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Strategic adaptation in para taekwondo following the five-minute single-round rule: the 2023 World Championships and 2024 Paris Paralympics

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Authors' Contribution:

A Study Design
B Data Collection
C Statistical Analysis
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Abstract:

Background and Study Aim: The unified K44 classification and the revised five-minute single-round format have reshaped tactical demands in para taekwondo. The purpose of research is empirical evidence that can significantly influence training practices and competition strategies in the evolving landscape of para taekwondo.

Material and Methods: A total of 173 athletes from the 2023 World Para Taekwondo Championships and the 2024 Paris Paralympics were analysed using notational analysis. Offensive frequency, kick-to-score ratio, defensive success rate, and technical diversity were examined to compare winners and non-winners and to identify predictors of victory.

Results: Cross-tabulation analysis showed that non-winners exhibited a higher overall offensive frequency than winners (69.5% vs. 61.3%, $p<0.001$, $V = 0.087$) and also demonstrated a higher frequency of technical actions during the final 4–5 min phase of the match (23.7% vs. 20.6%, $p<0.001$, $V = 0.042$). In contrast, independent-samples t-tests showed that winners had significantly higher kick-to-score ratios (40.17% vs. 16.09%, $p<0.001$) and defensive success rates (83.91% vs. 59.83%, $p<0.001$) than non-winners. Logistic regression analysis further identified defensive success rate (OR = 1.135, 95% CI = 1.102 to 1.169, $p<0.001$) and kick-to-score ratio (OR = 1.051, 95% CI = 1.029 to 1.074, $p<0.001$) as significant predictors of match outcomes.

Conclusions: Under the revised para taekwondo rules prioritizing technical efficiency (kick-to-score ratio) and defensive stability (defensive success rate) is significantly more critical for winning than merely increasing offensive volume. In male K44 competition strategic pacing and robust defence emerge as the central performance determinants.

Keywords: combat sports; notational analysis; tactical efficiency; taekwondo rules

Dictionary:

K44 sport class – is a para taekwondo kyorugi sport class for athletes who meet the K44 impairment criteria specified in the World Para Taekwondo Athlete Classification Rules [8], generally involving upper-limb impairment or limb deficiency..

Pacing strategy – is the regulation of performance speed, effort distribution, and energy expenditure throughout competition, by which athletes manage fatigue and adapt their actions to task demands, opponent behaviour, and changing competitive conditions [14].

Technical-tactical indicators – calculated on the basis of specialized formulas, characterize the technical tactical performance of athletes [42].

1. Introduction

Para taekwondo, an adapted hand-to-hand activity (referring in some sense to the tradition of martial art) for athletes with physical impairments, has grown rapidly since the inaugural World Para Taekwondo Championships in 2009 [1]. Its inclusion in major events, such as the 2020 Tokyo Paralympics and 2022 Hangzhou Asian Para Games, reflects its increasing global recognition [2, 3]. Participation levels have also risen substantially, with 70 athletes from 37 countries competing in Tokyo [4] and 121 athletes from 54 countries competing in Paris [5], securing para taekwondo's official status in the 2028 Los Angeles Paralympics [6].

With this growth, significant rule changes were implemented to enhance competitiveness and fairness. Since 2021, para taekwondo matches have transitioned from the traditional three-round, two-minute format to a single five-minute round [7]. Additionally, the classification system was unified, integrating the K41 and K44 disability classes into a single K44 category starting in 2022 [8]. These modifications impose greater physiological demands on athletes by extending the duration of continuous combat and broadening the functional variability among competitors.

Taekwondo matches rely on aerobic energy systems and require efficient pacing strategies to sustain high-intensity performance [9-11]. In open-skill sports such as taekwondo, athletes must dynamically adjust their energy distribution based on physiological and psychological feedback [12, 13]. Complex regulatory processes—including endpoint perception, sensory feedback, and anticipatory control—govern athlete speed, power output, and energy consumption [14, 15].

Thus, strategic adaptation is essential for managing the prolonged match duration. However, most existing research on taekwondo strategies has focused on able-bodied athletes, overlooking the distinct physical constraints faced by para taekwondo competitors [16-18, 3].

Para taekwondo athletes, characterised by differences in balance, mobility, and limb functionality, may adopt fundamentally different tactical and technical approaches compared to their able-bodied counterparts [19, 20]. These unique factors require separate understanding of pacing, defensive strategies, and energy management.

A recent analysis of the 2020 Tokyo Paralympics, conducted under the former three-round format, indicated that winning athletes employed an efficiency-centred approach, characterised by fewer attacks but higher scoring efficiency and a greater reliance on defensive actions [3]. However, given the subsequent introduction of the five-minute single-round format and classification unification, these findings may no longer fully represent the current strategic demands of para taekwondo competitions.

Despite the evolving structure of para taekwondo, there remains a paucity of research examining how athletes have adapted their strategies to these significant rule changes. In particular, no study has yet comprehensively examined how tactical and technical patterns vary across time phases and weight categories or identified the key strategic factors associated with match outcomes in male para taekwondo under the unified K44 classification and the five-minute single-round format.

The purpose of research is empirical evidence that can significantly influence training practices and competition strategies in the evolving landscape of para taekwondo.

2. Materials and Methods

Experimental approach

The decomposition of the goal into tasks revealed two main ones. The first is to examine tactical and technical variations across weight categories and time phases. Second, to determine which strategic factors, including defensive efficiency and kicking diversity, are most strongly associated with match outcomes.

Systematically analysed the technical, tactical, and physical elements of para taekwondo athletes using notational analysis [16, 21, 22, 3]. It is the first study to segment and analyse these three aspects across time phases following major rule changes in para taekwondo. The tactical and technical variables previously used in Olympic Taekwondo match analyses were modified and adapted to reflect the specific characteristics of para taekwondo athletes [23, 3, 24].

Considering that head kicks—permitted until the 2020 Tokyo Paralympics [3]—were prohibited in the 2024 Paris Paralympics for athlete safety (World Taekwondo, 2024), they were excluded from the current analysis. Previous research showed that winners in para taekwondo had higher kick-to-score ratios than non-winners, suggesting that offensive efficiency is a key determinant of match outcomes [3]. Building on this perspective, the present study also considered defensive efficiency and therefore included defensive success rate as an additional variable in the analysis. To address the limitations of previous studies, both the kick-to-score ratio (%) and defensive success rate (%) against opponent kicks were calculated and included, as defined below:

- **kick-to-score ratio** (%) = (scoring kick frequency [n] / kicking frequency [n]) × 100
- defensive success rate (%) = (1 − points conceded / opponent's total attack frequency) × 100

The operational definitions of the technical and tactical indicators based on the official nomenclature of taekwondo techniques. These indicators were used for the tactical analysis and evaluation of para taekwondo matches (Table 1).

Table 1. Description of tactical and technical indicators in para taekwondo.

Technical-tactical indicators		English and Korean names and meaning
fighting stance	closed stance	a stance in which both athletes adopt the same lead foot position—*eotsseogi*
	open stance	a stance in which the athletes adopt opposite lead foot positions (i.e., one left foot forward, the other right)—*matseogi*
tactic	offensive	a proactive tactical action initiated by the athlete to gain an advantage through attack
	defensive	A reactive tactical manoeuvre performed in response to an opponent's offensive action
	open exchange	engaging without clear dominance following one attack and one defence
	close-range exchange	executing a kick during a clinch or close-contact engagement
technique	kicking	roundhouse kick—*dollyeo chagi* skipping kick—*balbutyeo chagi* step-in kick—*apbal ditgo dollyeo chagi* push kick—mireo chagi double kick—*dubal yeonsok chagi* back kick—*dwi chagi* tornado kick—*360° dollyo chagi* anomalous kick—*byeonchik balchagi*

kicking leg	front	the leg positioned forward, used to initiate offensive or defensive kicking techniques
	rear	the leg positioned behind, commonly used for more powerful kicking techniques
target	trunk	2 points for a valid foot technique to the trunk
		3 points for a valid turning foot technique to the trunk protector
		4 points awarded for a valid spinning technique to the trunk protector

Participants

A total of 173 male K44-class para taekwondo athletes were included in this study. All athletes competed under the unified K43–K44 classification and the revised five-minute single-round rule implemented in September 2021. Specifically, 99 athletes participated in the 2023 World Para Taekwondo Championships and 74 athletes participated in the 2024 Paris Paralympics. By weight category, the sample comprised 36 athletes in the −58 kg division, 38 in the −63 kg division, 34 in the −70 kg division, 36 in the −80 kg division, and 29 in the +80 kg division, for a total of 173 athletes.

Official Paralympic match videos were obtained from World Taekwondo (WT) and used for analysis, with formal authorisation secured for the use of all match footage.

This study utilised publicly available match videos from the 2023 World Para Taekwondo Championships and the 2024 Paris Paralympics. According to the American Psychological Association (APA, 2017) guidelines, these videos were not subject to Institutional Review Board (IRB) approval requirements. Nevertheless, approval (HYUIRB-202504-017) was obtained from the IRB prior to commencement of the study, and all personal data were coded to ensure strict anonymity and confidentiality.

Procedures

In this study, match data were collected using Dartfish 24 software, recording a wide range of indicators, including factors such as match information, scoring and conceding, kicking technique, offensive and defensive, scoring-type, conceding-type, as well as kick-to-score ratio, defensive success rate, and the kicking technique diversity index. All data were analysed using Microsoft Excel for Windows 2016 (Microsoft Corp., Redmond, WA, USA).

Data collection was conducted by two national team performance analysts, each with over 20 years of experience and a fifth-degree black belt in taekwondo, along with one additional expert. To ensure inter-observer consistency and reliability, data from 10 matches were independently coded and compared, yielding an intraclass correlation coefficient (ICC) of 0.94 (95% *CI*: 0.88–0.96), indicating robust reliability.

Statistical analysis

Frequencies and percentages were presented for the categorical variables used in this study, including weight category (−58 to +80 kg), match situation factors (offence, defence, open exchange, close exchange), kicking techniques (roundhouse kick, axe kick, spin kick, back kick, step-in kick, front-leg roundhouse kick), kicking leg (left, right), and fighting stance (closed stance, open stance). Continuous variables such as kick-to-score ratio, the defensive success rate were reported with mean, standard deviation (SD), and 95% confidence interval (95% *CI*).

Normality of the data was assessed using the Kolmogorov–Smirnov test. Chi-square goodness-of-fit and independent tests were performed to examine the differences in the distribution of categorical variables. When statistically significant differences were identified, a post-hoc Bonferroni correction was applied to assess the differences in column proportions.

Independent samples t-tests were conducted to compare the kick-to-score and attack frequency ratios between winners and non-winners by weight class and match time intervals (0–1 minute, 1–2 minutes, 2–3 minutes, 3–4 minutes, and 4–5 minutes).

Effect sizes for chi-square tests were calculated using Cramér's V and Cohen's W (Cohen, 2013), with thresholds interpreted as 0.1 for a small effect, 0.3 for a medium effect, and 0.5 for a large effect. Finally, binary logistic regression analyses were conducted to examine factors influencing match outcomes, with results presented as odds ratios (*OR*) and 95% CI.

All statistical analyses were performed using SPSS version 28.0 (SPSS Inc., Chicago, IL, USA), with the significance level set at $\alpha = 0.05$.

3. Results

Across weight categories, winners generally exhibited a more selective tactical-technical profile than non-winners (Table 2, with additional commentary below). Because Cramer's V reflects only the magnitude of winner–non-winner differences, the corresponding frequency distributions were examined to interpret directionality. . Kicking type included roundhouse, skipping, step-in, push, double kick, back kick, tornado, and anomalous kicks. Kick execution time window was classified into five one-minute intervals: 0–1 min, 1–2 min, 2–3 min, 3–4 min, and 4–5 min. In weight classes showing significant effects, non-winners tended to demonstrate higher offensive frequencies, greater reliance on open exchanges, and more frequent use of roundhouse-based actions. By contrast, winners showed relatively lower offensive output and less dependence on repetitive technical patterns, suggesting a more controlled and less predictable approach to match management.

Table 2. Cramer's V values comparing winners and non-winners on tactical and technical variables by weight class.

Variable	–58 kg	–63 kg	–70 kg	–80 kg	+80 kg	Total
tactic1 (offensive vs. defensive)	0.014	**0.111*****	**0.103*****	**0.120*****	**0.116*****	**0.087*****
tactic 2 (open-exchange vs. clinch)	0.006	**0.079****	0.049	**0.061***	**0.091****	**0.056*****
kicking leg (left vs. right)	**0.029***	0.030	**0.068*****	**0.065*****	0.034	**0.029*****
kicking type	**0.101*****	**0.116*****	0.057	**0.108*****	**0.181*****	**0.083*****
kick execution time window	0.034	0.033	0.047	0.05	**0.074****	**0.042*****

Asterisks indicate significance levels (*p<0.05, **p<0.01, ***p<0.001).

Time-segmented analyses (Figure 1) revealed no interval-based differences in the −58 kg category. By contrast, in the −63, −70, −80, and +80 kg divisions, non-winners demonstrated increased offensive and kicking frequencies during the later stages (3–5 minutes). In particular, non-winners in the −70, −80, and +80 kg divisions recorded significantly higher offensive and kicking frequencies than winners during the 4–5 minute interval.

Efficiency-related indicators (Figure 2) further differentiated winners from non-winners. With the exception of the −63 kg division (where defensive success rate did not differ significantly), winners consistently achieved higher defensive success rates and kick-to-score ratios across all categories. At the aggregate level, winners outperformed non-winners in both defensive success rate (83.91% vs. 59.83%) and kick-to-score ratio (40.17% vs. 16.09%) (both $p<0.001$).

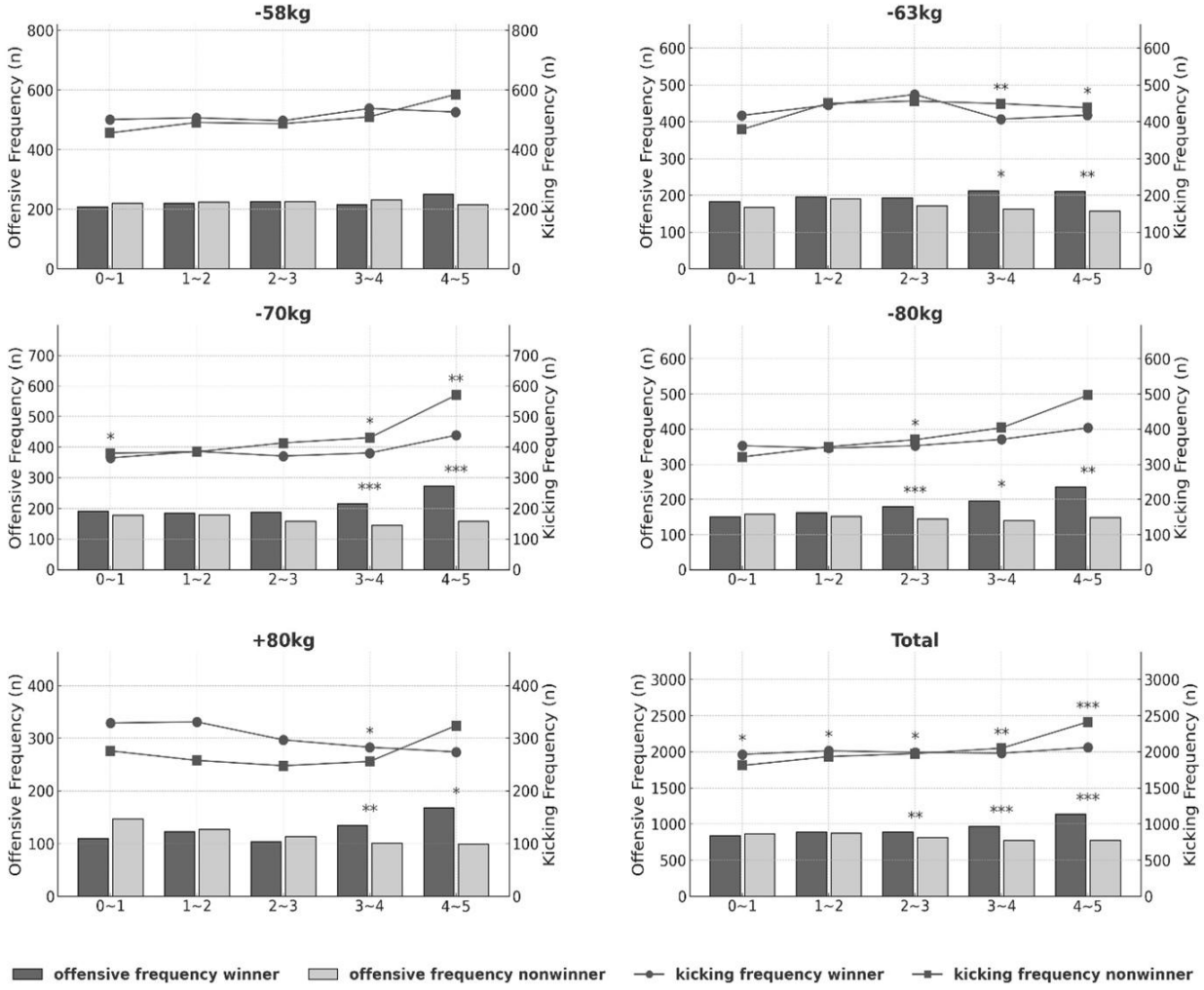

Figure 1. The results of offensive and kicking frequency according to match outcome (winner vs. non-winner) by weight category and time interval (significantly different from the winner group: *$p<0.05$, **$p<0.01$, ***$p<0.001$).

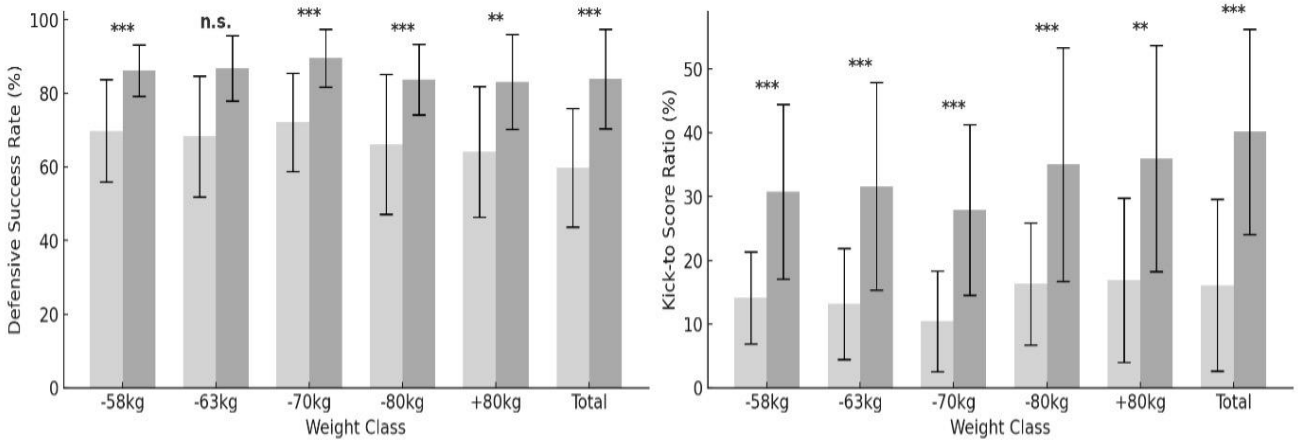

Figure 2. The results of defensive success rate and kick-to-score ratio according to match outcome (winner vs. non-winner) by weight class (significantly different from the winner group: **p*<0.05, ***p*<0.01, ****p*<0.001, n.s.: not significant)

Logistic regression analyses (Table 3) confirmed defensive success rate and kick-to-score ratio as significant predictors of match outcomes across weight divisions, with the exception that only defensive success rate was significant in the −63 kg division. In the overall sample, both indicators significantly predicted match success (kick-to-score ratio: *OR* = 1.051, 95% *CI* = 1.029 to 1.074, *p*<0.001; defensive success rate: *OR* = 1.135, 95% *CI* = 1.102 to 1.169, *p*<0.001).

In summary winners were distinguished from non-winners more by performance efficiency than by activity volume as they showed lower offensive frequencies but higher defensive success rates and kick-to-score ratios. These patterns were more evident in the later stages of the match and logistic regression further identified defensive success rate and kick-to-score ratio as the most consistent predictors of match outcomes.

Table 3. Logistic regression analysis for defensive success rate and kick-to-score ratio.

Weight	Variables	B	S.E.	Wald	*p* value	Odds Ratio[95% CI]
−58kg	defensive success rate	0.273	0.084	10.668	**0.001**	1.314 [1.115-1.547]
	kick-to score ratio	0.268	0.083	10.332	**0.001**	1.308 [1.110-1.540]
−63kg	defensive success rate	0.152	0.038	16.272	**<0.001**	1.164 [1.081-1.253]
−70kg	defensive success rate	0.555	0.202	7.525	0.006	1.741 [1.172-2.588]
	kick-to score ratio	0.501	0.174	8.297	**0.004**	1.651 [1.174-2.322]
−80kg	defensive success rate	0.122	0.037	10.886	**0.001**	1.129 [1.051-1.214]
	kick-to score ratio	0.136	0.039	12.113	**0.001**	1.146[1.061-1.237]
+80kg	kick-to score ratio	0.183	0.084	4.793	**0.029**	1.201 [1.019-1.415]
	defensive success rate	0.211	0.093	5.128	**0.024**	1.235 [1.029-1.484]
Total	kick-to score ratio	0.050	0.011	20.656	**<0.001**	1.051 [1.029-1.074]
	defensive success rate	0.127	0.015	71.462	**<0.001**	1.135 [1.102-1.169]

B unstandardized coefficient, **S.E.** standard error, 95% **CI** 95% confidence interval.

4. Discussion

This study provides knowledge how male para taekwondo athletes adapted their match strategies following the implementation of the unified K44 classification and the revised five-minute single-round format. Through notational analysis [25,26], technical and tactical elements—including pacing strategies, defensive success rates, and kick-to-score ratios—were systematically evaluated based on outcomes from the 2023 World Para Taekwondo Championships and the 2024 Paris Paralympics.

A central finding was that winners exhibited lower offensive frequencies, but significantly higher defensive success rates and kick-to-score ratios compared with non-winners. This efficiency-oriented approach is consistent with prior evidence from Olympic Taekwondo [27, 16] and earlier para taekwondo studies under the three-round system [3], underscoring the continuing importance of defensive efficacy and scoring efficiency as decisive determinants of success.

The introduction of the five-minute single-round format further magnifies the role of pacing. Time-segmented analyses (Figures 1 and 2) revealed that winners initiated higher kicking activity early, particularly within the first minute (p<0.001), to establish momentum, while non-winners increased offensive and kicking activity during the later stages (4–5 minutes), often without corresponding gains in scoring efficiency. These trends suggest that non-winners either rushed to recover deficits or were hindered by early inefficient energy expenditure [28].

Pacing refers to the strategic regulation of effort distribution throughout a match to optimise performance and delay fatigue [14,29]. Under the continuous five-minute single-round format, the absence of inter-round recovery likely accelerates fatigue accumulation and places greater importance on efficient energy distribution [29-31]. In this context, winners appeared to manage effort more effectively by scoring efficiently early and maintaining defensive stability in the later stages, whereas non-winners increased activity volume without comparable scoring returns.

Another critical finding was the consistent significance of defensive success rates as a predictor of victory. Except for the −63 kg category, winning athletes across all divisions demonstrated significantly higher defensive success rates (Figure 1, Table 3). Logistic regression analysis further confirmed that defensive success rates were significant positive predictors of match success across most weight categories (p<0.05).

In the context of continuous play without rest intervals, minimising conceded points controls the scoreboard, conserves energy, delays fatigue, and stabilises match dynamics [33, 34, 3]. High defensive efficacy disrupts opponents' momentum and provides psychological advantages [35]. Given that K44 athletes often face limitations in blocking techniques due to upper limb impairments [36], alternative defensive strategies, such as dodging, stepping, and distance control, become even more crucial. Moreover, effective counterattacks, including anticipatory, simultaneous, and delayed counters, can serve as powerful tools to neutralise opponent offences and shift match momentum [28]. Considering the potential for slower post-attack recovery in K44 athletes due to physical impairments, the timing and execution of counterattacks may be even more decisive compared to able-bodied competitions [36].

Criticism of the monotonous front-leg "paddle kicking" and reduced technical diversity in Olympic Taekwondo following the introduction of electronic protectors (PSS) has been well documented [37, 38]. In contrast, the present findings provide quantitative

support for this concern particularly among non-winners. In the −63 kg division non-winners showed significantly greater reliance on roundhouse kicks (V = 0.116, p<0.001), while in the −70 kg division they demonstrated significantly greater front-leg dependence (V = 0.068, p<0.001). Similar tendencies were also observed in the −80 kg and +80 kg divisions where non-winners continued to rely more heavily on front-leg and roundhouse-based attacking patterns. These results suggest that non-winners adopted more predictable and technically repetitive strategies whereas winners appeared to employ a more flexible and less anticipatable technical repertoire under the demands of the five-minute single-round format. Such technical-tactical flexibility may be particularly important for K44 athletes with unique mobility and balance challenges [36].

Overall, our results support the importance of the efficiency and quality of technical execution, rather than the quantity of attacks, in ultimately distinguishing winners from non-winners [40, 3]. However, some limitations should be acknowledged. This study focused solely on male K44 athletes, thus limiting its generalizability to other classifications (e.g., K43) or female athletes. Furthermore, as the analysis was based on video observation, direct measurements of physiological load (e.g., heart rate and lactate concentration) and psychological status (e.g., RPE) were not captured [40, 31] Additionally, heterogeneity within the K44 classification regarding impairment types was not separately analysed. Future studies should include female and K43 athletes, incorporate wearable physiological monitoring during matches, and perform subgroup analyses based on impairment type. Longitudinal studies tracking the long-term effects of rule changes and research focusing on the development of protective equipment are warranted [41].

5. Conclusions

This study showed that male para taekwondo athletes adapted strategically to the unified K44 classification and the five-minute single-round format by emphasising efficiency rather than attack volume. Winners were distinguished by higher kick-to-score ratios and defensive success rates, indicating the importance of effective pacing and defensive stability under the revised competition format. These findings suggest that training should prioritise impairment-specific defensive and counterattacking skills, competition-specific endurance, and flexible pacing strategies.

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Data Availability Statement: The data supporting this study's findings are available from the corresponding author upon reasonable request.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Hanyang University (protocol code HYUIRB-202504-017, approval date: April 2025).

Conflicts of Interest: The authors declare no conflicts of interest.

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