Performance indicators characterisation of a world champion underwater rugby team in the final stages of competition

Caracterización de los indicadores de rendimiento de un equipo campeón mundial de rugby subacuático en las fases finales de competición

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Abstract

Introduction: Underwater rugby is a team sport with unique physiological and spatial characteristics. Despite its increasing international competitiveness, there is limited evidence on performance analysis. This study aimed to examine the performance indicators of the Colombian men's team during the final phase of the 2019 World Championship.
Method: A nomothetic, longitudinal observational design was used, analyzing 2,515 sequences of offensive and defensive actions across three matches (quarter-final, semi-final, and final). Data was collected using a validated, expert-reviewed ad hoc instrument focused on passes, possession, and offensive efficiency. Descriptive statistics and heat maps were used to interpret spatial and tactical dynamics.
Results: Colombia demonstrated high pass completion rates and possession dominance (over 60% of total time, and more than 75% in the offensive zone). Offensive play primarily utilized central and wall zones for passing. Offensive efficiency varied: 14.8% in the quarter-final, 3.84% in the semi-final, and 6.8% in the final. The team showed tactical consistency, maintaining clear patterns of ball distribution and territorial control.
Discussion: The analysis revealed a strategy based on game control through possession and targeted use of key areas of the pool. Despite positional dominance, low goal efficiency indicates a need for improvement in offensive finishing. The findings provide useful insights for training and tactical planning, highlighting the value of performance analysis in emerging sports such as underwater rugby.

Keywords

Performance analysis; team sports; tactical behaviour; match analysis; athletic performance

Resumen

Introducción: El rugby subacuático es un deporte colectivo con características fisiológicas y espaciales únicas. A pesar de su creciente competitividad internacional, hay escasa evidencia sobre su análisis del rendimiento. Este estudio tiene como objetivo examinar los indicadores de rendimiento del equipo colombiano masculino durante la fase final del Campeonato Mundial 2019.
Método: Se empleó un diseño observacional nomotético y longitudinal, analizando 2.515 secuencias de acciones ofensivas y defensivas en tres partidos (cuartos de final, semifinal y final). Los datos fueron extraídos mediante un instrumento ad hoc validado por expertos, centrado en pases, posesión y eficiencia ofensiva. Se utilizó análisis estadístico descriptivo y mapas de calor para visualizar zonas de pase.
Resultados: Colombia presentó altos porcentajes de pases completados y dominio de la posesión (>60% del tiempo total, con más del 75% en zona ofensiva). Se privilegió el uso de zonas central y de pared para los pases ofensivos. La eficiencia ofensiva fue variable: 14.8% en cuartos, 3.84% en semifinal y 6.8% en la final. El equipo mostró consistencia táctica, manteniendo patrones de distribución del balón y control territorial.
Discusión: El análisis revela una estrategia enfocada en el control del juego mediante la posesión y el uso de zonas clave del campo. A pesar del dominio posicional, la baja eficiencia en goles sugiere la necesidad de optimizar la finalización ofensiva. Los hallazgos ofrecen herramientas aplicables al entrenamiento y la planificación táctica, resaltando la importancia del análisis del rendimiento en deportes emergentes como el rugby subacuático.

Palabras clave

Análisis del rendimiento; deportes de equipo; comportamiento táctico; análisis de juego; rendimiento deportivo

Introduction

In the realm of high-performance sports, performance observation during competition is crucial for understanding game dynamics and, more importantly, for developing strategies that lead to success. Through advanced analytical tools, such as video analysis and data collection, coaches can obtain valuable insights into both individual and collective actions, enabling optimal team preparation. This process transcends simple evaluation, serving as a cornerstone for innovation and continuous improvement by fostering technical refinement and the development of more effective tactical frameworks (Aquino et al., 2019; Suárez et al., 2014; Vergonis et al., 2019).

In team sports with segmented logic such as handball, basketball, and water polo, performance indicators derived from observational methodologies have proven to be critical in tactical and strategic analysis (Escalante et al., 2012; Garganta, 2009; Gruić et al., 2006). These sports share structural similarities with underwater rugby, particularly regarding the use of space, player positioning, and continuous alternation between offensive and defensive phases.

Underwater rugby is a sport with unique structural and physiological features, including full immersion, three-dimensional space, and breath-holding requirements(Martinez-Delgado et al., 2023). These characteristics differentiate it from both terrestrial and other aquatic team sports. However, despite its global competitive structure, there is a lack of performance analysis research specific to underwater rugby. Addressing this gap is essential for advancing tactical understanding and supporting evidence-based coaching in the sport (Gaviria Alzate & Ramírez González, 2023; Martinez-Delgado et al., 2023).

Underwater rugby, as a high-level team sport, requires meticulous analysis of in-game actions to uncover gameplay patterns and formulate strategies that maximize performance (Gaviria Alzate & Ramírez González, 2023; Martinez-Delgado et al., 2023). The Underwater Rugby World Championships, in particular, provide an environment of unparalleled competitive intensity, where even the smallest detail can determine the outcome. Performance observation during these tournaments, therefore, becomes indispensable not only for assessing the effectiveness of strategies but also for driving the ongoing evolution of the sport on a global scale (Amatria et al., 2019; Aquino et al., 2019; Sarmento et al., 2018).

This comprehensive understanding of the game, derived from performance observation, empowers coaches and players alike. It facilitates the optimization of physical and technical preparation, the design of opponent-specific strategies, and the ability to make informed tactical decisions during competition (Alves et al., 2019). Beyond evaluation, performance observation serves as a catalyst for innovation, inspiring the development of novel strategies, the exploration of alternative playing styles, and the ongoing advancement of underwater rugby at the international level (Dufour et al., 2017; Schulze et al., 2022).

The significance of performance analysis extends beyond traditional team sports to adaptive sports like wheelchair basketball, where athletes face unique functional challenges. (Arroyo et al., 2024) in their study, demonstrate how observational methodologies can provide critical insights into the shooting behaviour of athletes with different levels of functional limitation. Their findings underline the value of targeted performance analysis in improving training approaches and refining strategies for success in competitive environments. This research highlights the importance of tailored strategies in maximizing athlete performance, which is equally applicable to high-performance sports like underwater rugby, where understanding the finer details of gameplay is crucial for sustained success.

Performance observation, particularly during World Cup competitions, serves as a foundational pillar for success in underwater rugby (Alves et al., 2019; Stavropoulos et al., 2021; Vaz et al., 2019). This invaluable resource empowers national teams to maximize their potential and strive for glory on the sport's most prestigious stage. (Amatria et al., 2019) emphasize the pivotal role of performance analysis in understanding and optimizing team dynamics during championships, particularly by identifying successful offensive play patterns. Analysing a team's style of play yields actionable insights for emulating effective strategies and crafting counter-tactics. Through detailed observational studies, researchers uncover hidden behavioural patterns that drive team success, providing a framework to enhance training and game preparation (Stavropoulos et al., 2021). These results not only reinforce the effectiveness of

replicating successful strategies but also provide coaches with valuable insights for developing customised defensive approaches. As a result, performance analysis plays a crucial role in enhancing competitive success at the elite level by refining both tactical and strategic decision-making (Taha, 2022).

The aim of this study was to examine the performance indicators of the Colombian national underwater rugby team during the final stage of the 2019 World Championship in Graz.

Method

This study followed a nomothetic, descriptive, and multidimensional longitudinal observational design (Argilaga et al., 2011). The primary objective was to examine the performance indicators of the Colombian national underwater rugby team during the final stage of the 2019 World Championship in Graz.

The analysis was structured across two sampling levels: intersessional (three final-stage matches: quarter-final, semi-final, and final) and intrasessional, comprising a total of 2,515 discrete sequences of offensive and defensive actions. These sequences were identified and analysed post-match. The performance indicators were calculated as outcome-based metrics derived from systematic video analysis, rather than from a conventional field format or categorical observation system (Argilaga et al., 2011).

Sample

The analysis was based on three matches played by the Colombian men's team during the latter stages of the tournament: the quarter-final against Finland, the semi-final against Denmark, and the final against Norway (CMAS, 2019).

Procedure

Observation instrument

In order to obtain theoretical validation of the instrument, we followed the guidelines proposed by (Hernández-Nieto, 2011), which recommend involving three to five experts for content validation. For this study, five experienced underwater rugby coaches were invited to participate, selected through a convenience sampling method. Of these, three agreed to contribute to the validation process.

The selection criteria for the experts, based on (Alencar Abaide et al., 2007), required that none of them had prior involvement in the research design, each holding a minimum of ten years of active experience in coaching underwater rugby, and possessing advanced academic or professional credentials. Two of the experts held master's degrees, with one having obtained it from internationally recognized universities, specializing in sports science and match analysis. The third expert was a certified coach with extensive practical experience, including leading a team at the international competitive level. The collective expertise of the specialists ensured that the performance indicators outlined in Table 1 were both theoretically grounded and practically applicable for analysing gameplay dynamics in underwater rugby.

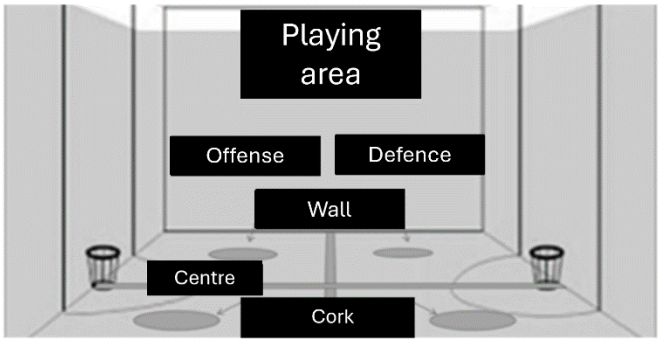
Table 1 presents the performance indicators used to assess gameplay dynamics, focusing on key metrics such as passing, ball possession, and offensive efficiency. These indicators were developed collaboratively by the aforementioned experts, whose contributions ensured their practical relevance. Further validation was achieved through expert discussions and consensus. To enhance reliability, a content validity index (CVI) was calculated based on expert assessments, yielding a satisfactory coefficient (>0.80), supporting its application in performance analysis (Hernández-Nieto, 2011).

The design process also incorporated scientific evidence from match analysis in team sports (Arroyo et al., 2024; Plakias et al., 2024; Taha, 2022), highlighting the effectiveness and strategic execution of team actions. The ad hoc observation tool described in Table 1 provides a structured framework for data collection, encompassing offensive and defensive actions, ball possession, and passing zones. To ensure consistency and accuracy, the spatial framework for these observations is illustrated in Figure 1, offering a systematic and transparent approach to team performance analysis.

Table 1. Performance indicators for gameplay dynamics analysis

Category	Metric	Definition
Passes (Number of Times)	Completed Passes	The number of passes that successfully reach a teammate without interference.
	Attacking Passes	The number of successful passes made in the offensive zone on the opponent's side of the field.
	Intercepted Passes	All passes that are intercepted before reaching their intended recipient.
	Pass Percentage	The percentage of passes completed by the team compared to the total passes between both teams.
	Total Passes	The total number of passes completed effectively.
	Central Defensive Passes	The number of successful passes made in the central defensive zone on the team's side of the field.
	Wall Defensive Passes	The number of successful passes made in the wall defensive zone on the team's side of the field.
	Cork Defensive Passes	The number of successful passes made in the cork defensive zone on the team's side of the field.
	Wall Attacking Passes	The number of successful passes made in the wall offensive zone on the opponent's side of the field.
	Cork Attacking Passes	The number of successful passes made in the cork offensive zone on the opponent's side of the field.
	Central Attacking Passes	The number of successful passes made in the central offensive zone on the opponent's side of the field.
Ball Possession (Seconds)	Per Match	The total time in seconds that the team maintained ball possession during the match.
	In Defense	The amount of time the ball was in the defensive zone on the team's side of the field.
	In Attack	The amount of time the ball was in the offensive zone on the opponent's side of the field.
	Possession Percentage	The total percentage of time the team maintained ball possession during the match.
Offensive Metrics (Number of Times)	Attacks	The total number of offensive plays completed, regardless of whether they resulted in a goal, where the attacker made contact with the opponent's goalkeeper.
	Number of Goals	The total number of goals scored by the team.
	Attack Efficiency Percentage	The total number of goals scored as a percentage of the total number of attacks per match.

Figure 1. Spatial framework for passing zones and game analysis



Developed by the authors

Match analysis and bias control

The matches were analysed using official recordings available on the championship's official website (CMAS, 2019). To enhance reliability and minimise potential bias, three physical education professionals with expertise in performance analysis underwent an intensive training programme totalling over 360 minutes, distributed across six sessions. These sessions were designed to standardise their observations and ensure consistency in the interpretation of the analysed variables.

Data were recorded only when all evaluators reached a unanimous agreement on the variables assessed. To verify data quality, an inter-observer reliability analysis was conducted, yielding an intraclass correlation coefficient (ICC) exceeding 0.90 across all variables listed in Table 1. This high level of agreement aligns with the standards proposed by (Koo & Li, 2016), reinforcing the consistency and reliability of the collected data.

Data analysis

Statistical analyses were performed using SPSS version 23. Results were reported as mean values derived from the observations of the three evaluators. The analyses focused on identifying trends in ball possession, passing accuracy, and scoring performance across the observed matches. Additionally, a heat map was generated using Python within the Visual Studio Code environment (Visual Studio Code, 2025) to visualise the spatial distribution of passing actions in the offensive and defensive zones, providing further insights into positional tendencies and field utilisation.

Results

Table 2 presents the performance indicators from the quarter-final match between Colombia and Finland during the 2019 Underwater Rugby World Championship. The data show that Colombia completed a total of 163 passes, with 129 (79.1%) executed in the offensive zone. Within this zone, 54 passes were directed through the central area. Regarding ball possession, the Colombian team maintained control for 1,487 seconds, corresponding to 79.4% of the total match time. Of this duration, 1,122 seconds (approximately 75.4%) were in the offensive zone.

Finland recorded 55 total passes, 31 of which were attacking passes. They maintained possession for 384 seconds (20.5% of total match time), with 298 seconds (77.6%) in their offensive zone.

In terms of offensive metrics, Colombia conducted 27 attacking sequences, resulting in four goals. This corresponds to an attack efficiency of 14.8%. Finland did not register any goals during the match.

These performance indicators suggest a higher frequency of ball circulation in offensive zones by Colombia and a greater amount of time maintaining possession during the match. No qualitative interpretations are provided beyond the metrics observed.

Table 2. Game Analysis of the quarterfinals: Colombia vs. Finland, 2019 underwater rugby world championship, Graz, Austria.

Criterion	Team	Colombia					Finland				
	Period	1st Half		2nd Half		Total Match	1st Half		2sd Half		Total Match
	Variable	Total	% relative to the opponent	Total	% relative to the opponent		Total	% relative to the opponent	Total	% relative to the opponent	
Passes	Completed Passes	86.3	78.6	72	74.5	158	23	21.3	24.7	25.5	48
	Attacking Passes	72.3	83.5	56.7	77.6	129	14.3	16.5	16.3	22.1	31
	Intercepted Passes	2.3	36.8	2.7	46.8	5	4	63.2	3	53	7
	Total Passes	88.7	76.6	74.7	73	163	27	23.4	27.6	27	55
	Central Defensive Passes	8.3	69.5	8.7	61.9	17	3.7	30.5	5.3	38	9
	Wall Defensive Passes	3	47.4	5	63	8	3.3	52.6	3	37.5	6
	Cork Defensive Passes	4	80	5.3	76.3	9	1	20	1.6	23.7	3
	Wall Attacking Passes	20	78.5	13	65	33	5.3	21.4	7	35	12
	Cork Attacking Passes	16	65.7	25.6	77.8	42	8.3	34.3	7.3	22.1	16
	Central Attacking Passes	36	93.9	17.7	82.8	54	2.3	6.7	3.7	17.2	6
Ball Possession (s)	Per Match	771.7	83.5	715	75.6	1487	152.6	16.1	231.3	24.4	384
	In Defense	132.7	71.6	188.3	78.3	321	52.7	28.4	52.3	21.7	105
	In Attack	640	83.4	481.7	73.8	1122	127	16.5	171.3	26.2	298
	Possession %	85.8	83.5	79.4	82.4	16.5	16.7	16.1	25.7	24.4	42
Offensive Metrics	Attacks	14.3	100	12.3	100	27	0	0	0	0	0
	Number of Goals	4	100	0	0	4	0	0	0	0	0
	Attack Efficiency %	27.9	100	0	0	28	0	0	0	0	0

Table 3 presents the performance indicators from the semi-final match between Colombia and Denmark, which included an additional third period resolved by a golden goal. Colombia completed a total of 318 passes, of which 276.4 were classified as attacking passes. A substantial proportion of these (142.3) occurred in the wall attacking zone.

Ball possession data show that Colombia maintained control for 1,602.3 seconds, accounting for approximately 60% of the total match duration. Of this time, 1,472 seconds (92%) occurred in the offensive zone. Denmark, by contrast, had a total possession time of 1,111.8 seconds (around 40%), with 652.3 seconds in the offensive zone.

Regarding offensive metrics, Colombia registered 26 attacking sequences but scored only one goal, achieved during the golden goal period. This resulted in an attack efficiency of 3.84%. Denmark also generated 18.3 attacking sequences but did not score.

In relation to interception data, Denmark achieved a higher percentage of intercepted passes during the third period (67.9%). The match data reflect a higher frequency of ball possession and attacking activity by Colombia, with both teams displaying similar totals in several categories, though outcomes varied.

Table 3. Game analysis of the semifinals: Colombia vs. Denmark, 2019 underwater rugby world championship, Graz, Austria.

Criterion	Team	Colombia							Denmark						
	Period	1st Half		2nd Half		3rd Half		Total Match	1st Half		2sd Half		3rd Half		Total Match
	Variable	Total	% relative to the opponent	Total	% relative to the opponent	Total	% relative to the opponent		Total	% relative to the opponent	Total	% relative to the opponent	Total	% relative to the opponent	
Passes	Completed Passes	102.0	52	119.0	57.3	87.0	61.6	308	94.3	48	88.0	42.7	54.3	38.4	236.6
	Attacking Passes	92.0	52.6	108.7	58.4	75.7	64.1	276.4	83.0	47.4	77.3	41.6	42.3	35.9	202.6
	Intercepted Passes	3.3	43.4	3.7	65	2.7	32.1	9.7	43.0	56.6	2.0	35	5.7	67.9	50.7
	Total Passes	105.3	51.6	123.3	57.8	89.7	59.9	318,3	98.7	48.4	90.0	42.2	60.0	40.1	248.7
	Central Defensive Passes	3.0	32.2	5.0	60.2	3.7	38.1	11.7	6.3	67.8	3.3	39.8	6.0	61.9	15.6
	Wall Defensive Passes	4.0	57.1	2.7	35	5.3	55.2	12	3.0	42.9	5.0	65	4.3	44.8	12.3
	Cork Defensive Passes	2.7	61.4	3.3	66	2.0	54	8	1.7	38.6	1.7	34	1.7	46	5.1
	Wall Attacking Passes	53.3	65	55.0	69.9	34.0	69.4	142.3	28.7	35	23.7	30.1	15.0	30.6	67.4
	Cork Attacking Passes	14.0	51.3	21.3	52.5	17.3	72	52.6	13.3	48.7	19.3	47.5	6.7	28	39.3
	Central Attacking Passes	25.3	38.2	32.0	48	24.7	54.4	82	41.0	61.8	34.7	52	20.7	45.6	96.4
Ball Possession (s)	Per Match	517.3	55.4	500.0	55.3	585.0	66.8	1602.3	416.7	44.6	404.7	44.7	290.0	33.2	1111.8
	In Defense	41.3	40.5	52.7	32.4	43.7	31	137.7	60.7	59.5	109.7	67.6	97.3	69	267.7
	In Attack	487.3	60.7	436.7	70.9	548.0	77.6	1472	315.3	39.3	179.0	29.1	158.0	22.4	652.3
	Possession %	57.5	55.4	55.6	55.3	65.0	66.9	178.1	46.3	44.6	45.0	44.7	32.2	33.1	123.5
Offensive Metrics	Attacks	5.3	45.7	11.0	55	9.7	76.4	26	6.3	54.3	9.0	45	3.0	23.6	18.3
	Number of Goals	0	0	0	0	1	100	1	0	0	0	0	0	0	0
	Attack Efficiency %	0	0	0	0	3.84	100	3.84	0	0	0	0	0	0	0

Table 4 summarises the performance metrics from the final match between Colombia and Norway. Colombia completed 181.6 total passes, of which 149.6 (82.3%) were attacking passes. Within the offensive zone, 84.6 passes were directed through the central area, indicating a frequent use of that space.

Ball possession for Colombia totalled 1,201.6 seconds (approximately 68.4% of the match time), with 1,087.2 seconds (90.5%) in the offensive zone. Norway recorded 555.6 seconds of ball possession (31.6%), with 438 seconds (78.8%) spent in their offensive zone.

Colombia executed 29.6 attacking sequences, scoring two goals, which corresponds to an attack efficiency of 6.8%. Norway registered 17.3 attacking sequences without scoring.

The data indicate a more frequent execution of passing actions and longer ball possession times by Colombia in offensive areas. No further interpretations beyond the observed indicators have been made in this section.

Table 4. Game analysis of the final: Colombia vs. Norway, 2019 underwater rugby world championship, Graz, Austria.

Criterion	Team	Colombia					Norway				
	Period	1st Half		2nd Half		Total Match	1st Half		2sd Half		Total Match
	Variable	Total	% relative to the opponent	Total	% relative to the opponent		Total	% relative to the opponent	Total	% relative to the opponent	
Passes	Completed Passes	93.6	71	75.6	59.1	169.2	38.3	29	52.3	40.9	90.6
	Attacking Passes	83.6	73.6	66	63.5	149.6	30	26.4	38	36.5	58
	Intercepted Passes	5.6	52.8	6.6	74.1	12.2	5	47.2	2.3	25.9	7.3
	Total Passes	99.3	69.6	82.3	60.1	181.6	43.3	30.4	54.6	39.9	97.9
	Central Defensive Passes	4.3	44.8	5.6	50	9.9	5.3	55.2	5.6	50	11
	Wall Defensive Passes	3.6	58	3.6	69.2	7.2	2.6	42	1.6	30.8	4.2
	Cork Defensive Passes	1.6	61.5	1.6	21	3.2	1	38.5	6	79	7
	Wall Attacking Passes	26	79.7	13.6	67.3	39.6	6.6	20.3	6.6	32.7	13.2
	Cork Attacking Passes	11.6	64.8	7.3	61.3	19	6.3	35.2	4.6	38.7	11
	Central Attacking Passes	45	72.6	39.6	61.3	84.6	17	27.4	25	38.7	42
Ball Possession (s)	Per Match	632.3	71.4	569.3	65.3	1201.6	253	28.6	302.6	34.7	555.6
	In Defense	0.56	0.6	82.3	59.5	83	90.6	99.4	56	40.5	147
	In Attack	579.6	75.5	507.6	67	1087.2	187.3	24.5	250.3	33	438
	Possession %	70.2	71.4	63.2	65.3	133.4	28.1	28.6	33.6	34.7	62
Offensive Metrics	Attacks	13.3	64.5	16.3	62	29.6	7.3	35.5	10	38	17.3
	Number of Goals	1	100	1	100	2	0	0	0	0	0
	Attack Efficiency %	7.5	100	6.1	100	13.6	0	0	0	0	0

To facilitate direct comparison, Table 5 summaries the main performance indicators recorded for Colombia across the three final stage matches. The data include total passes, offensive pass proportions, possession time, offensive zone activity, number of attacking sequences, goals scored, and offensive efficiency.

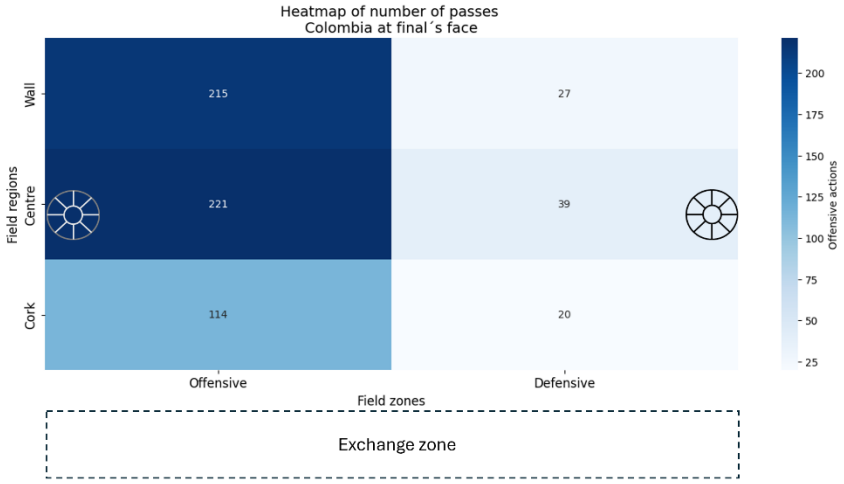
Table 5. Summaries the main performance indicators recorded for Colombia across the three final stage matches

Indicator	Quarter-final (vs Finland)	Semi-final (vs Denmark)	Final (vs Norway)
Total passes	163	318.3	181.6
Offensive pass percentage %	79.1	86.8	82.3
Possession time (seconds)	1487	1602.3	1201.6
% possession in offensive zone	75.4	91.8	90.5
Offensive attacks	27	26	29.6
Goals	4	1	2
Offensive efficiency (%)	14.8	3.84	6.8

Figure 2 presents a heatmap illustrating the distribution of passing actions across offensive and defensive zones, segmented into three distinct regions: wall, centre, and cork. The visualisation integrates data from the three analysed matches, the quarter-final, semi-final, and final, providing a comprehensive overview of Colombia's tactical ball distribution patterns. It highlights the total number of passes within each region and zone across all three matches.

The heatmap depicts the distribution of passing actions across both offensive and defensive zones during Colombia's matches. A substantial proportion of passes took place in the offensive zone, with the wall and central areas being the most frequently utilised. In the defensive zone, passing actions were primarily concentrated along the wall, highlighting the key areas where possession was either maintained or initiated.

Figure 2. Heatmap of passing actions by field zones and regions during Colombia's matches in the 2019 Underwater Rugby World Championship.



Discussion

The aim of this study was to examine the offensive and defensive actions of the Colombian national underwater rugby team during the final phase of the 2019 World Championship. The results highlighted a consistently high percentage of ball possession in the offensive zone, as well as a predominance of passing actions through central and wall areas, which suggest deliberate tactical choices. Offensive efficiency varied across matches, with the highest value observed in the quarter-final (14.8%), while the semi-final and final showed lower conversion rates.

Given the specificity of underwater rugby, characterised by breath control, three-dimensional movement, continuous player rotation, and spatial constraints, comparisons with land-based sports should be made cautiously. Although structural parallels exist among team sports with segmented logic (e.g., handball, water polo, basketball), the aquatic environment imposes unique physiological and tactical demands. For instance, unlike water polo, underwater rugby restricts surface breathing and involves full immersion, which influences spatial orientation and passing dynamics (Martínez-Delgado et al., 2023).

In all three matches, Colombia maintained over 60% of total possession time, with more than 75% of that time occurring in offensive zones. These patterns align with performance models from other segmented sports, where possession dominance has been linked to increased control of match tempo and territorial advantage (Garganta, 2009). The predominance of passes in offensive central zones further suggests a strategy aimed at penetrating high-density areas near the goal, a behaviour also observed in elite handball and basketball teams (Gruić et al., 2006; Sarmento et al., 2018).

The heatmap analysis (Figure 2) supports this interpretation, indicating a clear preference for passing through the offensive wall and central zones. The cork zone, associated with player substitutions and increased congestion, was avoided. This may reflect a conscious tactical decision to reduce the risk of interceptions during transitions, as frequent player exchanges near the cork can generate unpredictable defensive pressure (CMAS, 2019).

Defensive passing patterns revealed frequent use of the central zone, likely due to its wider field of vision and tactical advantages in initiating transitions. As noted in previous studies on spatial dominance

(Caetano et al., 2021; Zhang et al., 2025), occupying central areas can facilitate quicker and more effective shifts from defence to attack. Moreover, avoiding overly lateral or congested spaces allows for better anticipation of pressure and safer ball distribution.

The offensive efficiency recorded, despite a high volume of attacking actions, indicates that possession alone may not guarantee scoring success. Similar observations have been made in water polo, where teams with higher possession rates do not necessarily produce more goals, emphasising the role of shot quality and opponent pressure (Escalante et al., 2012). Thus, while Colombia's possession and spatial control were dominant, their conversion efficiency suggests areas for further tactical refinement.

An additional aspect worth noting is the likely influence of substitutions on defensive organisation. In underwater rugby, transitions between phases are often accompanied by player changes, especially after regaining possession in defensive zones. This routine may delay offensive progression and introduce vulnerability if ball control is lost during the transition. Future studies should consider measuring the impact of substitution timing and its interaction with possession retention.

Finally, the integration of performance data from different tactical zones and sequences presents a useful framework for coaches. This study provides preliminary insights into how ball circulation and zone usage influence match dynamics. Coaches can use these indicators to develop more specific training environments that replicate real-game scenarios, particularly in managing spatial distribution, timing of passes, and maintaining pressure in key areas of the field.

Conclusions

The findings of this study highlight the tactical and technical excellence demonstrated by the Colombian men's underwater rugby team during their championship-winning campaign at the 2019 World Championship in Austria. Their success stemmed from a dynamic playing style, marked by effective spatial utilisation and a pronounced emphasis on ball possession, particularly in offensive zones. These aspects distinguished Colombia from their opponents and underscore the importance of strategic coherence in competitive underwater rugby.

Future research should examine the contextual factors influencing tactical efficacy, exploring how game dynamics evolve over time through longitudinal designs. Additionally, further investigation is needed into the interplay between team strategies and individual player attributes to refine approaches to training and competition preparation.

Practical Applications

The findings from this study can inform coaching practices in underwater rugby by identifying key performance zones, emphasising possession-based play, and understanding the trade-offs in passing choices across areas. These insights are especially valuable given the scarcity of empirical data on this sport and may contribute to the professionalisation of its tactical and analytical frameworks.

Limitations and Future Research

While the study offers a unique contribution to the analysis of underwater rugby, it is limited by the lack of time motion variables and contextualised player tracking. Future research should incorporate spatial tracking and biomechanical data to further understand how movement strategies and player substitutions affect performance. Additionally, using statistical models such as Generalised Estimating Equations (GEE) could provide greater insight into repeated actions and their outcomes under different tactical contexts (Plakias et al., 2024).

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