 min 59 s/bout |
| 1ª PSQ | 1ª PSQ | TWTS: 54 s/bout |
| 2ª WSQS | 2ª WSQS | *TWTF: 1 min 24 s/bout* |
| 2ª WSQF | 2ª PSQ | TPT: 2 min 52 s/bout |
| 2ª PSQ | 3ª WSQS | **Time—men:** TBT 4 min 26 s/bout |
| 3ª WSQS | 2ª WSQF | TWT: 2 min 10 s/bout |
| 3ª PSQ | 3ª PSQ | *TWTS: 1 min 22 s/bout* |
| 4ª WSQS | 4ª WSQS | TWTF: 60 s/bout |
| 3ª WSQF | 4ª PSQ | TPT: 2 min 38 s/bout |
| 4ª PSQ | 5ª WSQS | **Sequence duration—women:** |
| 5ª WSQS | 3ª WSQF | WSQT: 19.68 s/seq. |
| 4ª WSQF | 5ª PSQ | WSQTS: 7.84 s/seq. |
| 5ª PSQ | 6ª WSQS | WSQTF: 15.34 s/seq. |
| 6ª WSQS | 6ª PSQ | PSQT: 21.11 s/seq. |
| 5ª WSQF | 7ª WSQS | **Sequence duration—men:** |
| 6ª PSQ | 4ª WSQF | WSQT: 22 s/seq. |
| 7ª WSQS | 7ª PSQ | *WSQTS: 11.66 s/seq.* |
| **Combat End** | 8ª WSQS | WSQTF: 12.93 s/seq. |
| | **Combat End** | PSQT: 19.65 s/seq. |