universidad de león

Revista de Artes Marciales Asiáticas
Volume *19*(2), 151-170 ~ July-December 2024
DOI: 10.18002/rama.v19i1.2413
http://revpubli.unileon.es/ojs/index.php/artesmarciales

RAMA
I.S.S.N. 2174-0747

Events and event records (scoring and penalties) across temporal units in elite judo contests: implications for tactical preparation

Xurxo DOPICO-CALVO[1], Luis SANTOS[2], Eduardo CARBALLEIRA[*1], Xián MAYO[1,3], Bayram CEYLAN[4], Jozef SIMENKO[5], Marta SEVILLA-SÁNCHEZ[1], & Eliseo IGLESIAS-SOLER[1]

[1] *Performance and Health Group, Department of Physical Education and Sport, Universidade da Coruña (Spain)*

[2] *Department of Physical Education and Sport, Universidad de León (Spain)*

[3] *Observatory of Healthy and Active Living of Spain Active Foundation, Centre for Sport Studies, Universidad Rey Juan Carlos (Spain)*

[4] *Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University (Turkey)*

[5] *Faculty of Sport, University of Ljubljana (Slovenia)*

Received: 20/02/2024; Accepted: 01/11/2024; Published: 03/11/2024

CC BY NC SA

ORIGINAL PAPER

Abstract

Introduction: This study examines the distribution of events and event records (EVRs) in elite judo competitions, encompassing both male and female categories. *Sample:* By analyzing data from the 2018, 2019, and 2021 World Championships, the study incorporates 6487 events (EVs) and 2340 contests classified by their last event (cEV). *Results:* The predominant occurrence of EV2 and EV3 in male (23.2% and 36.6%) and female (26.8% and 31.7%) contests suggests consistent patterns. Statistical analyses reveal non-uniform distributions of events within temporal units (TUs). Small associations were found between EVRs and TUs for EV1, EV2 and EV3 (Cramer's V = 0.103 to 0.171; p<0.001), while moderate associations were observed for EV4 (Cramer's V = 0.260 to 0.271; p<0.001) with no associations detected for EV5 and EV6, in both sexes. Female contests generally feature fewer events, concentrated within the same TU, indicating shorter durations compared to males. The study emphasizes the association between the occurrence of EVRs and the moment they occur, demonstrating similar patterns across sexes. Waza-ari was significantly overrepresented in the TU1 for both males and females (SR = 2.1 and 2.2, respectively). In contrast, Ippon was overrepresented in the Golden Score (TU-GS) period (SR = 3.3) for males. Notably, cEV1, cEV2, and cEV3 exhibit timing variations between male and female categories, while cEV4 share equivalent timing. *Conclusion:* This research provides comprehensive insights into the dynamics of elite judo contests, informing professionals on the nuanced strategies needed for male and female judo athletes. The observed tendency of athletes to adopt an offensive approach at the beginning of contests, focusing on throws or body controls in groundwork over penalizations, adds a valuable layer to understanding the competitive dynamics in judo.

Keywords: Martial arts; combat sports; judo; penalty; score; performance analysis; tactic.

Eventos y tipo de eventos (puntuaciones y penalizaciones) en las unidades temporales de competiciones de judo de élite: implicaciones para la preparación táctica

Resumen

Introducción: Este estudio examina la distribución de eventos y tipos de eventos (EVRs) en competiciones de judo de élite en categoría masculina y femenina. *Muestra:* Se analizaron los Campeonatos Mundiales de 2018, 2019

Eventos e tipos de eventos (pontuações e penalizações) nas unidades temporais das competições de judô de elite: implicações para a preparação tática

Resumo

Introdução: Este estudo examina a distribuição de eventos e tipos de eventos (EVRs) em competições de judô de elite, tanto na categoria masculina quanto feminina. *Amostra:* Foram analisados os Campeonatos

[*] *Corresponding author*: Eduardo Carballeira (eduardo.carballeira@udc.es)

Contributions: Xurxo Dopico-Calvo (ABCEFGIJKMN), Luis Santos (BCEFIMN), Eduardo Carballeira (ABCEFIJKLMN), Xián Mayo (BCEFN), Bayram Ceylan (EFKN), Jožef Simenko (EFKN), Marta Sevilla-Sánchez (EFKN), Eliseo Iglesias-Soler (ACEFKN). Codes according to CRediT (Contributor Roles Taxonomy): (A) Conceptualization. (B) Data curation. (C) Formal Analysis. (D) Funding acquisition. (E) Investigation. (F) Methodology. (G) Project administration. (H) Resources. (I) Software. (J) Supervision. (K) Validation. (L) Visualization. (M) Writing – original draft. (N) Writing – review & editing.

Funding: The authors received no funding for this work.

Conflicts of interest: The authors report there are no competing interests to declare.

© 2024 by the authors. Licensee Universidad de León, Spain. www.unileon.es

y 2021, incorporando 6487 eventos (EVs) y 2340 combates clasificados por su evento final (cEV). *Resultados:* La predominancia de EV2 y EV3 en combates masculinos (23.2% y 36.6%) y femeninos (26.8% y 31.7%) sugiere patrones consistentes. Los análisis estadísticos revelan distribuciones no uniformes de eventos dentro de unidades temporales (TUs). Se encontraron asociaciones pequeñas entre los EVRs y las UTs para EV1, EV2 y EV3 (Cramer's V = 0.103 a 0.171; p<0.001), mientras que se observaron asociaciones moderadas para EV4 (Cramer's V = 0.260 a 0.271; p<0.001), y no se detectaron asociaciones para EV5 y EV6, tanto en mujeres como en hombres. Los combates de las categorías femeninas generalmente presentan menos eventos, concentrados dentro de la misma TU, indicando duraciones más cortas en comparación con las masculinas. Se observó una asociación entre la ocurrencia de EVRs y el momento en que ocurren, demostrando patrones similares entre sexos. El Waza-ari estuvo significativamente sobrerrepresentado en la UT1 tanto para hombres como para mujeres (SR = 2.1 y 2.2, respectivamente). En contraste, el Ippon estuvo sobrerrepresentado en el periodo de Golden Score (UT-GS) (SR = 3.3) solo para hombres. Especialmente, cEV1, cEV2 y cEV3 muestran variaciones de tiempo entre categorías masculinas y femeninas, mientras que cEV4 se producen en tiempos similares. *Conclusión:* Esta investigación ofrece una visión integral de la dinámica de las competiciones de judo de élite. Esta información es útil para conocer las estrategias utilizadas por los judocas masculinos y femeninos. La tendencia observada de los judocas a adoptar un enfoque ofensivo al principio de los combates, centrándose en proyecciones y controles en el suelo, en comparación con las penalizaciones, supone una valiosa contribución a la comprensión de la dinámica competitiva en el judo.

Palabras clave: Artes marciales; deportes de combate; judo; penalización; puntuación; análisis de rendimiento; táctica.

Mundiais de 2018, 2019 e 2021, incorporando 6487 eventos (EVs) e 2340 combates classificados pelo seu último evento (cEV). *Resultados:* A predominância de EV2 e EV3 em combates masculinos (23,2% e 36,6%) e femininos (26,8% e 31,7%) sugere padrões consistentes. As análises estatísticas revelam distribuições não uniformes de eventos dentro de unidades temporais (TUs). Foram encontradas associações pequenas, mas significativas, entre os EVRs e as UTs para EV1, EV2 e EV3 (Cramer's V = 0.103 a 0.171; p<0.001), enquanto associações moderadas foram observadas para EV4 (Cramer's V = 0.260 a 0.271; p<0.001) em ambos os sexos. Não foram detectadas associações para EV5 e EV6 tanto em mulheres quanto em homens. Os combates das categorias femininas geralmente apresentam menos eventos, concentrados na mesma TU, indicando durações mais curtas em comparação com os masculinos. Observou-se uma associação entre a ocorrência de EVRs e o momento em que ocorrem, demonstrando padrões semelhantes entre os sexos. O Waza-ari esteve significativamente sobrerrepresentado na UT1 tanto para homens quanto para mulheres (SR = 2.1 e 2.2, respectivamente). Em contraste, o Ippon esteve sobrerrepresentado no período de Golden Score (UT-GS) (SR = 3.3) para homens. Especificamente, cEV1, cEV2 e cEV3 mostram variações de tempo entre as categorias masculina e feminina, enquanto cEV4 ocorrem em tempos semelhantes. *Conclusão:* Esta pesquisa fornece uma visão abrangente da dinâmica das competições de judô de elite, sendo esta informação útil para entender as estratégias usadas pelos judocas masculinos e femininos. A tendência observada dos judocas para adotarem uma abordagem ofensiva no início dos combates, focando em projeções ou controles corporais no chão em comparação com as penalizações, é uma contribuição valiosa para a compreensão da dinâmica competitiva no judô.

Palavras-chave: Artes marciais; desportos de combate; judo; penalização; pontuação; análise de desempenho; tática.

1. Introduction

In contemporary sports, performance analysis has emerged as a fundamental tool used by coaches, athletes, sports organisations and researchers (Agostinho & Franchini, 2021; Kashiwagura et al., 2022; Mayo et al., 2019). The collection and interpretation of performance data enable coaches to refine their training programmes, assist athletes in making more informed tactical decisions, facilitate more effective competition management by sports organisations, and support the development of a deeper understanding of sports performance by researchers (Ko et al., 2022; Kons, Agostinho, Lopes-Silva, et al., 2022; Kons, Agostinho, Santos, et al., 2022; Miarka et al., 2016; Segedi et al., 2014).

In the context of high-level judo, several studies have focused on determinant parameters of scoring actions in standing judo, such as grips, displacement, lateral structure, directions of attacks, throwing area, and attacking type (Camargo et al., 2019; Kashiwagura et al., 2021; Kashiwagura & Franchini, 2022; Mayo et al., 2019). In addition, critical behaviours during groundwork at the international competition level have been investigated (Dopico-Calvo et al., 2022). Since judo athletes can lose a contest by accumulating three penalties, several authors have also studied the distribution of penalties compared to the distribution of scoring actions and their possible effects on them (Balci & Ceylan, 2020; Ceylan et al., 2022; Dopico-Calvo et al., 2023; Franchini et al., 2019; Kons, Agostinho, Lopes-Silva, et al., 2022).

All these elements cited above can be considered performance indicators (PI) (Ramírez-Arroyo et al., 2022). PIs are used to evaluate the performance of a player (or a team) and serve as a

distinguishing factor between winning and losing (Csataljay et al., 2009). Scientific literature has identified two PI types, static and dynamic; being static PI the analysis concerning final game/contest statistics, while dynamic PI analysis aims to explain the dynamics of the game/contest and the relationship between the athlete and their environment (García-Rubio et al., 2013). The main purpose of analyzing dynamic PI is to identify, characterize, and explain the variables with the most significant influence in the most crucial moments of a judo contest (García-Rubio et al., 2015). Among dynamic PI, we highlight two indicators: sex (male and female) and the dynamics in the scoreboard during the contests (Ibáñez et al., 2003; Moreno et al., 2013; Sampaio et al., 2010). Notwithstanding, despite the large quantity of scientific literature on temporal patterns, combat time, scoring actions, penalties, and other performance analyses, we are currently unaware of any study that has comprehensively analysed the dynamics in the scoreboard in both sexes. These dynamic PIs may influence the performance model of a judo contest, potentially encompassing a range of events (EVs) that are associated with specific scoring or penalty records, each of which could have a distinct effect across the temporal units (TUs) within the judo contests.

Temporal distribution of each venue, leading to the alteration of the scoreboard, from now on referred to as EVs within the contest, could facilitate the identification of patterns and trends, thereby providing valuable information to coaches and athletes. This information can improve decision-making, enhance tactical awareness, and refine technical skills (Kröckel & Bodendorf, 2020). In judo competitions, according to the rules established by International Judo Federation rules (IJF, 2023) in 2018, a maximum of six EVs, labeled EV1 to EV6, can be recorded during a contest. In a scenario where all six EVs have occurred, the contest would include up to two shido penalties and one waza-ari for each judoka. The contest continues until a seventh decisive event—such as an *ippon*, a second *waza-ari* resulting in a *waza-ari awasete ippon*, or one judoka receiving a third *shido*—concludes the match, with this final event determining the outcome.

Thus, the primary objectives of the present study were to examine a cohort of elite judo contests and investigate the event-related PIs in male and female athletes, aiming to: (a) explore the distribution of EVs (EV1 to EV6) across the TUs occurring in high-level judo contests; (b) analyse the association between the different types of EVR (i.e., scores or penalties) with the corresponding TU per EV. Furthermore, given the variations in contests duration attributed to differences in the number of EVs, this study also aimed (c) to establish the distribution of EVs across the TU for contests characterized by one unique EV (cEV), as well as those with two, three, four, five and six EVs.

2. Methods

2.1. Study type

The present work is a cross-sectional observational study based on the analysis of male and female judo contests from three World Championships. These contests were conducted following revised competition rules that were implemented in 2018.

2.2. Sample

Competitions analysed were the World Judo Championship of Baku 2018 (WC18, https://www.ijf.org/competition/1591/contests), Tokyo 2019 (WC19, https://www.ijf.org/competition/1751/contests) and Budapest 2021 (WC21, https://www.ijf.org/competition/2239/contests). We initially observed 2370 contests; however, 30 were excluded, leaving a final sample of 2340 contests. The reasons for exclusion were due to failure to appear (*Fusen Gachi*), abandonment or injury (*Kiken Gachi*), and disqualification by the direct way (*Hansoku Make*). Our analysis covered 6487 EVs, comprising 2540 involving females and 3947 males. The study sample included 2244 judo athletes, 901 female and 1343 male; thus, a similar mean ratio of events per female (2.8 events per athlete) and male (2.9 events per athlete) was observed.

2.3. Ethical issues

Deeming that the analysed data were attained from an open-access website in secondary form and not generated by experimentation, there are no ethical issues in examining or interpreting them (Morley & Thomas, 2005). Additionally, the personal identification or nationalities of the athletes whose contests were assessed were not specified.

2.4. Data collection and procedures

We used an *ad-hoc* tool implemented in the Lince PLUS version 1.3.2 program (Soto-Fernández et al., 2022) designed to collect data to cover the purposes of the present study. An EV is defined as every venue that leads to an alteration in the scoreboard. Any change in the scoreboard resulting from an EV is recognized as an EVR, which can take the form of a score (*ippon* or *waza-ari*) or a penalty (*shido*). These EVRs manifest when the judo athletes execute throws or hold on their opponents on the ground following the regulations or when they breach the rules, resulting in being penalized. All the EV, EVR, and TU were considered during WC18, WC19, and WC21.

Regarding the EVR, the nine possibilities of scores and penalties were coded and registered as *ippon* (IPP), *waza-ari* (WAZ), double *waza-ari* (WW), first *shido* (SH1), second *shido* (SH2), third *shido*) (SH3), first *shido*-both (SH-B1), *shido*-both that implies, at least, one-second *shido* for one of the athletes (SH-B2), and *shido*-both that implies the third *shido* for one of the athletes (SH-B-HSK). A detailed description of EV and EVR can be found in Table 1. The events were organized based on their order as the first event (EV1), the second event (EV2), and so on, up to the sixth event (EV6). After assigning labels from EV1 to EV6, we recorded the temporal unit (TU) in which each EV occurred. To accomplish this, we considered five distinct temporal units: 0 to 59 seconds (TU1), 60 to 119 seconds (TU2), 120 to 179 seconds (TU3), 180 to 240 seconds (TU4), and durations greater than 240 seconds (TU-GS). Detailed information about TU can be consulted in Table 1. All the aforementioned variables were collected considering the sex category.

Table 1. Main variables of the study and abbreviations

Concept	Abbreviation	Description
Event	EV	Moment of the contest in which one score, or penalty, is obtained.
	EV1; EV2; EV3; EV4; EV5; EV6	1st event; 2nd event; 3rd event; 4th event; 5th evento; 6th event
Event Record	EVR	The obtained score, or penalty, in each event.
Ippon	IPP	
Waza-ari	WAZ	
Double *waza-ari*	WW	
First *shido*	SH1	
Second *shido*	SH2	
Third *shido*	SH3	
Shido Both	SH-B1	Double *shido*, meaning a first *shido* for both judo athletes.
Second *Shido* Both	SH-B2	Double *shido*, meaning a second *shido* for one or both athletes.
Third *Shido* Both	SH-B-HSK	Double *shido*, meaning a third *shido* and *hansoku-make* for one judo athlete.
Temporal Unit	TU	Temporal structure in secs
	TU1; TU2; TU3; TU4; TU-GS	1st temporal unit. From 0 to 59 s.; 2nd temporal unit. From 60 to 119 s.; 3rd temporal unit. From 120 to 179 s.; 4th temporal unit. From 180 to 240 s.; Extended temporal unit, or Golden score (GS) time (s).
Contests characterised by their last event	cEV	
	cEV1; cEV2; cEV3; cEV4; cEV5; cEV6	Contests with one unique event; Contests with just 2 events; Contests with just 3 events; Contests with just 4 events; Contests with just 5 events; Contests with just 6 events.

2.5. Reliability

The analysis conducted in this study relies on official data provided by referees, and the data collection process did not involve decisions made by researcher observations. As a result, there was no necessity to calculate the agreement between observers.

2.6 Data analysis

Descriptive data are presented in both absolute values and percentages. To analyse the hypothesis of a uniform distribution and assess the over or underrepresentation of (a) the number

of EVs per contest, (b) the total number of EV1, Ev2, EV3, EV4, EV5, and Ev6 per TU, and (c) the distribution of contests characterized by their last EV (cEV: one unique event, cEV1; contest ended at two, cEV2; three, cEv3; four, cEV4; five, cEV5; and six, cEV6) per TU, a one-sample Pearson's chi-squared ($\chi 2$) test was employed. When observer frequencies significantly differed from the expected values, interpretation was made using standardised residuals (SR). Residuals with values greater than 2 or lower than -2 were considered statistically significant. Furthermore, Pearson's chi-squared ($\chi 2$) test of independence was utilized to analyse the association between variables. If a significant association was detected, the interpretation was again conducted by considering SR, where residuals with values greater than 2 or lower than -2 were considered statistically significant. The calculation of SR was accomplished using the following formula:

$$Standardised\ residual = \frac{\text{observed}_{ij} - \text{model}_{ij}}{\sqrt{\text{model}_{ij}}}$$

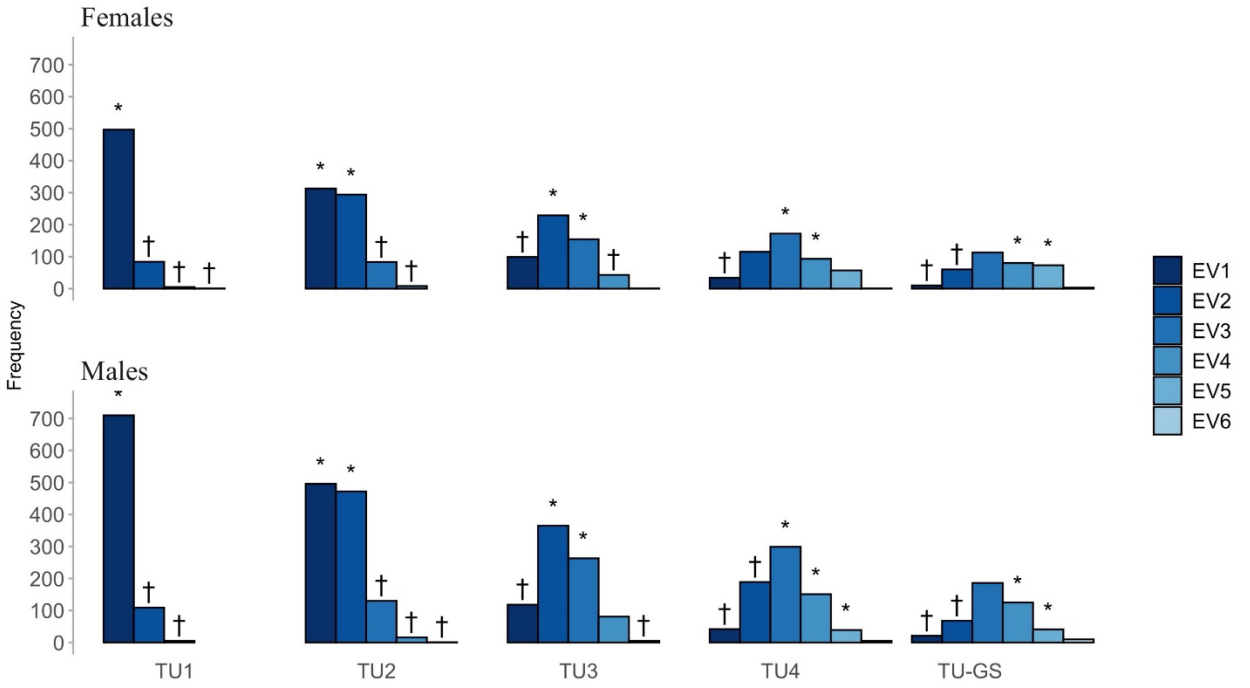
Where "observed" is the frequency corresponding to cell ij (i.e., row i; column j) and "model" is the expected frequency in that cell for independent variables (Field, 2009). The strength of the significant associations was reported as Cramer's V (V). A V value lower than 0.20 was considered a small effect, a value within the range of 0.21–0.35 as a moderate effect, and a value larger than 0.35 as a large effect (Cohen, 1988). All the statistical analyses were executed with SPSS 27 (IBM, Chicago, IL, USA). The level of significance was set at 0.05.

3. Results

3.1. Distribution of the EVs across the TU in males and females

The distribution of the events across the TU for female and male athletes is presented in Figure 1. One sample chi-square goodness of fit test indicated that EV1 to EV5 were not uniformly distributed within the TUs ($p < 0.001$) for both males and females. On the other hand, no significant evidence was found to indicate different proportions of EV6 across the TUs in both male ($p = 0.197$) and female ($p = 0.317$) categories. Nevertheless, it is important to interpret these findings cautiously due to the relatively low frequency of EV6 occurrences in both sex categories. Data regarding frequencies and SR can be consulted in detail in Appendix 1.

Figure 1. Distribution of events (EVs) across the temporal units (TUs) in females and males



Note: TU1, TU2, TU3, TU4, and TU-GS: TU from the first minute to extended time; EV1, EV2, EV3, EV4, EV5, and EV6: EV from first to sixth. (*) Standardised residuals equal to or greater than 2. (†) Standardised residuals equal to or lower than -2.

3.2. Distribution of the contests characterised by their last event (cEV) in males and females

The male category showed the following distribution of cEV (n = 1387): 13.2% were cEV1, 23.2% cEV2, 36.6% cEV3, 20.8% cEV4, 5.1% cEV5, and merely 1.1% were cEV6. A chi-square test demonstrated a non-uniform distribution of cEV in males ($p < 0.001$; $\chi2 = 704.3$), with SR of -3.2, 6.0, 18.2, 3.7, -10.5, and -14.2 for cEV1 to cEV6, respectively.

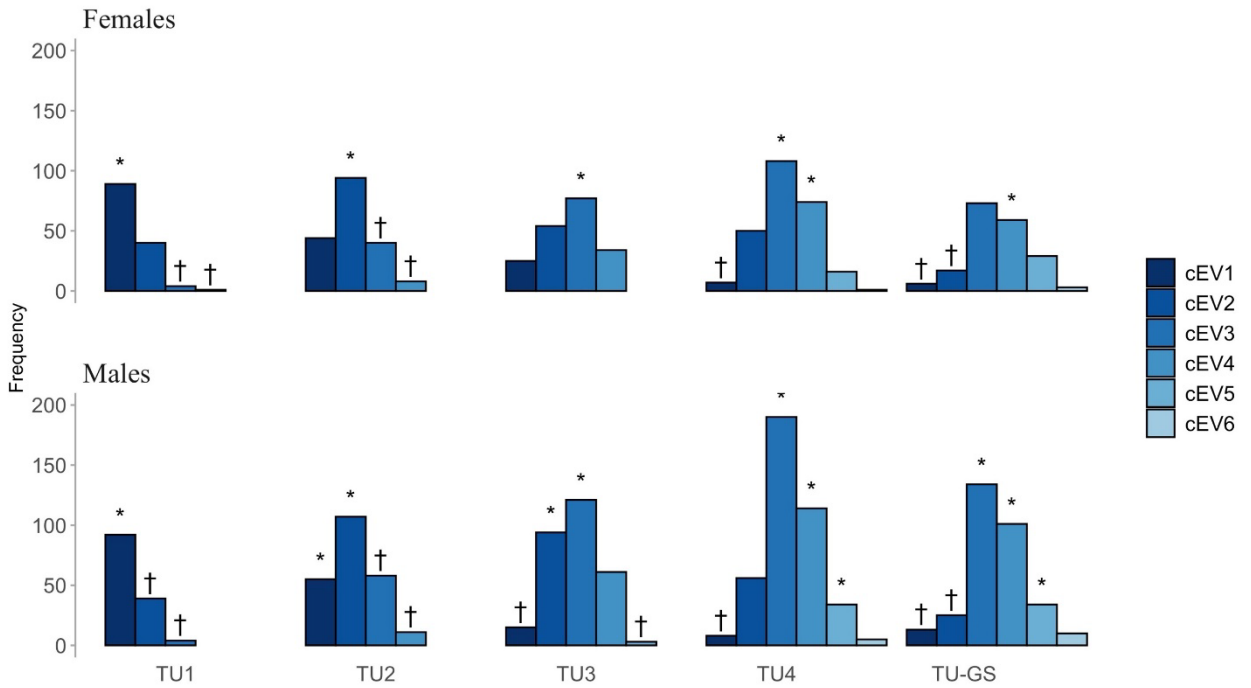
The female category (n = 953) showed the following proportions 17.9%, 26.8%, 31.7%, 18.5%, 4.7%, and 0.4% for cEV1 to cEV6, respectively ($p < 0.001$; $\chi2 = 422.6$; SR = 1.0, 7.6, 11.4, 1.4, -9.0, and -12.2, respectively).

The chi-square test of independence showed a small association between the cEV (cEV1 to cEV6) and sex categories ($p = 0.001$; $V = 0.092$). The cEV1 in females was overrepresented (SR from cEV1 to cEV6 = 2.2, 1.3, -1.5, -0.9, -0.3, and -1.3, respectively); however, males showed a uniform distribution of cEV (SR from cEV1 to cEV6 = -1.9, -1.1, 1.3, 0.8, 0.3, and 1.1, respectively).

3.3. Distribution of the contests characterised by their last event (cEV) across the temporal units (TUs) in males and females

The distribution of 2337 cEV across TUs is shown in Figure 2 for males (n = 1384 events) and females (n = 953 events). The distribution of cEV1 to cEV5 in males and cEV1 to cEV4 in females exhibited non-uniformity across the TUs (Figure 2). Conversely, the results of the Chi-square analysis indicated no significant difference in the distribution of cEV5 ($p = 0.053$) and cEV6 ($p = 0.317$) across TUs in females, as well as cEV6 in males ($p = 0.197$). Data regarding frequencies and SR can be consulted in detail in Appendix 1.

Figure 2. Distribution of contests characterised by their last event (cEV) across the temporal units (TUs) in females and males



Note: TU1, TU2, TU3, TU4, and TU-GS: TU from the first minute to extended time; cEV1, cEV2, cEV3, cEV4, cEV5, and cEV6: cEV from first to sixth. (*) Standardised residuals equal to or greater than 2. (†) Standardised residuals equal to or lower than -2.

3.4. Distribution of the EVRs (i.e., score or penalty) within each TU per EV in males and females

- *First event (EV1): event record (EVR) distribution across temporal units (TUs)*

The distribution of EVRs across TUs for EV1 within the male category (n = 1387 records; Figure 3) showed a small association between variables ($p < 0.001$; $V = 0.103$). Specifically, WAZ was

overrepresented in TU1 and IPP in TU-GS (SR= 2.1 and 3.3, respectively). On the other hand, SH1 was underrepresented in TU1 and SH-B1 in TU3 (SR = -2.0 and -2.1, respectively), indicating that SH1 and SH-B1 occurred less frequently than expected under the assumption of a uniform distribution. The distribution of EVRs across TUs for EV1 within the female category (n=953 records; Figure 4) showed a small association between variables ($p < 0.001$; $V = 0.122$). Specifically, WAZ was overrepresented in TU1 and underrepresented in TU2 (SR=2.2 and -2.3, respectively). Conversely, SH1 was underrepresented in TU1 and overrepresented in TU2 (SR=-2.7 and 2.9, respectively). Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

- *Second event (EV2): event record (EVR) distribution across temporal units (TUs)*

The distribution of EVRs across TUs for EV2 within the male category (n = 1203; Figure 3) showed a small association between variables ($p < 0.001$; $V = 0.122$). Specifically, WW and SH-B1 were overrepresented in TU1 and SH2 in TU-GS; conversely, SH2 was underrepresented in TU1 (SR = 5.3, 3.3, 2.0, and -2.1, respectively). The distribution of the EVRs across TUs for EV2 within the female category (n=782; Figure 4) showed a small association between variables ($p < 0.001$; $V = 0.160$). Specifically, WW was overrepresented in TU1 and SH2 in TU3; conversely, WW was underrepresented in TU-GS (SR = 6.0, 2.4, and -2.5, respectively). Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

- *Third event (EV3 event record (EVR) distribution across temporal units (TUs)*

The distribution of the EVRs across TUs for EV3 within the male category (n = 883; Figure 3) showed a small association between variables ($p < 0.001$; $V = 0.135$). Specifically, WW was overrepresented in TU1, SH-B1 in TU2, and SH3 in TU-GS; conversely, WW and SH2 were underrepresented in TU-GS (SR = 4.1, 2.2, 2.3, -2.1, and -2.0, respectively). The distribution of the EVRs across TUs for EV3 within the female category (n = 527; Figure 4) showed a small association between variables ($p < 0.001$; $V = 0.171$). Specifically, WW was overrepresented in TU2 and SH3 in TU-GS; conversely, WW was underrepresented in TU-GS (SR = 4.0, 2.1, and -3.3, respectively). Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

- *Fourth event (EV4 event record (EVR) distribution across temporal units (TUs)*

The distribution of the EVRs across TUs for EV4 within the male category (n=373; Figure 3) showed a moderate association between variables ($p < 0.001$; $V = 0.271$). Specifically, IPP and WW were overrepresented in TU3, SH2 in TU4, and WAZ and SH3 in TU-GS; conversely, SH3 was underrepresented in TU3 and WW in TU-GS (SR = 2.2, 2.4, 2.2, 3.2, 3.5, -2.1, and -4.0, respectively). An EV4 never occurred in TU1 within the male category. The distribution of the EVRs across TUs for EV4 within the female category (n=225; Figure 4) showed a moderate association between variables ($p < 0.001$; $V = 0.260$). Specifically, IPP was overrepresented in TU1 and TU2, WW in TU2 and TU3, SH1 in TU4 and WAZ in TU-GS; conversely, WW was underrepresented in TU-GS (SR = 2.0, 2.3, 2.0, 2.4, 2.2, 2.0, and -3.1, respectively). There were no SH-B2 penalties in the female category. Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

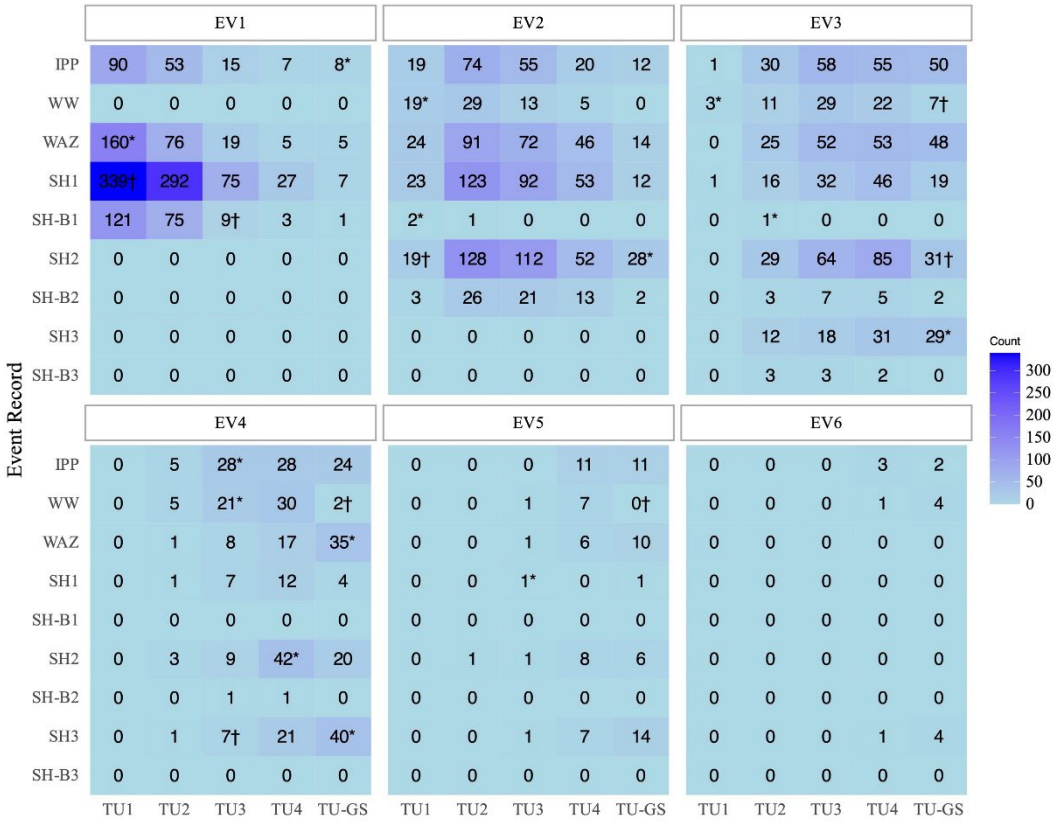
- *Fifth event (EV5): event record (EVR) distribution across temporal units (TUs)*

The distribution of the EVRs across TUs for EV5 within the male category (n=87; Figure 3) and the female category (n=50; Figure 4) showed that EV5 never occurred in TU1, in both categories, and neither did it happen in TU2, in the female category. Chi-square analysis showed no association between variables in both males ($p = 0.057$) and females ($p = 0.055$) categories. Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

- *Sixth event (EV6): event record (EVR) distribution across temporal units (TUs)*

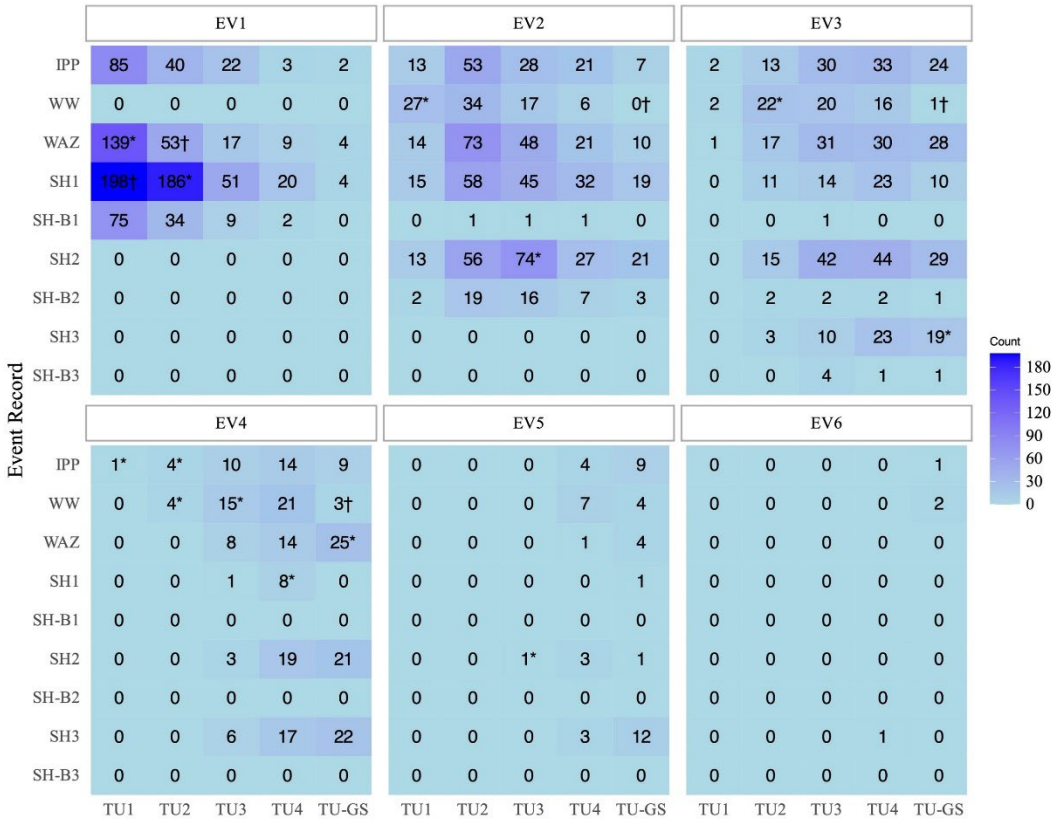
The distribution of the EVRs across TUs in EV6 within the male category (n=15; Figure 3) and the female category (n=4; Figure 4) showed that EV6 never occurred in TU1, TU2, or TU3 in any of the categories. Chi-square analysis showed no association between variables in both males ($p = 0.057$) and females ($p = 0.055$) categories. Data regarding relative frequencies and SR for male and female can be consulted in detail in Appendix 2.

Figure 3. The event records (EVRs) frequencies across temporal units (TUs) for each event (EV) in males



Note: (*) Standardised residuals equal to or greater than 2 are denoted adjacent to the EVR frequency value. (†) Standardised residuals equal to or lower than -2 are denoted adjacent to the EVR frequency value.

Figure 4. The event records (EVRs) frequencies across temporal units (TUs) for each event (EV) in females.



Note: (*) Standardised residuals equal to or greater than 2 are denoted adjacent to the EVR frequency value. (†) Standardised residuals equal to or lower than -2 are denoted adjacent to the EVR frequency value.

4. Discussion

In the present study, the major findings can be summarized as follows: a) A comparable mean ratio of events per athlete was observed between the female (2.8 events per athlete) and male (2.9 events per athlete) categories; b) EV1 to EV5 exhibited a non-uniform distribution across the temporal units for both females and males, although a similar pattern of event occurrence was observed across temporal units in both sexes; c) The occurrence of IPP was observed more than expected in EV4 for both females and males. However, it was noteworthy that IPP occurred earlier in females (TU1 and TU2) compared to males (TU3); d) The occurrence of WAZ was identified to be more frequent during TU1, corresponding to EV1, and during TU-GS, corresponding to EV4, for both females and males; e) WW was observed mainly from TU1 to TU3, corresponding to EV2 to EV4 in both sexes; f) SH2 was received in females during TU3 corresponding to EV2, and in males during TU-GS, corresponding to EV2 and during TU4 corresponding to EV4. However, SH3 was mainly obtained in TU-GS corresponding to EV3 and EV4 for males and to EV3 for females; g) Contests were typically resolved in three to four EVs in females and one to five EVs in males, with a similar proportion of cEV2 (female: 26.8% vs. male: 23.2%) and cEV3 (female: 31.7% vs. male: 36.6%) in both sexes; h) The distribution of cEVs across TU was similar between both sexes, although males took more time to resolve the contest.

The probability that a maximum of six events will occur is given by the rules established by the International Judo Federation (IJF) in 2018 (IJF, 2023). Our study revealed that most of the judo contests are probably decided in EV2 or EV3. However, when analysing the association between cEVs and sex, we found that only cEV1 was overrepresented in female athletes. This suggests that female contests are resolved with fewer events compared to males, indicating less interaction on the scoreboard for females. The underlying reasons for these sex-based differences are not yet fully understood, but it may be possible that the male category exhibits a higher level of competitive homogeneity compared to the female category. Alternatively, as noted by Barreto et al. (2022), the reduction in regular combat time from 5 to 4 minutes for women in 2015, followed by the same change for men in 2017, may explain the quicker resolution of female contests. With women having competed under the shorter time limit for a longer period, the urgency to score earlier may have shaped the dynamics of their contests. This time pressure likely encouraged faster pacing and earlier resolution of contests.

To the best of our knowledge, no scholarly articles have specifically examined this potential disparity in the level of competitive homogeneity in elite judo competitions based on sex. Nevertheless, previous studies have identified differences between male and female elite judo athletes in various aspects such as scores, penalties, intensity of the contests, and time-motion analysis. For instance, (Calmet et al., 2017) compared match duration, frequency of scores, and penalties between male and female athletes during the London 2012 and Rio 2016 Olympic Games, finding differences between the sexes in scoring and penalty outcomes. Franchini et al. (2019) studied pacing in judo matches, highlighting sex-based differences in high-intensity to low-intensity effort ratios during 1-minute matches. Their findings align with ours, as male athletes often tend to maintain a more balanced pace throughout the contest, which is reflected in our observations of more scoring actions in the later stages, particularly in TU-GS. This pacing strategy likely allows them to conserve energy and execute decisive techniques when the contest reaches critical moments, such as golden score. In contrast, female athletes typically adopt a more aggressive approach earlier in the contest, likely influenced by the shorter combat time, which encourages them to resolve contests as quickly as possible. Sterkowicz-Przybycie et al. (2017) examined combat and pause phases during elite judo competitions and found that females tend to have shorter pauses between high-intensity actions, especially in the middleweight category. This finding can explain the tendency for females to accumulate fewer penalties and resolve contests earlier, as they maintain a higher work rate early on to secure a decisive victory before the contest extends into later temporal units. Kajmovic et al. (2022) investigated individual penalties by sex and weight categories in judo, identifying differences in assigned individual penalties between categories for both sexes during various Judo World Championships (i.e., Budapest 2017, Baku 2018, Tokyo 2019, and Budapest 2021). Their study highlighted that the likelihood of receiving a penalty increases as the match progresses. These collective findings emphasize the importance for judo coaches and trainer planners to account for distinct pacing strategies and interaction levels between male and female athletes considering match

duration. Further research delving into the factors contributing to observed sex-based differences in judo contests would offer valuable insights for the sport.

Our analysis of EV distribution across TUs revealed a non-uniform pattern (EV1 to EV5) for both female and male judo athletes. Despite this non-uniformity, a similar distribution pattern across TUs was observed in both sexes. The underlying mechanisms behind these observations, which have significant implications for tactical strategies, remain to be elucidated. Judo professionals can leverage these findings to address uncertainty in contests. Further insights could be gained by scouting the specific distribution of events in high-level judo athletes facing various opponents with specific stance positions and/or functional dominance. This knowledge would aid in understanding the distinct pacing strategies adopted by judokas during contests, facilitating effective technical-tactical plans against individual athletes for enhanced performance and strategic advantage. Additionally, our study provides novel insights for accurately estimating the number of EVs in a judo contest based solely on its duration, applicable to all contests regulated by the International Judo Federation (IJF) rules established in 2018. While previous studies have explored the temporal structure of judo contests (Monteiro et al., 2019), our investigation is the first to approach the topic from this particular perspective, making direct comparisons with prior outcomes currently unfeasible.

Concerning the distribution of contests characterised by their last event (cEV) across TU, the prevalence of specific cEVs in each TU was examined. Overrepresentations were observed for cEV1 in TU1 for females and TU1 and TU2 in males. Additionally, cEV2 was overrepresented in TU2 for females and TU2 and TU3 for males. Notably, females demonstrated a quicker resolution for cEV1 and cEV2 compared to males. Later in the contests, cEV3 was overrepresented in TU3 and TU4 for females and TU3, TU4, and TU-GS for males. Furthermore, cEV4 occurred mainly in TU4 and TU-GS for both females and males. In contrast, cEV5 was only overrepresented in TU4 and TU-GS for males. Similar patterns were observed in cEV3, where female judo athletes required less time (TU3 and TU4) than males (TU3, TU4, and TU-GS) to conclude contests, indicating females do not exceed four minutes or the golden score period to finalise a contest with just three events. Notably, both male and female judo athletes resolved contests with four events (cEV4) within the same temporal unit (TU4 or TU-GS), suggesting equivalent time requirements. Lastly, cEV5 was exclusively significant in the male category in TU4 and TU-GS, implying that females tend to end the contests earlier than males. Despite these findings, the underlying mechanisms remain unknown, and no existing scientific literature addresses this topic, rendering comparisons and evidence-based conclusions impossible. Future studies should explore these patterns comprehensively.

In examining the distribution of EVR types across distinct TUs, IPP was notably more frequent than anticipated corresponding to EV4 for both females and males. Importantly, IPP manifested earlier in females (TU1 and TU2) than in males (TU3), providing support for the hypothesis that females may exhibit more heterogeneity in the competition level among their athletes than males. The results highlight that in the first temporal unit (TU1) corresponding to EV1, WAZ was overrepresented in both males and females. WW was overrepresented in TU1 corresponding to EV1 in both sexes, and TU1 and TU2 for males and females respectively corresponding to EV3. Furthermore, WW was relatively more frequent in TU3 corresponding o EV4 for males and females. The disproportionate occurrence of EVR associated with scoring actions in the initial events during the firsts temporal units suggests a tendency among athletes to adopt an offensive approach at the beginning of the contests, prioritizing attempts with throws or body controls in groundwork over penalizations. This offensive strategy is observed consistently across genders in the analyzed competitions.

Simultaneously, the high occurrence (i.e., absolute frequency) of SH1 in TU1, despite its negative standardized residual (i.e., relative frequency), can be understood in the context of the unequal number of observations across temporal units. Since many contests did not reach the later temporal units, the expected frequency under a uniform distribution may overestimate the occurrence of events like *shido* in TU1. Consequently, while *shido* is indeed frequent in the first minute of the contest, its distribution across all temporal units is skewed toward the middle and later stages, resulting in a lower-than-expected occurrence in TU1 under the uniform distribution assumption. In shorter contests, fewer penalties may appear simply because they end before these

later stages are reached. On the other hand, SH1 was overrepresented in TU3 (EV5) in males and in TU2 (EV1) and TU4 (EV4) in females. Furthermore, SH2 was overrepresented in TU-GS (EV2) and TU4 (EV3) in males and in TU3 (EV2 and EV5). These results reinforce the idea that judokas competing in world championships engage in actions that might result in penalties from the middle of the contest to the end. Alternatively, referees may be more inclined to sanction in the latter stages of the contest. However, it is important to highlight that males tend to receive penalties later in the contest, particularly in TU4 and TU-GS, compared to females. As shown in Figures 3 and 4, while SH1 penalties are frequent in TU1 for both sexes, SH1 and SH2 penalties accumulate disproportionately in TU3, TU4, and TU-GS, especially in males.

Recently, it has been explored the impact of penalties on attack frequency in elite judo matches (Ceylan et al., 2022). The analysis of these authors concentrated on matches where at least one of the competitors received a SH2 penalty, revealing that attack frequency reached its peak following SH2, contrasting with its lowest frequency prior to athletes receiving SH1. Balci & Ceylan (2020) studied the effects of *shido* penalties on match outcomes and factors influencing these penalties. Their findings indicated that receiving a *shido* significantly influenced competitors' technical-tactical choices throughout the contest, indirectly shaping the ultimate match results. However, it is noteworthy that no study to date has specifically examined this aspect concerning sex differences. Our data show that males produced slightly more scoring actions in the later stages, particularly in TU-GS, with two overrepresentations of scoring actions in TU-GS (as EV1 and EV4), compared to only one overrepresentation in females (as EV4). This suggests that males may adopt more offensive strategies in the final stages of the contest, likely to resolve the match before accumulating further penalties.

The analysis of EV5 and EV6 disclosed no discernible association between EVRs and TUs for both male and female participants. The limited number of events poses a challenge in extracting meaningful information due to an insufficient sample size for statistical analysis. This absence of association implies that these events may be regarded as essentially similar within the framework of the contest and relatively marginal in their influence on the overall outcome.

The findings of the present study underscore the significance of analysing EVRs in judo competitions, revealing distinct approaches in determining the final outcome between sexes. These variations suggest potential divergences in training and tactical strategies employed by male and female athletes. The underlying mechanisms influencing these patterns within the judo contest remain unidentified, and as of now, no peer-reviewed article has explored the correlation between the type of EVR in judo contests and the corresponding TU where they occurred.

5. Practical applications

The findings of this study shed light on the number, prevalence, timing, and nature of event records occurring in elite judo contests for both male and female athletes. This valuable information provides professionals with the insights needed to formulate targeted strategic plans tailored to the unique requirements of male and female judo athletes competing at high level. Additionally, it serves as a valuable tool for contest monitoring, enabling professionals to make tactically informed decisions in response to specific situations that may arise during the competition.

After observing direct rivals and ensuring that the pacing strategies align with the patterns identified in this study, the strategies indicated below can be incorporated into training sessions. While this does not imply that judokas should neglect preparation for the entire range of possible scenarios, the specific alignments highlighted here can serve as a guide for more effective programming of training sessions.

1) *Sex-specific pacing strategy planning:* The differences in how male and female athletes distribute their scoring actions across temporal units highlight the need for sex-specific tactical preparation. Male athletes, who tend to spread their scoring efforts throughout the contest and peak during the later stages (TU3, TU4, and TU-GS), may benefit from training programs focused on endurance and maintaining high-intensity performance over longer periods. In contrast, female athletes, who concentrate their scoring actions in the earlier phases (TU1 and TU2), should prioritize quick, high-intensity actions early in the contest, as they tend to resolve matches faster. Furthermore,

coaches can utilize this information to refine pacing strategies during training, helping athletes manage their energy levels and efforts more effectively, particularly in longer or more tactical contests. For example, a coach preparing a male judo athlete for a major competition could design a training session where the athlete works on maintaining explosive power of key actions (i.e., grip dispute and throw attacks) deep into the match. Simulated matches might be extended beyond the usual duration to emphasize performing well under fatigue, particularly during golden score (TU-GS). In contrast, a female judo athlete might focus on executing a high frequency of scoring techniques within the first minutes, followed by defensive drills to maintain the advantage, or to actively recover before new burst of high frequency attacks.

2) *Time-specific strategy planning:* The timing of penalties and scoring actions throughout a contest offers crucial insights for coaches to make real-time tactical adjustments. For example, the accumulation of penalties in the later stages, particularly for male athletes, highlights the need to balance riskier throwing attacks with safer, more controlled defensive tactics, such as maintaining good posture, effective displacement, and less risky techniques like sweeps, as the match progresses. For example, during a match, a coach or athlete may notice that two penalties (shidos) have been accumulated by the start of TU4. Recognizing that penalties typically increase in the later stages and that attack frequency often peaks after the second penalty, the focus should shift to executing decisive scoring actions with safer, less risky throws. This approach minimizes the risk of further penalties while taking advantage of the opponent's likely caution, transitioning from a defensive to a controlled offensive strategy to prevent a penalty-induced loss.

3) *Performance monitoring and data-driven feedback:* These findings also serve as a valuable tool for real-time performance monitoring and post-competition analysis. By tracking athletes' performance in terms of the timing and nature of event records, professionals can provide data-driven feedback to enhance future strategies. This approach allows coaches to address specific areas of improvement, such as managing penalty risks or capitalizing on scoring opportunities during key moments of the contest. For example, after a competition, a coach reviews the performance of a male athlete who scored multiple times but accumulated penalties that led to a loss in golden score. By analyzing the timing of the penalties (e.g., SH1 in TU3 and SH2 in TU-GS), the coach could identify a pattern of risky behavior during the later stages of matches. This data-driven insight would guide the coach to modify the athlete's tactics, advising him to focus on more controlled, risk-averse techniques during these critical moments in future contests.

6. Conclusion

In summary, elite judo competitions, encompassing both male and female categories and accounting for contests concluding before the regular time as well as those concluding at regular or extended time, generally consist of one to six EVs, with a predominance of EV2 and EV3. Furthermore, the study results suggest that female contests generally exhibit a lower EV frequency compared to males, albeit most EVs occurring within the same TU. Additionally, the occurrence of EVRs in male and female contests is associated with the moment they occurred, with similar patterns observed in both sexes. Notably, cEV1, cEV2, and cEV3 varied in the moment of occurrence between male and female categories, while contests with four events (cEV4) showed equivalent timing. Consequently, females appear to engage in contests of shorter duration than males and require less time to produce an equivalent number of EVs. The disproportionate occurrence of EVR associated with scoring actions in the initial events during the firsts temporal units suggests a tendency among athletes to adopt an offensive approach at the beginning of the contests, prioritizing attempts with throws or body controls in groundwork over penalizations.

References

Agostinho, M. F. & Franchini, E. (2021). Observational analysis of the variability of actions in judo: the key for success? *Revista de Artes Marciales Asiáticas*, *15*(2), 69–77. https://doi.org/10.18002/rama.v15i2.6341

Balci, Ş. S. & Ceylan, B. (2020b). Penalties in judo: the impact of shido on match durations and results. *International Journal of Performance Analysis in Sport*, *20*(4), 1–9. https://doi.org/10.1080/24748668.2020.1775413

Barreto, L. B. M., Aedo-Muñoz, E. A., Sotto, D. A. S., Miarka, B. & Brito, C. J. (2022). Judo combat time, scores, and penalties: Review of competition rules changes between 2010 and 2020. *Revista de Artes Marciales Asiáticas*, *17*(1), 19–37. https://doi.org/10.18002/rama.v17i1.7122

Calmet, M., Pierantozzi, E., Sterkowicz, S., Challis, B. & Franchini, E. (2017). Rule change and Olympic judo scores, penalties and match duration. *International Journal of Performance Analysis in Sport*, *17*(4), 1–8. https://doi.org/10.1080/24748668.2017.1350489

Camargo, R. G. de, Guerra, G. M., Rosa, R. L., Calmet, M., Takito, M. Y. & Franchini, E. (2019). Attack side and direction during the 2017 Judo World Championship. *Sport Sciences for Health*, *15*(2), 477–480. https://doi.org/10.1007/s11332-019-00540-6

Ceylan, B., Balcı, Ş. S., Taşkın, H. B. & Santos, L. (2022). The impact of penalties on attack frequency in high-level judo matches. *International Journal of Performance Analysis in Sport*, *22*(6), 715–724. https://doi.org/10.1080/24748668.2023.2188364 Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Routledge. https://doi.org/10.4324/9780203771587

Csataljay, G., O'Donoghue, P., Hughes, M. & Dancs, H. (2009). Performance indicators that distinguish winning and losing teams in basketball. *International Journal of Performance Analysis in Sport*, *9*(1), 60–66. https://doi.org/10.1080/24748668.2009.11868464

Dopico-Calvo, X., Iglesias-Soler, E., Santos, L., Carballeira, E. & Mayo, X. (2022). Analysis of Successful Behaviors Leading to Groundwork Scoring Skills in Elite Judo Athletes. *International Journal of Environmental Research and Public Health*, *19*(6), 3165. https://doi.org/10.3390/ijerph19063165

Dopico-Calvo, X., Mayo, X., Santos, L., Carballeira, E., Šimenko, J., Ceylan, B., Clavel, I. & Iglesias-Soler, E. (2023). When and How a Judo Contest Ends: Analysis of Scores, Penalties, Rounds and Temporal Units in 2018, 2019 and 2021 World Championships. *Applied Sciences*, *13*(4), 2395. https://doi.org/10.3390/app13042395

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). Sage Publications Ltd.

Franchini, E., Moura, C. F. D. de, Shiroma, S. A., Humberstone, C. & Julio, U. F. (2019). Pacing in judo: analysis of international-level competitions with different durations. *International Journal of Performance Analysis in Sport*, *19*(1), 1–10. https://doi.org/10.1080/24748668.2019.1570458

García-Rubio, J., Ibáñez, S. J., Cañadas, M. & Antúnez, A. (2013). Complex system theory in team sports, example in 5 on 5 basketball contest. *Revista de Psicología Del Deporte*, *22*(1), 209–213.

García-Rubio, J., Gómez, M. Á., Cañadas, M. & Ibáñez, J. S. (2015). Offensive Rating-Time coordination dynamics in basketball. Complex systems theory applied to Basketball. *International Journal of Performance Analysis in Sport*, *15*(2), 513–526. https://doi.org/10.1080/24748668.2015.11868810

Ibáñez, S. J., Sampaio, J., Sáenz-López, P. & Janeira, M. A. (2003). Games statistics discriminating the final outcome of junior world basketball championship matches. *Journal of Human Movement Studies*, *45*(1), 1–19.

IJF. (2023). *IJF Sport and Organisation Rules*. https://www.eju.net/download-file/?id=179647

Kajmovic, H., Karpljuk, D., Kapo, S. & Simenko, J. (2022). Comparison of Individual Penalties According to Gender and Weight Categories of Elite Judo Athletes from Four World Championships. *Biology*, *11*(9), 1284. https://doi.org/10.3390/biology11091284

Kashiwagura, D., Courel-Ibáñez, J., Kashiwagura, F., Agostinho, M. F., & Franchini, E. (2021). Judo technical-tactical dynamics: analysis of attack system effectiveness in high-level athletes. *International Journal of Performance Analysis in Sport*, *21*(6), 922–933. https://doi.org/10.1080/24748668.2021.1958533

Kashiwagura, D. & Franchini, E. (2022). The grip dispute (kumi-kata) in judo: A scoping review. *Revista de Artes Marciales Asiáticas*, *17*(1), 1–18. https://doi.org/10.18002/rama.v17i1.7030

Kashiwagura, D., Kashiwagura, F. B., Agostinho, M. F., Moraes, A. L. G. de & Franchini, E. (2022). Objectivity and reliability of the Judo Attack System Software. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, 175433712210881. https://doi.org/10.1177/17543371221088191

Ko, W.-Y., Yan, J.-J., Hsu, C.-Y., Hsieh, P.-L. & Chien, C.-Y. (2022). How Judo Professionals Win and Lost in Competition: A Closer Look at Gender, Weight, Technique, and Gripping. *Annals of Applied Sport Science*, *10*(4), 0–0. https://doi.org/10.52547/aassjournal.1093

Kons, R. L., Agostinho, M. F., Lopes-Silva, J. P., Santos, D. F. C. dos, Detanico, D. & Franchini, E. (2022). More time for judo matches? Analysis of type of techniques, time, scores, and penalties in the Tokyo 2020 Olympic Games. *Frontiers in Sports and Active Living*, *4*, 960365. https://doi.org/10.3389/fspor.2022.960365

Kons, R. L., Agostinho, M. F., Santos, D. F. C., Lopes-Silva, J., Detanico, D. & Franchini, E. (2022). Match-related performance during the Olympic Games 2020: a technical variability analysis of high-level judo athletes. *International Journal of Performance Analysis in Sport*, , *22*(4), 516–525. https://doi.org/10.1080/24748668.2022.2084594

Kröckel, P. & Bodendorf, F. (2020). Process Mining of Football Event Data: A Novel Approach for Tactical Insights Into the Game. *Frontiers in Artificial Intelligence*, *3*, 47. https://doi.org/10.3389/frai.2020.00047

Mayo, X., Dopico-Calvo, X. & Iglesias-Soler, E. (2019). An Analysis Model for Studying the Determinants of Throwing Scoring Actions During Standing Judo. *Sports*, *7*(2), 42. https://doi.org/10.3390/sports7020042

Miarka, B., Fukuda, H. D., Vecchio, F. B. D. & Franchini, E. (2016). Discriminant analysis of technical-tactical actions in high-level judo athletes. *International Journal of Performance Analysis in Sport*, *16*(1), 30–39. https://doi.org/10.1080/24748668.2016.11868868

Monteiro, L. F., Gonçalves, J., Chambel, L. & Abel, M. (2019). Evolution of the temporal structure of world high competition judo combat (2013 a 2017). *Revista de Artes Marciales Asiáticas*, *14*(2s), 15–17. https://doi.org/10.18002/rama.v14i2s.6022

Moreno, E., Gómez, M. A., Lago, C. & Sampaio, J. (2013). Effects of starting quarter score, game location, and quality of opposition in quarter score in elite women's basketball. *Kinesiology*, *45*, 48–54.

Morley, B. & Thomas, D. (2005). An investigation of home advantage and other factors affecting outcomes in English one-day cricket matches. *Journal of Sports Sciences*, *23*(3), 261–268. https://doi.org/10.1080/02640410410001730133

Ramírez-Arroyo, A. P., Gómez-Carmona, C. D., García-Rubio, J. & Ibañez, S. J. (2022). Influencia del Resultado Parcial en el Resultado Final del Partido en Baloncesto Profesional según el Sexo y Tipo de Competición. *RICYDE. Revista Internacional de Ciencias Del Deporte*, *18*(70), 202–218. https://doi.org/10.5232/ricyde2022.07001

Sampaio, J., Lago, C., Casais, L. & Leite, N. (2010). Effects of starting score-line, game location, and quality of opposition in basketball quarter score. *European Journal of Sport Science*, *10*(6), 391–396. https://doi.org/10.1080/17461391003699104

Segedi, I., Sertić, H., Franjić, D., Kuštro, N. & Rožac, D. (2014). Analysis of judo match for seniors. *Journal of Combat Sports and Martial Arts*, *5*(2), 57–61. https://doi.org/10.5604/20815735.1141976

Soto-Fernández, A., Camerino, O., Iglesias, X., Anguera, M. T. & Castañer, M. (2022). LINCE PLUS software for systematic observational studies in sports and health. *Behavior Research Methods*, *54*(3), 1263–1271. https://doi.org/10.3758/s13428-021-01642-1

Sterkowicz-Przybycie, K., Miarka, B. & Fukuda, D. H. (2017). Sex and Weight Category Differences in Time-Motion Analysis of Elite Judo Athletes. *Journal of Strength and Conditioning Research*, *31*(3), 817–825. https://doi.org/10.1519/jsc.0000000000001597

~

Author's biographical data

Xurxo Dopico-Calvo (Spain) works as Associate Professor for more than 30 years at the University of A Coruna, and he is Senior researcher of the research group "Performance and Health Group". He has a forty-year experience in judo as practitioner, trainer and university professor and has published several studies about this sport, some of them about performance analysis, laterality, etc. E-mail: xurxo.dopico@udc.es

Luis Santos (Spain) is a Lecturer in the Department of Physical Education and Sport at the Universidad de León (León, Spain). Currently serving as the Vice-Dean of the Faculty. In addition to his academic role, Luis Santos instructs Judo within the Bachelor's program for Sport and Exercise Science at the Faculty and he holds a 5th DAN Judo belt. Furthermore, he works for the *Federación de Judo y Deportes Asociados del Principado de Asturias* (a Judo sports federation of a Spanish region), in the area of coaches training, and has published several studies about judo. E-mail: lsanr@unileon.es

Eduardo Carballeira (Spain) is a Researcher and Assistant Lecturer in Physical Education and Sport at the University of A Coruna. He has earned a Ph.D. and a master's degree in high performance in sport. Additionally, he serves as the sports director and head coach of Judo Hércules (A Coruna), as well as high-performance technician of the Galician Judo Federation. He also works as a physiologist and strength and conditioning coach for elite combat athletes. He holds a 6th DAN Judo belt and is a former elite judo athlete. His main research areas include neuromuscular and cardiovascular responses and adaptations to resistance exercise, power and functionality in older adults, the application of blood flow restriction training to injury rehabilitation, as well as enhancing health and performance. Additionally, he specializes in strength and conditioning evaluation, monitoring, and prescription for combat sports athletes. E-mail: eduardo.carballeira@udc.es

Xián Mayo (Spain) owns a PhD in Exercise Physiology from the University of A Coruna. He is a Lecturer of Combat Sports at URJC (Madrid, Spain) and Academic Secretary at the Research Centre in Sports Science. He is also Research Coordinator at Spain Active Foundation. His scientific topics of interest in combat sports are related to the determinants of scoring actions and the learning process. Professionally, he was a judo coach for more than ten years. Other research topics of interest are clinical exercise, responses and adaptations to resistance training, and physical activity intervention analysis. E-mail: xian.mayo@urjc.es

Bayram Ceylan (Türkiye) is an Associate Professor at the Department of Coaching Education, Faculty of Sport Sciences, Kastamonu University. He is serving as a member of the Educational Committee of the Turkish Judo Federation and the Scientific Committee of the European Judo Union. He has twenty years of experience in judo and represented his country at the international level and has prestigious publications on judo-specific tests, dehydration in judo, and judo match analysis. E-mail: bceylan@kastamonu.edu.tr

Jožef Simenko (Slovenia) is a researcher and an Assistant Professor at the Faculty of Sport, University of Ljubljana. He holds a PhD in Kinesiology. He holds a 2nd DAN belt degree in Judo and is a Certified Judo Coach in Slovenia and the United Kingdom and a member of the International Martial Arts and Combat Sports Scientific Society (IMACSSS). He also works in strength & conditioning and rehabilitation with elite judo athletes. He was the president of the Slovenian Judo Association Coaching Committee and a member of the Slovenian National team as an athlete. Email: jozef.simenko@fsp.uni-lj.si

Marta Sevilla-Sanchez (Spain) serves as an assistant lecturer at the University of A Coruña, where she obtained her Ph.D. and currently teaches the subject of Combat Sports. Additionally, for the past eight years, she has been instructing judo at Judo Hercules club. With a third-degree black belt, she is a former elite judoka. Her primary research areas encompass motor control and learning, cognitive effects of exercise and sports, health-related fitness across different life stages, and performance analysis in judo. Email: marta.sevilla@udc.es.

Eliseo Iglesias-Soler (Spain) is an Associate Professor in the Department of Physical Education and Sports at the University of A Coruna (Spain). Senior researcher of the research group "Performance and Health Group" at University of A Coruna. His main research areas include: neuromuscular and cardiovascular responses and adaptations to resistance exercise; health related fitness across different life stages; laterality and performance analysis in judo. E-mail: eliseo.iglesias.soler@udc.es

Appendix 1

Distribution of events (EVs) across the temporal units (TUs) in males

		EV1 **n=1387** p < 0.001 (χ2 = 1375.2)	**EV2** **n=1203** p < 0.001 (χ2 = 493.7)	**EV3** **n=883** p < 0.001 (χ2 = 306.6)	**EV4** **n=373** p < 0.001 (χ2 = 112.2)	**EV5** **n=86** p < 0.001 (χ2 = 64.1)	**EV6** **n=15** p = 0.197
TU1		n=710	n=109	n=5	-	-	-
	SR	26.0*	-8.5*	-12.9*	-	-	-
TU2		n=496	n=472	n=130	n=16	n=1	-
	SR	13.1*	14.9*	-3.5*	-8.0*	-4.4*	-
TU3		n=118	n=365	n=263	n=81	n=5	-
	SR	-9.6*	8.0*	6.5*	-1.3	-3.6*	-
TU4		n=42	n=189	n=299	n=151	n=39	n=5
	SR	-14.1*	-3.3*	9.2*	6.0*	3.8*	n/s
TU-GS		n=21	n=68	n=186	n=125	n=41	n=10
	SR	-15.4*	-11.1*	0.7	3.3*	4.2*	n/s

EV1-EV6: first to sixth event; TU1-TU4: first to fourth temporal unit; TU-GS: extended temporal unit, Golden Score time; SR: standardized residuals; n/s: no significant. SR with absolute values equal to 2 or higher.

Distribution of events (EVs) across the temporal units (TUs) in females

		EV1 **n=953** p < 0.001 (χ2 = 914.9)	**EV2** **n=782** p < 0.001 (χ2 = 258.7)	**EV3** **n=527** p < 0.001 (χ2 = 165.4)	**EV4** **n=225** p < 0.001 (χ2 = 151.9)	**EV5** **n=49** p < 0.001 (χ2 = 27.6)	**EV6** **n=4** p = 0.317
TU1		n=497	n=84	n=5	n=1	-	-
	SR	22.2*	-5.8*	-9.8*	-6.5*	-	-
TU2		n=313	n=294	n=83	n=8	-	-
	SR	8.9*	11.0*	-2.2*	-5.5*	-	-
TU3		n=99	n=229	n=154	n=43	n=1	-
	SR	-6.6*	5.8*	4.7*	0.3	-3.8*	-
TU4		n=34	n=115	n=172	n=93	n=57	n=1
	SR	-11.3*	-0.4	6.5*	7.2*	0.2	n/s
TU-GS		n=10	n=60	n=113	n=80	n=73	n=3
	SR	-13.1*	-7.7*	0.7	5.2*	3.6*	n/s

EV1-EV6: first to sixth event; TU1-TU4: first to fourth temporal unit; TU-GS: extended temporal unit, Golden Score time; SR: standardized residuals; n/s: no significant. *SR with absolute values equal to 2 or higher.

Distribution of contests characterised by their last event (cEV) across the temporal units (TUs) in males

		cEV1 **n=183** p < 0.001 (χ2 = 143.4)	**cEV2** **n=321** p < 0.001 (χ2 = 77.2)	**cEV3** **n=507** p < 0.001 (χ2 = 203.8)	**cEV4** **n=287** p < 0.001 (χ2 = 89.9)	**cEV5** **n=71** p < 0.001 (χ2 = 27.0)	**cEV6** **n=15** p = 0.197
TU1		n=92	n=39	n=4	-	-	-
	SR	9.2*	-3.1*	-9.7*	-	-	-
TU2		n=55	n=107	n=58	n=11	-	-
	SR	3.0*	5.3*	-4.3*	-7.2*	-	-
TU3		n=15	n=94	n=121	n=61	n=3	-
	SR	-3.6*	3.7*	2.0*	-1.3	-4.2*	-
TU4		n=8	n=56	n=190	n=114	n=34	n=5
	SR	-4.7*	-1.0	8.9*	5.0*	2.1*	n/s
TU-GS		n=13	n=25	n=134	n=101	n=34	n=10
	SR	-3.9*	-4.9*	3.3*	3.5*	2.1*	n/s

TU1, TU2, TU3, TU4, and TU-Golden Score: temporal units from the first minute to extended time; cEV1, cEV2, cEV3, cEV4, cEV5, and cEV6: contest characterised by their last event; SR = standardised residuals; n/s = no significant. *SR with absolute values equal to 2 or higher.

Distribution of contests characterised by their last event (cEV) across the temporal units (TUs) in females

		cEV1 n=171 p < 0.001 (χ2 = 137.9)	cEV2 n=255 p < 0.001 (χ2 = 61.5)	cEV3 n=302 p < 0.001 (χ2 = 104.3)	cEV4 n=176 p < 0.001 (χ2 = 113.1)	cEV5 n=45 p = 0.053	cEV6 n=4 p = 0.317
TU1		n=89	n=40	n=4	n=1	-	-
	SR	9.4*	-1.5	-7.3*	-5.8*	-	-
TU2		n=44	n=94	n=40	n=8	-	-
	SR	1.7	6.0*	-2.6*	-4.6*	-	-
TU3		n=25	n=54	n=77	n=34	-	-
	SR	-1.6	0.4	2.1*	-0.2	-	-
TU4		n=7	n=50	n=108	n=74	n=16	n=1
	SR	-4.6*	-0.1	6.1*	6.5*	n/s	n/s
TU-GS		n=6	n=17	n=73	n=59	n=29	n=3
	SR	-4.8*	-4.8*	1.6	4.0*	n/s	n/s

TU1, TU2, TU3, TU4, and TU-Golden Score: temporal units from the first minute to extended time; cEV1, cEV2, cEV3, cEV4, cEV5, and cEV6: contest characterised by their last event; SR = standardised residuals; n/s = no significant. *SR with absolute values equal to 2 or higher.

Appendix 2

Relative frequencies and standardised residuals for male and female

First Event: EVRs across TUs

EVRs/TUs Overall: (n=2340)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	53.8%	28.6%	11.4%	3.1%	3.1%	
(n=325)	.6	-1.8	1.2	-.2	2.7**	13.9%
WAZ	61.4%	26.5%	7.4%	2.9%	1.8%	
(n=487)	3.0**	-3.0**	-1.4	-.5	1.0	20,8%
SH1	44.8%	39.9%	10.5%	3.9%	0.9%	
(n=1199)	-3.3**	3.1**	1.4	1.3	-1.2	51.2%
SH-B1	59.6%	33.1%	5.5%	1.5%	0.3%	
(n=329)	2.0**	-.4	-2.3**	-1.7	-1.6	14.1%
Men (n=1387)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	52.0%	30.6%	8.7%	4.0%	4.6%	
(n=173)	.2	-1.1	.1	.8	3.3**	12.5%
WAZ	60.4%	28.7%	7.2%	1.9%	1.9%	
(n=265)	2.1**	-1.9	-.7	-1.1	.5	19.1%
SH1	45.8%	39.5%	10.1%	3.6%	0.9%	
(n=740)	-2.0**	1.7	1.5	1.0	-1.3	53.3%
SH-B1	57.9%	35.9%	4.3%	1.4%	0.5%	
(n=209)	1.4	.0	-2.1**	-1.3	-1.2	15.1%
Women (n=953)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	55.9%	26.3%	14.5%	2.0%	1.3%	
(n=152)	.6	-1.4	1.6	-1.0	.3	15.9%
WAZ	62.6%	23.9%	7.7%	4.1%	1.8%	
(n=222)	2.2**	-2.3**	-1.3	.4	1.1	23.3%
SH1	43.1%	40.5%	11.1%	4.4%	0.9%	
(n=459)	-2.7**	2.9**	.5	.9	-.4	48.2%
SH-B1	62.5%	28.3%	7.5%	1.7%	0,0%	
(n=120)	1.6	-.9	-1.0	-1.1	-1.1	12.6%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, p < 0.001, V=0.103; men, p < 0.001, V=0.103; women, p < 0.001, V=0.122. (**) Highlight residuals with absolute values equal to 2, or higher.

Second Event: EVRs across TUs

EVRs/TUs Overall (n=1985)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	10.6%	42.1%	27.5%	13.6%	6.3%	
(n=302)	.5	1.0	-.8	-.8	-.1	15.2%
WAZ	9.2%	39.7%	29.1%	16.2%	5.8%	
(n=413)	-.3	.4	-.3	.5	.5	20.8%
WW	30.7%	42.0%	20.0%	7.3%	0.0%	
(n=150)	8.2**	.7	-2.2**	-2.5**	-3.1**	7.6%
SH1	8.1%	38.3%	29.0%	18.0%	6.6%	
(n=472)	-.2	-.1	-.4	1.5	.1	23.8%
SH2	6.0%	34.7%	35.1%	14.9%	9.2%	
(n=530)	-2.7**	-1.4	2.2**	-.2	2.5**	26.7%
SH-B1	33.3%	33.3%	16.7%	16.7%	0.0%	
(n=6)	1.9	-.2	-.6	.1	-.6	0.3%
SH-B2	4.5%	40.2%	33.0%	17.9%	4.5%	
(n=112)	-1.8	.3	.6	.7	-.8	5.6%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, $p < 0.001$, V=0.126; men, $p < 0.001$, V=0.122; women, $p < 0.001$, V=0.160. (**) Highlight residuals with absolute values equal to 2, or higher.

Third Event: EVRs across TUs

EVRs/TUs Overall (n=1410)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	1.0%	14.5%	29.7%	29.7%	25.0%	
(n=296)	.6	-.3	.0	-1.1	1.4	21.0%
WAZ	0.4%	14.7%	29.1%	29.1%	26.7%	
(n=285)	-,7	-,2	-,1	-1,3	2,0**	20.2%
WW	3.8%	24.8%	36.8%	28.6%	6.0%	
(n=133)	4.2**	2.9**	1.5	-1.0	-3.8**	9.4%
SH1	0.6%	15.7%	26.7%	40.1%	16.9%	
(n=172)	-.2	.2	-.7	1.5	-1.2	12.2%
SH2	0.0%	13.0%	31.3%	38.1%	17.7%	
(n=339)	-1.6	-1.0	.6	1.5	-1.4	24.0%
SH3	0.0%	10.3%	19.3%	37.2%	33.1%	
(n=145)	-1.0	-1.5	-2.3**	.8	3.1**	10.3%
SH-B1	0.0%	50.0%	50.0%	0.0%	0.0%	
(n=2)	-.1	1.3	.5	-.8	-.7	0.1%
SH-B2	0.0%	20.8%	37.5%	29.2%	12.5%	
(n=24)	-.4	.7	.7	-.4	-.9	1.7%
SH-B3	0.0%	21.4%	50.0%	21.4%	7.1%	
(n=14)	-.3	.6	1.4	-.8	-1.1	1.0%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, $p < 0.001$, V=0.129; men, $p < 0.001$, V=0.135); women, $p < 0.001$, V=0.171. (**) Highlight residuals with absolute values equal to 2, or higher.

Fourth Event: EVRs across TUs

EVRs/TUs Overall (n=598)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	0.8%	7.3%	30.9%	34.1%	26.8%	
(n=123)	1.8	1.8	2.5**	-1.2	-1.4	20.6%
WAZ	0.0%	0.9%	14.8%	28.7%	55.6%	
(n=108)	-.4	-1.6	-1.4	-2.0**	3.8**	18.1%
WW	0.0%	8.9%	35.6%	50.5%	5.0%	
(n=101)	-.4	2.5**	3.3**	1.5	-5.0**	16.9%
SH1	0.0%	3.0%	24.2%	60.6%	12.1%	

(n=33)	-.2	-.3	.4	1.8	-2.2**	5.5%
SH2	0.0%	2.6%	10.3%	52.1%	35.0%	
(n=117)	-.4	-.8	-2.5**	1.9	.1	19.5%
SH3	0.0%	0.9%	11.4%	33.3%	54.4%	
(n=114)	-.4	-1.7	-2.2**	-1.2	3.7**	19.1%
SH-B2	0.0%	0.0%	50.0%	50.0%	0.0%	
(n=3)	-.1	-.3	.9	.2	-.8	0.3%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, $p < 0.001$, V=0.230; men, $p < 0.001$, V=0.271; women, $p < 0.001$, V=0.260. (**) Highlight residuals with absolute values equal to 2, or higher.

Fifth Event: EVRs across TUs

EVRs/TUs Overall (n=137)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	-	0.0%	0.0%	42.9%	57.1%	
(n=35)	-	-.5	-1.2	.1	.3	25.5%
WAZ	-	.0%	4.5%	31.8%	63.6%	
(n=22)	-	-.4	.0	-.7	.7	16.1%
WW	-	0.0%	5.3%	73.7%	21.1%	
(n=19)	-	-.4	.2	2.2**	-1.9	13.9%
SH1	-	0,0%	33.3%	0.0%	66.7%	
(n=3)	-	-.1	2.4**	-1.1	.3	2.2%
SH2	-	4.8%	9.5%	52.4%	33.3%	
(n=21)	-	2.2**	1.1	.8	-1.3	15.3%
SH3	-	0.0%	2,7%	27,0%	70,3%	
(n=37)	-	-.5	-.5	-1.4	1.4	27.0%
Men (n=87)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	-	0.0%	0.0%	50.0%	50.0%	
(n=22)	-	-.5	-1.1	.4	.1	25.3%
WAZ	-	0.0%	5.9%	35.3%	58.8%	
(n=17)	-	-.4	.0	-.6	.6	19.5%
WW	-	0.0%	12.5%	87.%	0.0%	
(n=8)	-	-.3	.8	1.8	-2.0	9.2%
SH1	-	0.0%	50.0%	0.0%	50.0%	
(n=2)	-	-.2	2.6	-.9	.0	2.3%
SH2	-	6.3%	6.3%	50.0%	37.5%	
(n=16)	-	1.9	.1	.3	-.6	18.4%
SH3	-	0.0%	4.5%	31.8%	63.6%	
(n=22)	-	-.5	-.2	-.9	1.0	25.3%
Women (n=50)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	-	-	0.0%	30.8%	69.2%	
(n=13)	-	-	-.5	-.5	.3	26.0%
WAZ	-	-	0.0%	20.0%	80.0%	
(n=5)	-	-	-.3	-.6	.5	10.0%
WW	-	-	0.0%	63.6%	36.4%	
(n=11)	-	-	-.5	1.5	-1.1	22.0%
SH1	-	-	0.0%	0.0%	100%	
(n=1)	-	-	-.1	-.6	.5	2.0%
SH2	-	-	20.0%	60.0%	20.0%	
(n=5)	-	-	2.8	.9	-1.2	10.0%
SH3	-	-	0.0%	20.0%	80.0%	
(n=15)	-	-	-.5	-1.0	.9	30.0%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, $p = 0.008$; V=0.276; men, $p = 0.057$; women: $p = 0.055$. (**) Highlight residuals with absolute values equal to 2, or higher.

Sixth Event: EVRs across TUs

EVRs/TUs Overall (n=19)	TU1	TU2	TU3	TU4	TU-GS	TOTAL
IPP	-	-	-	50.0%	50.0%	
(n=6)	-	-	-	.8	-.5	31.6%
WW	-	-	-	14.6%	85.4%	
(n=7)	-	-	-	-.8	.6	36.8%
SH3	-	-	-	33.3%	66.7%	
(n=6)	-	-	-	.1	-.1	31.6%
Men (n=15)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	-	-	-	60.0%	40.0%	
(n=5)	-	-	-	1.0	-.7	33.3%
WW	-	-	-	20.0%	80.0%	
(n=5)	-	-	-	-.5	.4	33.3%
SH3	-	-	-	20.0%	80.0%	
(n=5)	-	-	-	.5	.4	33.3%
Women (n=4)	**TU1**	**TU2**	**TU3**	**TU4**	**TU-GS**	**TOTAL**
IPP	-	-	-	0.0%	100.0%	
(n=1)	-	-	-	-.5	.3	25%
WW	-	-	-	0.0%	100.0%	
(n=2)	-	-	-	-.7	.4	50.0%
SH3	-	-	-	100,0%	0,0%	
(n=1)	-	-	-	1.5	-.9	25.0%

TU1, TU2, TU3, TU4, and TU-GS: temporal unit 1, 2, 3, 4, and golden score; EVR: event record. Statistics: overall, p = 0.383); men, p = 0.301; women, p = 0.135.