BIOMECHANICAL ANALYSIS OF TECHNICAL ACTIONS USED IN THE 2021 EUROPEAN JUDO CHAMPIONSHIP – BEHAVIORAL PATTERNS AND EFFECTIVENESS

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ABSTRACT

In Judo, each motor action depends greatly on the behavioural and technical variability of each judoka, which largely determines the options and the predominance of biomechanical actions inherent to the movements themselves. The objective was to biomechanically analyse the technical actions used in the 2021 European Judo Championships based on combat time and gold score and verify the effectiveness of these same technical actions both genders. The study sample focused on 400 combats of the European Judo Championship 2021. We used an observation system created for this purpose, according to the classification system proposed by Sacripanti. Cross-frequency tables were produced, where the association degree between variables was analysed using the Chi Square test, where the significance level was set at $p \leq 0.05$. We complemented the association analysis between variables by calculating the adjusted standardized residuals. In both genders and phases of combat, the use of binary techniques predominated over lever techniques, with the hierarchy of technical resources used by judokas being identical. In golden score, women showed a significant association with the use of trunk-leg binary techniques. Throughout the fights, women registered differences in the use of groups of techniques. The trunk-leg binary and minimum arm lever techniques revealed significant effectiveness in both phases of combat in both the male and female categories.

Keywords: *Judo, Biomechanics, Lever techniques, Binary techniques, Competitive performance analysis.*

INTRODUCTION

Judo is a dynamic, intermittent, high-intensity combat sport that requires complex skills and tactical excellence for success *(Franchini & Herrera-Valenzuela, 2017)*. In each combat, judokas must perform a high number of motor actions of a technical nature, making the physical demand high in each combat and consequently in each competition. Each motor action depends greatly on the behavioral and technical variability of each judoka, which largely marks the options and predominance of biomechanical actions inherent to the movements themselves *(Sterkowicz, Sacripanti, & Sterkowicz-Przybycien, 2013; Batista et al, 2022)*.

Batista et al. *(2022)* observed in international competitions, the combat phase the most used techniques by the female gender are the maximum arm lever class, unlike the male gender that are the variable arm lever and minimum arm lever techniques. There were significant differences between genders in this phase in the mentioned classes. It should be noted a high use of techniques of maximum arm lever by the male categories, but without evidence of statistical significance, as well as a reduced use of medium arm techniques by both genders. The same authors observed an application predominance in the male categories of variable arm lever techniques and arm/leg binary. The female categories showed a predominance of the use of maximum arm lever and variable arm lever techniques, as well as leg-arm binary. There is a significant association of minimum arm lever techniques scored with Wazari in the male categories, as well as a significantly higher use of medium arm techniques scored with Ippon.

The objective of this study was to biomechanically analyze the technical actions used in the 2021 European Judo Championships based on combat time and gold score and verify the effectiveness of these same technical actions both genders.

METHODS

Participants

The study sample focused on the European Judo Championship 2021, which had the participation of 359 athletes registered, 210 male athletes, and 149 female athletes, from 45 countries. 400 judo combats were observed, in the different male and female weight categories, with 6555 technical actions in combat being categorized.

Measures

We used an observation system created for this purpose, allowing registration and categorization of each technical action observed in combat, according to the following variables described. Each technique was categorized according to the classification system proposed by Sacripanti *(2012 in Sterkowicz, Sacripanti & Sterkowicz-Przybycien, 2013)*. Data analysis was carried out to identify each technique according to seven categorization classes for Tachi-Waza, also used by other authors *(Batista et al., 2022; Sterkowicz, Sacripanti & Sterkowicz-Przybycien, 2013)*.

Procedures

For this research preparation, no ethical issues involved in the analysis and interpretation of the data used were considered, since they were obtained using publicly available and freely accessible International Judo Federation *(IJF)* online sources and were not generated by any experimentation process. The athletes' personal identification was not done since the observation was not individualized. The identification of each observed combat was replaced by a code, which guaranteed anonymity and confidentiality.

Analysis

The techniques count distribution frequency was compared using the software IBM SPSS 26.0 software. For this purpose, cross-frequency tables were produced, where the association degree between variables was analysed using the Chi Square test, where the significance level was set at $p \leq 0.05$. We complemented the association analysis between variables by calculating the adjusted standardized residuals, taking as reference positive values equal to or greater than 1.96, assuming that the higher the residual, the more significant the trend is *(Marôco, 2018)*. To determine differences between groups in the frequencies recorded proportions, the Z test was applied, where the significance level was set at $p \leq 0.05$.

RESULTS

The results revealed in both genders and both in the combat and golden score phases, a predominance of use of binary techniques *(60%)* compared to lever techniques *(40%)*, respectively men 55% - 45% and women 66.5% – 33.5%. The hierarchy recorded in binary techniques was arm-leg techniques, trunk-leg techniques, and arm techniques. In lever techniques the hierarchy was variable arm lever technique, maximum arm, minimum arm, and medium arm. Women showed a significant association with the use of trunk-leg binary techniques in the golden score phase. There were differences in the use of groups of techniques by women as opposed to men where this aspect was not verified.

Table 1. Predominance of binary techniques during combat

	Phase	Arm Leg	Trunk Leg	Arms	Total
Male	Combat	1324 a	438 a	3a	1765
	%	75.0%	24.8%	0.2%	100.0%
	Golden Score	125 a	51 a	0.0	176
	%	71.0%	29.0%	0,00%	100.0%
	Total	1449	489	3	1941
	%	74.7%	25,20%	0.2%	100.0%
	Phase	**Arm Leg**	**Trunk Leg**	**Arms**	**Total**
Female	Combat	1330 a	455 b	5 a, b	1790
	%	74.3%	25.4%	0.3%	100.0%
	Golden Score	140 a	71* b	1 a, b	212
	%	66.0%	33.5%	0.5%	100.0%
	Total	1470	526	6	2002
	%	73.4%	26.3%	0.3%	100.0%

Table 2. Predominance of lever techniques during combat

	Phase	Midlle Arm	Max Arm	Variab Arm	Min Arm	Total
Male	Combat	59a	507a	618a	213a	1397
	%	4.2%	36.30%	44.2%	15.2%	100,00%
	Golden Score	6a	84a	87a	28a	205
	%	2.9%	41.0%	42.4%	13.7%	100,00%
	Total	65	591	705	241	1602
	%	4,10%	36,90%	44,00%	15,00%	100,00%
	Phase	**Midlle Arm**	**Max Arm**	**Variab Arm**	**Min Arm**	**Total**
Female	Combat	31 a, b	308 b	393 a	150 a, b	882
	%	3.5%	34.9%	44.6%	17.0%	100,00%
	Golden Score	2 a, b	33 b	74 a	19 a, b	128
	%	1.60%	25.8%	57.8%	14.8%	100,00%
	Total	33	341	467	169	1010
	%	3.3%	33.8%	46.2%	16.7%	100,00%

*(technical *group shows a significant residue); a b c(technical group differs)*

When we observed the effectiveness in the male categories, there were significant associations in both combat phases, in the trunk-leg binary techniques with the Ippon advantage and with Wazari advantage only in the combat phase. Significant associations were recorded equally in both phases, with the advantage of Ippon and Wazari in the application of minimum arm lever techniques. Significant associations with non-scoring techniques were recorded in the combat phase, in the application of arm-leg binary techniques, medium arm lever techniques and variable arm lever techniques. In the golden score phase, this same association was only recorded with arm-leg binary techniques.

Table 3. Male binary techniques and advantages

	Adv Combat	Arm Leg	Trunk Leg	Arms	Total
Male	Ippon	26 a	16* b	0	42
	%	61.9%	38.1%	0.00%	100.0%
	Wazari	26 a	18* b	0	44
	%	59.1%	40.9%	0.00%	100.0%
	Non Score	1269* a	407 b	3	1679
	%	75.6%	24.2%	0.2%	100.0%
	Total	1321	441	3	1765
	%	74.8%	25.0%	0.2%	100.0%
	Adv GS	**Arm Leg**	**Trunk Leg**	**Arms**	**Total**
Male	Ippon	1a	3* b	0	4
	%	25.0%	75.0%	0.00%	100.0%
	Wazari	2a	3a	0	5
	%	40.0%	60.0%	0.00%	100.0%
	Non Score	122* a	45 b	0	167
	%	73.1%	26.9%	0.00%	100.0%
	Total	125	51	0	176
	%	71.0%	29.0%	0,00%	100.0%

Table 4. Male lever techniques and advantages

	Adv Combat	Midle Arm	Max Arm	Variab Arm	Min Arm	Total
Male	Ippon	0a	21a	19a	20* b	60
	%	0.0%	35.0%	31.7%	33.3%	100.0%
	Wazari	0a	26a,b	27 a	17* b	70
	%	0.0%	37.1%	38.6%	24.3%	100.0%
	Non Score	59* a	460b	572* b	176 c	1267
	%	4.7%	36.3%	45.1%	13.9%	100.0%
	Total	59	507	618	213	1397
	%	4.2%	36.3%	44.2%	15.2%	100.0%
	Adv GS	**Midle Arm**	**Max Arm**	**Variab Arm**	**Min Arm**	**Total**
Male	Ippon	0a, b	1 b	2a, b	3* a	6
	%	0.0%	16.7%	33.3%	50.0%	100.0%
	Wazari	0 a, b	1 b	1 b	4* a	6
	%	0.0%	16.7%	16.7%	66.7%	100.0%
	Non Score	6 a, b	82 b	84 b	21 a	193
	%	3.1%	42.5%	43.5%	10.9%	100.0%
	Total	6	84	87	28	205
	%	2.9%	41.0%	42.4%	13.7%	100.0%

When we observed the effectiveness in the female categories, there were significant associations in the use of trunk-leg binary techniques with the advantage of Wazari in the combat phase and Ippon in golden score. There were also significant associations in the combat phase, with the advantage of Ippon and Wazari in the application of minimum arm lever techniques. Significant associations with non-scoring techniques were recorded in the combat phase, in the application of arm-leg binary techniques and variable arm lever techniques.

Table 5. Female binary techniques and advantages

	Adv Combat	Arm Leg	Trunk Leg	Arms	Total
Female	Ippon	21a	12a	0	33
	%	63.6%	36.4%	0.00%	100.0%
	Wazari	14a	18* b	0	32
	%	43.8%	56.3%	0.00%	100.0%
	Non Score	1290* a	430 b	5	1725
	%	74.8%	24.9%	0.3%	100.0%
	Total	1325	460	5	1790
	%	74.0%	25.7%	0.3%	100.0%
	Adv GS	**Arm Leg**	**Trunk Leg**	**Arms**	**Total**
Female	Ippon	0a	3*b	0	3
	%	0.0%	100.0%	0.00%	100.0%
	Wazari	2a	2a	0	4
	%	50.0%	50.0%	0.00%	100.0%
	Non Score	137* a	67 b	1	205
	%	66.8%	32.7%	0.5%	100.0%
	Total	139	72	1	212
	%	65.5%	34.0%	0.5%	100.0%

Table 6. Female lever techniques and advantages

	Adv Combat	Midlle Arm	Max Arm	Variab Arm	Min Arm	Total
Female	Ippon	1a, b	6 b	5 b	9* a	21
	%	4.8%	28.6%	23.8%	42.9%	100.0%
	Wazari	0a, b	14 b	15 b	14* a	43
	%	0.0%	32.6%	34.9%	32.6%	100.0%
	Non Score	30a, b	288 b	373* b	127 a	818
	%	3.7%	35.2%	45.6%	15.5%	100.0%
	Total	31	308	393	150	882
	%	3.5%	34.9%	44.6%	17.0%	100.0%
	Adv GS	**Midlle Arm**	**Max Arm**	**Variab Arm**	**Min Arm**	**Total**
Female	Ippon	0a	2a	1a	0a	3
	%	0.0%	66.7%	33.3%	0.0%	100.0%
	Wazari	0a, b	5 b	3a	2a, b	10
	%	0.0%	50.0%	30.0%	20.0%	100.0%
	Non Score	2a, b	26b	70* a	17 a, b	115
	%	1.7%	22.6%	60.9%	14.8%	100.0%
	Total	2	33	74	19	128
	%	1.6%	25.8%	57.8%	14.8%	100.0%

DISCUSSION

Overall, we observed a predominance of use by judokas of binary techniques *(60%)* compared to the use of lever techniques *(40%)*. This evidence contradicts the results observed by Sterkowicz, Sacripanti and Sterkowicz-Przybycien *(2013) (lever 60.5% and binary 39.5%)* and Batista et al. *(2022) (lever 62% and binary 38%.)* which recorded an opposite reality. When analyzed by groups of techniques, the hierarchy of technical actions used in the combats analyzed in Tachi-Waza respect the same trend found by Batista et al. *(2022)*, in binary techniques *(arm-leg binary and trunk-leg binary)* and in lever techniques *(variable-arm, maximum-arm, minimum-arm and medium-arm lever techniques)*. However, if we analyze by genders the work of Batista et al. *(2022)* the hierarchical trend was not fully fulfilled in the same way as the results of our study, as well as the significant associations found between gender and type of techniques.

The trunk-leg binary and minimum arm lever techniques revealed significant effectiveness in both phases of combat in both genders categories, contrary to what reported Batista et al. *(2022)*, where they recorded significant effectiveness with minimum arm lever techniques, judged with the Wazari score in the male categories.

Throughout the combat phase in both genders, there were significant associations with the unscored execution of arm-leg binary techniques and variable arm lever techniques. Apparently, the training standardization worldwide tends to shape the technical options and their application frequency in modern judo *(Batista et al., 2022)*, with innovative technical actions even appearing in chaotic forms that escape the technical classicism observed in the recent past *(Sterkowicz, Sacripanti, & Sterkowicz-Przybycien, 2013)*.

This work, despite presenting a method of classifying the technique different from the conventionality of technical analysis works in judo, presents an interpretative limitation based on the absence of other technical-tactical indicators before the technical execution by the competitors.

Due to the somatotypical variability and decision-making of athletes, it will be interesting in future studies to evaluate trends in technical options and technical-tactical patterns in different weight categories and phases of the competition.

CONCLUSION

In both genders and phases of combat, the use of binary techniques predominated over lever techniques, with the hierarchy of technical resources used by judokas being identical.

In golden score, women showed a significant association with the use of trunk-leg binary techniques. Throughout the fights, women registered differences in the use of groups of techniques. The trunk-leg binary and minimum arm lever techniques revealed significant effectiveness in both phases of combat in both the male and female categories.

REFERENCES

1. Batista, M., Sequeira, D., Gancho, H., & Fernandes, J. (2022). Predominance of techniques analysis used in the final rounds of judo international competitions scoring for the Olympic ranking: A biomechanical approach. Retos, 46, 833–842.
2. Franchini, E. & Herrera-Valenzuela, T. (2017). Preparación Fisica para deportes de combate. Bogota: Kinesis. ISBN: 978-9588952284.
3. Marôco, J. (2018). Análise estatística com o SPSS Statistics (7ªed). Lisboa: Report Number.
4. Sterkowicz, S., Sacripanti, A., & Sterkowicz-Przybycien, K. (2013). Techniques frequently used during London Olympic judo tournaments: a biomechanical approach. Archives of Budo, 1(9), 51-58.