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Development of an eight-shaped field test for aerobic capacity assessment in wheelchair basketball: a pilot study

Desarrollo de una prueba de campo en ocho para evaluar la capacidad aeróbica en baloncesto en silla de ruedas: estudio piloto

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Abstract

Wheelchair basketball (WB) requires sport-specific assessment procedures that reflect the propulsion and turning demands of on-court performance. Traditional shuttle-based field tests may not fully reproduce the movement patterns of WB, particularly regarding bidirectional turns and continuous wheelchair propulsion. This pilot study aimed to develop and describe a novel eight-shaped field-test protocol designed to better reflect WB-specific propulsion and turning demands, and to explore its feasibility and preliminary cardiorespiratory responses compared with a laboratory treadmill protocol. Two male WB athletes with different functional classifications (1.0 and 3.0) completed a maximal incremental treadmill protocol and the proposed on-court test, both performed with Oxycon Jaeger® metabolic gas analysers. VO₂max values reached during the field test were lower than those recorded in the laboratory for both participants (38.6 vs. 44.42 mL/kg/min for class 3.0; 32.35 vs. 38.33 mL/kg/min for class 1.0). Despite these differences, absolute VO₂max values ranged from 2.11 to 2.49 L/min across both testing conditions, while ventilation responses followed the same overall pattern, with higher values generally observed in the laboratory. The proposed test is presented here as a novel protocol for future validation; it may provide a promising on-court alternative to VO₂max measurement by offering greater ecological specificity than traditional shuttle run tests. Its structure allows bidirectional turns and smoother propulsion, which could help mitigate mechanical asymmetries inherent to conventional protocols. Given these preliminary results, broader validation is needed to confirm reproducibility and to establish reference percentiles across functional classes, age, and gender.

Keywords: wheelchair basketball; exercise test; oxygen consumption; cardiorespiratory fitness; sports for people with disabilities; team sport

Resumen

El baloncesto en silla de ruedas (BSR) requiere procedimientos de evaluación específicos que reflejen las demandas de propulsión y giro propias del rendimiento en pista. Las pruebas de campo basadas en desplazamientos de ida y vuelta pueden no reproducir plenamente los patrones de movimiento del BSR, especialmente en lo relativo a los giros bidireccionales y la propulsión continua en silla de ruedas. Este estudio piloto tuvo como objetivo desarrollar y describir un nuevo protocolo de prueba de campo en forma de ocho, diseñado para reflejar mejor las demandas específicas de propulsión y giro del BSR, y explorar su viabilidad y sus respuestas cardiorrespiratorias preliminares en comparación con un protocolo incremental de laboratorio en tapiz rodante. Dos jugadores masculinos de BSR con diferentes clasificaciones funcionales (1.0 y 3.0) completaron un protocolo incremental máximo en tapiz rodante y la prueba propuesta en pista, ambos realizados con analizadores metabólicos de gases Oxycon Jaeger®. Los valores de VO₂max alcanzados durante la prueba de campo fueron inferiores a los registrados en el laboratorio en ambos participantes (38.6 frente a 44.42 mL/kg/min para la clase 3.0; 32.35 frente a 38.33 mL/kg/min para la clase 1.0). A pesar de estas diferencias, los valores absolutos de VO₂max oscilaron entre 2.11 y 2.49 L/min en ambas condiciones de evaluación, mientras que las respuestas ventilatorias siguieron un patrón general similar, con valores habitualmente superiores en el laboratorio. La prueba propuesta se presenta como un



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protocolo novedoso para futuras validaciones; podría constituir una alternativa prometedora en pista para la medición del VO₂max, al ofrecer una mayor especificidad ecológica que las pruebas tradicionales de ida y vuelta tipo *shuttle run*. Su estructura permite giros bidireccionales y una propulsión más fluida, lo que podría ayudar a mitigar las asimetrías mecánicas inherentes a los protocolos convencionales. Dados estos resultados preliminares, se requiere una validación más amplia para confirmar su reproducibilidad y establecer percentiles de referencia según la clase funcional, la edad y el género.

Palabras clave: baloncesto en silla de ruedas; prueba de esfuerzo; consumo de oxígeno; capacidad cardiovascular; deportes para personas con discapacidad; deporte de equipo

Introduction

Wheelchair basketball (WB) is a high-intensity and dynamic Paralympic sport characterised by substantial upper-body strength requirements, high on-court locomotion speed, and enhanced cardiorespiratory fitness (Coutts, 1992; van der Woude et al., 2002; Vanlandewijck et al., 1999; Vanlandewijck et al., 2001). For competition purposes, players are classified according to their functional movement capacity using a point system that ranges from 1.0 to 4.5, with higher classifications indicating greater functional movement capacity (Yanci, Iturricastillo et al., 2015; IWBF, 2021). Accordingly, the total classification score of the players on the court must not exceed 14 points. Therefore, the assessment of the physical condition of WB players is a key element of preparation, considering each player's characteristics and the intermittent and prolonged nature of exertion during competition (Pérez-Tejero et al., 2020; Petrigna et al., 2022; Tachibana et al., 2019; Yanci, Granados et al., 2015).

In this context, measuring oxygen consumption (VO₂max) is a fundamental physiological indicator that allows for the assessment of a WB player's aerobic capacity (Bernardi et al., 1999; Coutts, 1983; Coutts, 1990). Moreover, VO₂max is associated with the capacity to sustain repeated high-intensity efforts throughout a match (Vanlandewijck et al., 2006; Yanci, Granados et al., 2015), enabling faster recovery between exertions and, ultimately, enhanced competitive performance (Goosey-Tolfrey & Tolfrey, 2008; Leicht et al., 2012).

Various studies have analysed VO₂max during incremental tests in individuals with spinal cord injuries (Coutts & McKenzie, 1995; Haisma et al., 2006), individuals with paraplegia or tetraplegia (Coutts, 1983), wheelchair athletes (Leicht et al., 2012;



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Vanderthommen et al., 2002; Vanlandewijck et al., 2006; Vinet et al., 1996), and elite wheelchair basketball players (De Lira et al., 2010; Gavel et al., 2023; Goosey-Tolfrey, 2005; Luarte et al., 2022). These studies aimed to analyse the physiological responses of maximal oxygen consumption and heart rate, explore differences based on disability type or functional classification, and define sport-specific performance profiles.

Although VO₂max has traditionally been assessed via laboratory-based protocols (Coutts & McKenzie, 1995; Hutzler, 1993; Rotstein et al., 1994; Schmid et al., 1998; van der Woude et al., 2002), recent decades have seen an increasing focus on developing, adapting and validating field-based protocols that enable sport-specific VO₂max estimation, while reducing the financial and logistical demands of laboratory testing (Bernardi et al., 2010; da Silva et al., 2022; Gavel et al., 2023; Goosey-Tolfrey & Leicht, 2013; Molik et al., 2017; Petrigna et al., 2022). Moreover, sport-specific field tests not only demonstrate high ecological validity but also enable a more contextualised and sport-specific assessment of players' cardiorespiratory performance, while allowing for the simultaneous evaluation of multiple athletes (Impellizzeri et al., 2005).

By the late twentieth century, several validation studies emerged that indirectly estimated VO₂max using field-based methods. One prevalent adaptation was the modified Léger and Lambert (1982) protocol—known as the Multi-Stage Fitness Test (MSFT), Shuttle Run Test or 'Beep' Test—which involves repeated propulsion between two lines spaced 20 metres apart at incrementally increasing speeds (Goosey-Tolfrey & Leicht, 2013; Goosey-Tolfrey & Tolfrey, 2008; Pérez-Tejero et al., 2018; Vanlandewijck et al., 1999; Vanlandewijck et al., 2006). A further adaptation led to the Yo-Yo Test, which introduced a 5-metre active recovery zone (Gil et al., 2015; Yanci, Granados et al., 2015; Yanci, Iturricastillo et al., 2015). In addition, the 30-15 Intermittent Fitness Test has also been adapted for elite WB players (Weissland et al., 2015b).

Despite growing academic interest in sport-specific assessments for athletes with physical disabilities, the scientific literature validating field-based VO₂max protocols in WB remains limited. Most studies thus far have relied on laboratory procedures or generic adaptations of field tests from other sports, lacking validation within the WB context.



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Over the past two decades, two more contextualised proposals have attempted to refine the MSFT layout. The first employs an octagonal route based on a 15×15 m square, enabling corner turns and avoiding abrupt 180-degree directional changes (Vanderthommen et al., 2002). The second proposes a figure-of-eight configuration comprising two octagons, facilitating bidirectional turning within each 15×15 m module (Weissland et al., 2015a). This figure-eight design may address limitations in earlier back-and-forth protocols, which lacked standardised turning radii. For instance, Vanlandewijck et al. (2006) suggested a turning radius three times the wheelchair's width, whereas Pérez-Tejero et al. (2018) defined 3-metre lanes to delimit turning space. Specifying turning geometry in field-based wheelchair protocols is essential for accurate workload prescription. To our knowledge, no field-test protocol to date has established turning-radius criteria specifically for WB athletes.

Therefore, the main objective of the present pilot methodological study was to develop and describe a sport-specific eight-shaped field-test protocol for wheelchair basketball, based on the protocol proposed by Pérez-Tejero et al. (2018), and to explore its feasibility and preliminary cardiorespiratory responses compared with a laboratory treadmill protocol. The protocol was designed to better reflect wheelchair basketball-specific propulsion and turning demands and to provide a methodological basis for future validation studies aimed at developing a practical and ecologically specific field-based assessment tool for coaches, strength and conditioning professionals, and researchers.

Materials and Methods

Study design

This study used a pilot methodological case-series design. The purpose was to develop and describe an eight-shaped field-test protocol for wheelchair basketball and to explore its feasibility and preliminary physiological responses in comparison with a laboratory treadmill protocol.



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Participants

Two elite male wheelchair basketball players, both members of a top-level national team at the time of the study, participated voluntarily. The athletes had different functional classifications, 1.0 and 3.0, allowing preliminary exploration of the protocol in players with different functional profiles. Inclusion criteria were being an active wheelchair basketball player, competing at national or international level, having medical clearance to perform maximal exercise testing, and being familiar with sport-specific wheelchair propulsion. Exclusion criteria were acute injury, illness, pain, or any medical condition that could interfere with maximal exercise performance or increase testing risk. Assessments were conducted at two points during the regular season. The laboratory test took place in April, and the field test was performed in May, at the end of the competitive season. Both athletes, along with the rest of the team, undertook three two-hour training sessions per week, in addition to two hours of strength and/or cardiovascular endurance training, plus wheelchair-handling and shooting practice. They also competed in one official match each week. The field test was administered one week after the cessation of regular training. Player characteristics are provided in Table 1.

TABLE 1. Descriptive characteristics and functional classification of the participants.

Participant	Age	Weight (kg)	Height (cm)	Functional class	Disability	Impairment	Daily mobility aid
1	33	65	178	1	Paraplegia	T5	Wheelchair
2	42	54	166	3	Poliomyelitis	Both legs	Crutches

Procedure

Physiological responses were assessed during two incremental exercise protocols: a laboratory treadmill test and the proposed eight-shaped on-court field test. The field-test structure was developed from the protocol described by Pérez-Tejero et al. (2018), with modifications to incorporate a figure-eight trajectory and bidirectional turning patterns specific to wheelchair basketball.

In incremental exercise testing, a longer test duration indicates higher physical fitness. The protocols used in this study were progressive, starting with a brief warm-up, followed by



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stepwise increases in workload, aiming for an optimal duration of 8–12 minutes, and always intended to reach maximal effort (Arós et al., 2000).

For a test to be considered maximal, participants had to meet at least two of the following criteria adapted from Veeger et al. (1991): (a) volitional exhaustion or inability to maintain the required treadmill speed despite verbal encouragement; (b) $RER \geq 1.10$; (c) a plateau or clear levelling-off in oxygen uptake despite increasing workload; and/or (d) peak HR within 10 beats/min of the age-predicted maximum ($220 - \text{age}$). Given the unique physiological profile of athletes with spinal cord injuries, HR response was interpreted individually and cautiously, and was not used as the sole criterion for maximal effort.

Variables

The recorded variables included absolute $VO_{2\max}$ (L/min), relative $VO_{2\max}$ (mL/kg/min), peak VO_2 , minute ventilation (VE, L/min), dead-space to tidal-volume ratio (V_d/V_t), carbon dioxide output (VCO_2 , L/min), respiratory exchange ratio (RER), ventilatory equivalents for O_2 and CO_2 (EqO_2 , $EqCO_2$), oxygen pulse (mL/beat), heart rate (HR, beats/min), and respiratory rate (RR, breaths/min).

Field Test

The proposed field-test course consisted of an eight-shaped, diamond-based trajectory designed to reproduce repeated propulsion, acceleration, deceleration, and bidirectional turning demands in wheelchair basketball. The final layout was developed through pilot trials in which the trajectory was progressively adjusted according to player feedback, wheelchair handling demands, and the need to maintain a continuous incremental rhythm.

Phase 1: The initial design used a 28-metre path (full basketball-court length), aligned with the audio cues described by Pérez-Tejero et al. (2018). The layout consisted of an “8”, with its central intersection serving as both the starting point and the origin of the audio signal. Each symmetrical loop measured 28 metres and featured a semi-circular turning radius, which was adjusted from 4 m to 5 m and finally to 6 m during pilot trials. However, this configuration



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prevented players from reaching maximal speed because they needed to continuously correct their trajectory throughout the curves (Figure 1).

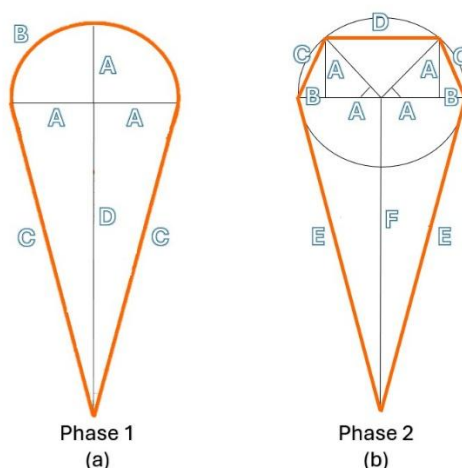


FIGURE 1. Schematic representation of the field test protocol development phases: (a) A = 3 m, B = 9.42 m, C = 9.28 m, and D = 8.78 m; (b) A = 2.12 m, B = 0.88 m, C = 2.29 m, D = 4.24 m, E = 9.58 m, and F = 10.71 m. Both circuits have a total distance of 28 meters and a diameter of 6 meters.

Phase 2: Pilot testing showed that semi-circular turns were suboptimal. Based on player feedback, a diamond-shaped layout proved more effective, as it incorporated straight segments that allowed for propulsion and acceleration. Figure 2 illustrates the final trajectory adopted, which best suited the players' characteristics.

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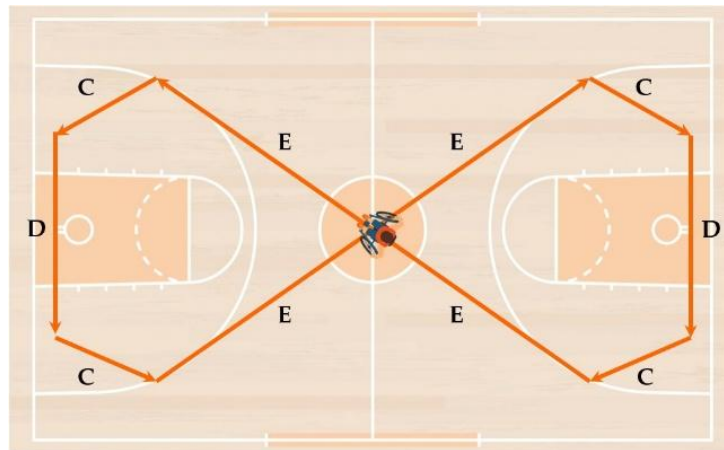


FIGURE 2. Final eight-shaped field-test layout overlaid on a basketball court; C = 2.29 m, D = 4.24 m, and E = 9.58 m.

To control the incremental load, customised audio cues—adapted from Pérez-Tejero et al. (2018)—were integrated. These consisted of two-second tones based on a modified Léger & Lambert (1982) protocol, starting at 6 km/h and increasing by 0.5 km/h every minute. The auditory signals, which became higher-pitched as the stages progressed (“Stage 1”, “Stage 2”, etc.), indicated that the athlete should be positioned at the 2-metre-wide central intersection of the “8” or diamond track.

Pulmonary ventilation and respiratory gas exchange were measured directly using a Jaeger® Oxycon Mobile analyser (Eriksson et al., 2012; Perret & Mueller, 2006). To ensure data consistency and minimise potential measurement errors between devices, both the Oxycon Mobile and the laboratory Oxycon Champion underwent an identical 1:1 calibration protocol before each session. Furthermore, the interchangeability and reliability of these specific Jaeger® systems have been previously validated, showing high consistency in metabolic variables between the portable and stationary versions (Akkermans et al., 2012). Heart rate was monitored with a Polar® Accurex Plus device.

The test ended when the player failed to reach the intersection on cue twice consecutively. The total number of completed stages was recorded, subtracting any incomplete attempts. A preliminary trial was performed to verify distance calibration, audio synchronisation, and equipment connectivity between the players’ chest belts and the recording



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computer. Before the actual measurement, each player completed a familiarisation run at moderate intensity.

Laboratory Test

To compare the physiological responses of the field-test with a reference laboratory protocol, each participant performed an incremental treadmill test while using their own sports wheelchair. The protocol proposed by Rabadán et al. (2001) was applied, starting with a 1-minute warm-up at 3 km/h with a 0% incline. The main phase began at 6 km/h and 0% incline, introducing constant increments every 15 seconds of 0.125 km/h in speed and 0.04% in incline, continuing until volitional exhaustion. Finally, the test concluded with a 3-minute recovery period at 3 km/h and 0% incline. The treadmill used was a Jaeger-HP Cosmos model LE-600 C, featuring a 250 × 75 cm running surface and a safety system with side rails and front and rear bars. Pulmonary ventilation and respiratory gas exchange during exercise were measured directly using a Jaeger® Oxycon Champion analyser with a breath-by-breath system and a Triple-V® bidirectional volume transducer. Cardiac function was monitored using a 12-lead Marquette® CASE 8000 ECG system, and heart rate was recorded with a Polar Sport Tester®.

Recorded maximal variables included: VEmax, absolute and relative VO₂max, EqO₂, EqCO₂, RER, HRmax, oxygen pulse, test duration, maximal speed (Vmax), and maximal incline (Inclmax). Submaximal parameters such as ventilatory thresholds were also determined: anaerobic threshold (AT, expressed as %VO₂, HR, speed, and incline) and time spent above AT (T+AT).

Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki. All participants received verbal and written information about the aims, procedures, potential risks, and benefits of the study and provided written informed consent before participation. The study was approved by the university's Ethics Committee. Due to the small number of elite athletes and the potential identifiability of functional classification and



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impairment-related information, all data were anonymised and reported only for research purposes.

Data analysis

Given the pilot methodological case-series design and the sample size, data were analysed descriptively and individually. No inferential statistics were performed. Results are presented as individual physiological responses and preliminary feasibility indicators rather than as evidence of criterion validity.

Results

Field Test Results

In the field test, the class 3.0 player reached a relative VO₂max of 38.6 mL/kg/min, with a maximum HR of 181 beats/min and a maximum speed of 11 km/h. His absolute VO₂max was 2.16 L/min, and VE reached 97 L/min. The class 1.0 player reached a relative VO₂max of 32.35 mL/kg/min, a maximum HR of 187 beats/min and a maximum speed of 10.5 km/h. His absolute VO₂max was 2.11 L/min, and VE reached 84 L/min.

The data indicate physiological differences between the two players, consistent with their functional classifications.

Laboratory Test Results

In the laboratory test, the class 3.0 player reached an absolute VO₂max of 2.43 L/min and a relative VO₂max of 44.42 mL/kg/min, with a HR_{peak} of 193 beats/min. His VE was 146.1 L/min, and VCO₂ reached 3.051 L/min. The achieved oxygen pulse was 12.59 mL/beat, and the maximum speed attained was 12.25 km/h with a 2.5% incline.

The class 1.0 player obtained an absolute VO₂max of 2.49 L/min and a relative VO₂max of 38.33 mL/kg/min, with a HR_{peak} of 198 beats/min. His VE was 106 L/min, and VCO₂ was 2.99 L/min. The oxygen pulse was 12.6 mL/beat, the final speed reached was 11.13 km/h, and the incline was 2.14%. For both athletes, EqO₂, EqCO₂, respiratory rate, and RER values are



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presented in Table 2. Together with HRpeak and volitional exhaustion, these variables indicate that both protocols elicited high-intensity physiological responses.

TABLE 2. Physiological responses during laboratory and field tests.

		Participant FC 3.0		Participant FC 1.0	
Variable		Laboratory	Field	Laboratory	Field
Time (min)		12.43	11	10.19	10
HR (bpm)		193	181	198	187
VO ₂ (L/min)		2.43	2.16	2.49	2.11
Rel VO ₂ (mL/kg/min)		44.42	38.6	38.33	32.35
RR (breath/min)		70	54	67	48
VCO ₂ (L/min)		3.05	2.64	2.99	2.56
EQCO ₂		47.89	34.5	35.36	30.6
EQO ₂		60.12	42.1	42.48	37.2
VE (L/min)		146.1	97	106	84
Pulso O ₂ (mL/bpm)		12.59	11.9	12.6	11.26
Speed (km/h)		12.25	11	11.12	10.5
Respiratory Quotient		1.25	1.22	1.2	1.21
Anaerobic Threshold	VO ₂	34.7	33.42	34.7	25.21
	HR (bpm)	175	175	191	161
	Speed (km/h)	10.63	10	10.37	9

Discussion

This pilot methodological study developed and described a novel eight-shaped field-test protocol for wheelchair basketball and explored its preliminary physiological responses in two elite players, aiming to better replicate the real movement patterns of wheelchair athletes. The main finding was that the field protocol was feasible and elicited high-intensity cardiorespiratory responses, although VO₂max, VE, HRpeak, and final speed were generally lower in the field condition than in the laboratory protocol. Therefore, the results should be interpreted as preliminary feasibility evidence rather than as proof of validity. By doing so, the test was designed to enhance ecological specificity. Overall, the results obtained in this study are consistent with previous research that has assessed VO₂max in this population through both laboratory and field protocols. Below, the most relevant variables from both contexts are



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analysed concerning previous studies and considering the functional differences between the evaluated players.

The maximum HR values recorded were higher in the laboratory test than in the field test (“8”), which aligns with the findings of Pérez-Tejero et al. (2018) but contrasts with those of Vanlandewijck et al. (1999). This discrepancy could be related to the greater distance covered in each “shuttle” of the more recent tests. Likewise, HR values in the present field test resemble those reported for other protocols such as the traditional MSFT (Vanlandewijck et al., 1999; Goosey-Tolfrey et al., 2008; Gavel et al., 2023), the 28-m MSFT (Pérez-Tejero et al., 2018), the octagon test (Vanderthommen et al., 2002), and the MSFT-8 (Weissland et al., 2015a), where maximum HR values typically range from 170 to 190 beats/min.

In line with previous studies (Coutts, 1995; Pérez et al., 2018; Veeger et al., 1991; Weissland et al., 2015a), VO₂max values were lower in the eight-shaped field test than in the laboratory test. The relative difference was -13.1% in the class 3.0 player and -15.6% in the class 1.0 player. This suggests that, although the field protocol elicited high-intensity responses, the laboratory protocol produced higher cardiorespiratory strain in these two athletes. Possible explanations include differences in testing context, familiarity with each protocol, end-of-season fatigue, and the specific mechanical demands of the field trajectory. In contrast, some studies (Vanlandewijck et al., 1999; Goosey-Tolfrey et al., 2008; Gavel et al., 2023) reported higher estimated VO₂max values for field tests. In the latter two, this difference may be due to formula overestimations or to variations in the functional classification of the participants.

The absolute VO₂max values observed in this study are similar to those reported in prior research (Gavel et al., 2023; Goosey-Tolfrey et al., 2008; Pérez et al., 2018; Vanderthommen et al., 2002; Vanlandewijck et al., 1999; Weissland et al., 2015a), which typically range between 2.0 and 2.9 L/min. Relative VO₂max values are also consistent with the estimations reported by Pérez-Tejero et al. (2018) and Weissland et al. (2015a), although it should be noted that these studies did not rely on direct measurements. Differences from other studies (Goosey-Tolfrey et al., 2008; Vanderthommen et al., 2002; Veeger et al., 1991) may be related to overestimation due to the formulas used, participant heterogeneity in functional classes, or performance level. Relative VO₂max is particularly relevant in this population given the variability in active



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muscle mass. Players with higher functional classifications generally have greater motor capacity, which explains their higher VO₂max values. This pattern was observed in the two participants evaluated here.

Regarding ventilatory parameters, VE, RF, VCO₂, EqO₂, and EqCO₂ systematically showed higher values in the laboratory test than in the field test, confirming that the laboratory protocol elicited higher maximal intensities.

The RER values were ≥ 1.20 in both protocols, which supports the interpretation that both tests elicited high-intensity effort (Rostein et al., 1994; Veeger et al., 1991; Rabadán et al., 2001; Pérez et al., 2018). Nevertheless, RER alone does not establish that both protocols imposed equivalent maximal demands. Differences between laboratory and field responses may have been influenced by the timing of data collection, accumulated fatigue, different levels of familiarisation with each protocol, and the athletes' training status at the end of the competitive season. Moreover, they were more familiar with the laboratory protocol than with the field test, which had been performed fewer times.

When considering different field test designs, traditional shuttle run tests (Gavel et al., 2023; Gil et al., 2015; Goosey-Tolfrey et al., 2008; Pérez-Tejero et al., 2015; Vanlandewijck et al., 1999; Yanci et al., 2015) have structural disadvantages: they require 180° turns in each shuttle, often always in the same direction, which places greater mechanical demand on one side and results in uneven wheel trajectories, especially since wheelchairs restrict lateral displacement. The octagon-based MSFT (Vanderthommen et al., 2002) partially addresses this issue by incorporating 90° turns, allowing more fluid movement, yet it still maintains a single-sided turning bias. The MSFT-8 (Weissland et al., 2015a) further improved this by alternating directions in an octagonal pattern. The eight-shaped protocol proposed in the present study was designed to reduce some of these limitations by incorporating bidirectional turns and straighter propulsion segments. This configuration may better reflect wheelchair basketball-specific locomotor demands than traditional back-and-forth protocols, although future biomechanical and reliability analyses are required to confirm this assumption.



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Limitations

This study has several limitations. First, the sample included only two elite male wheelchair basketball players; therefore, the findings cannot be generalised and no inferential statistics, predictive equations, or validation analyses could be performed. Second, the laboratory and field tests were conducted at different points of the competitive season, which may have influenced physiological responses due to changes in training load, fatigue, motivation, or recovery status. Third, the field protocol was performed after limited familiarisation, which may have affected pacing, wheelchair handling, and maximal performance. Fourth, although respiratory gas exchange was directly measured, the protocol has not yet been tested for reliability, agreement with laboratory measures, or sensitivity to training-induced changes. Future studies should include larger samples, both sexes, repeated trials, different functional classes, and analyses of reliability, typical error, minimal detectable change, agreement, and criterion validity.

Practical Applications

The proposed “8-shaped” field test may offer a potentially practical and accessible alternative for estimating VO₂max in wheelchair basketball athletes. Its design allows for bidirectional turns and more natural propulsion patterns, better reflecting the sport’s movement demands compared to traditional shuttle run tests.

This test can be implemented on-court without specialised equipment, making it suitable for routine use by coaches and practitioners to monitor aerobic fitness, track seasonal changes in performance, and inform conditioning strategies adapted to each athlete’s functional profile.

Moreover, by applying it in larger samples, the test could also contribute to the creation of reference percentiles or performance benchmarks for VO₂max, considering variables such as functional classification, age, and gender. This would enhance its utility for long-term monitoring, comparative assessment, and even talent identification programs.



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Conclusions

The eight-shaped field-test protocol developed in this pilot methodological study was feasible and elicited high-intensity physiological responses in two elite wheelchair basketball players. VO₂max, VE, HRpeak, and final speed were generally lower during the field test than during the laboratory treadmill protocol, although RER values indicated high effort in both conditions. These findings support the protocol as a preliminary sport-specific testing proposal, but not yet as a validated tool for estimating aerobic capacity. Larger studies including repeated trials, both genders, different functional classes, and appropriate reliability and validity analyses are required before the test can be recommended for routine indirect assessment of VO₂max in wheelchair basketball.

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