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Anaerobic performance capacity of wheelchair basketball players in Benin

Oscar Dagbémabou Oladouni Azé [1, 2, *], Colombe Prudence Mensah [2], Mountaga Diop [3], Marc Charbel Gnonhossou [2], Florentine Donhouèdé Kouglo [2] and Barnabé Akplogan [2]

[1] University of Lyon, Jean Monnet University (UJM)-Saint-Etienne, Interuniversity Laboratory of Human Movement Biology (LIBM), EA 7424, F-42023, Saint-Etienne, France

[2] Research Unit: Disabilities, Adapted Physical Activities and Rehabilitation (DAPAR), Laboratory of Motor Skills, Performance and Health in Athletes (LaMoP2S), National Institute of Youth, Physical Education and Sport (INJEPS) – University of Abomey-Calavi (UAC), 01 BP 169, Porto-Novo, Benin.

[3] Research Laboratory in Sciences and Techniques of Physical and Sports, Activities, Youth and Leisure, National Higher Institute of Popular Education and Sport (INSEPS), Cheikh Anta Diop University, Dakar, Senegal.

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Abstract

Context: Wheelchair basketball, as part of Adapted Physical Sports Activities (APSA), plays a key role in improving physical fitness and promoting social inclusion for persons with disabilities (PWD). Despite its growth in Africa, few studies have examined its physiological effects, particularly in Benin.

Objective: To compare the anaerobic capacity of wheelchair basketball players from the Lions Handisport Club of Cotonou with that of sedentary wheelchair users.

Methods: A sample of two groups of PWD participated in two tests: a 20-meter sprint and a 30-second sprint test. Data were analyzed to assess anaerobic performance. Variables such as age, body mass index (BMI), and wheelchair characteristics were also considered.

Results: No significant differences were found between groups in terms of age or BMI. However, anaerobic performance was significantly higher in wheelchair basketball players for both the 20-meter sprint ($p = 0.002$) and the 30-second sprint test ($p = 0.001$), despite the use of non-regulation sports wheelchairs.

Conclusion: Regular participation in wheelchair basketball improves the anaerobic capacity of PWD. It is recommended to promote APSA among sedentary individuals and train a new generation of players to ensure the sustainability of wheelchair basketball in Benin. Future research should explore other components of physical fitness.

Keywords: Anaerobic Threshold; Wheelchair Sports; Basketball; Athletic Performance; Benin

1. Introduction

According to the WHO, disability results from the interaction between impairments, activity limitations, and participation restrictions, in connection with environmental and personal factors. It reflects the negative effects of a health condition on an individual's social life [1]. Disability is therefore characterised by a lasting physical, mental, or sensory impairment that affects a person's functional abilities relative to those expected for their age, resulting from an injury, a disease, or potentially emerging at a later stage [2]. A motor disability, for instance, results from an impairment affecting mobility, whether partial or total, involving the upper or lower limbs and limiting physical performance [3]. In

* Corresponding author: Oscar Dagbémabou Azé

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2021, approximately 3.5 million people, representing 5.3% of the population, had reduced mobility, of whom 650,000 were wheelchair users [4].

Sport refers to any physical activity aimed at improving physical or mental condition, fostering social relationships, or enhancing performance, whether practised in an organised or informal manner [5]. It must be accessible to everyone, regardless of physical ability. Para sport, by definition, is a form of practice in which the rules have been adapted for persons with disabilities [3]. The practice of physical activity promotes the secretion of beneficial hormones, reducing stress, improving sleep, alleviating pain, and acting as an antidepressant. It therefore represents a source of pleasure [6]. Moreover, it helps prevent hypertension, maintain a healthy weight, and improve mental health and well-being [7]. In the context of para sport, which is an adapted form of sport, certain disciplines have been specifically modified or created to facilitate their practice by persons with disabilities [8]. As a specific example, in wheelchair basketball, the use of an adapted wheelchair enables the mobility of players with motor impairments. Upper limb and trunk strength are engaged to perform sequences of game actions. A classification system ensures balance between teams [9].

In the ICF model, physical capacity assesses the ability to perform bodily functions, carry out daily activities, and participate in social life [10]. Regular monitoring of the physical capacity of persons with disabilities is essential to adapt interventions, physical activity programmes, and to promote their social participation [11]. In this regard, physical capacity, defined as the ability to perform daily and leisure activities, is expressed through aerobic and anaerobic capacity, muscular strength, flexibility, and balance [12]. Short periods of exercise are dominated by the anaerobic system, whereas energy for activities lasting more than 30 to 45 seconds is primarily generated by the aerobic system [13,14]. Good aerobic capacity has beneficial effects on numerous parts of the body: the heart, lungs, muscles, bones, blood, the immune system, and the nervous system [15]. As for the anaerobic energy system (meaning “without oxygen”), it can provide a limited amount of energy, but at a very high rate [16]. Phases of oxygen-free contractions are short, producing no waste, and do not exceed 30 seconds [16].

Studies show that wheelchair basketball players perform intermittent efforts, with short, high-intensity efforts playing a key role [17,18]. Tolfrey (2010) emphasises the importance of short efforts in wheelchair basketball players and suggests that improving anaerobic performance could enhance their on-court abilities [19]. Basketball is estimated to be 80% anaerobic and 20% aerobic [24]. Daily motor activities of persons with lower-limb disabilities are often brief and generate high levels of stress [20,21]. As a result, performing activities of daily living involves relatively high physical effort, often combined with reduced physical capacity [22]. Since their daily motor activities rely on anaerobic metabolism, it is crucial to assess this capacity in persons with reduced mobility. In this context, modified Wingate protocols and wheelchair sprint tests have been developed and standardised [17]. It is recommended to use it to assess anaerobic capacity when the equipment is available; otherwise, a 20- to 45-second sprint test constitutes a suitable alternative [23].

In sub-Saharan Africa, few studies have addressed wheelchair basketball and anaerobic capacity. This study measures this capacity in athletes from the Lions Handisport Association of Cotonou and in non-athletic persons with disabilities, using a 20 m sprint test and a 30-second test.

2. Materials and methods

2.1. Framework and Research Typee

This was a cross-sectional study conducted at UNAFRICA and carried out by the Research Unit “Deficiencies, Adapted Physical Activities and Rehabilitation” (UR-DAPAR) of the Motricity, Performance, and Health in Sport Laboratory (LaMoP2S), affiliated with the National Institute of Youth, Physical Education, and Sport (INJEPS) of the University of Abomey-Calavi, Benin. The target population included wheelchair basketball players from the Lions Handisport Club of Cotonou as well as non-athletic persons with reduced mobility who were able to manoeuvre a wheelchair. Inclusion criteria (being an athlete practising wheelchair basketball within the Lions Handisport Association; having at least one year of practice; being a person not practising adapted sport; providing informed written consent; having a motor impairment; being over 18 years old) resulted in a sample of 16 persons with reduced mobility, of whom 8 were athletes and 8 were non-athletes.

2.2. Data Collection Plan

Data collection was conducted in three phases: awareness, familiarisation, and test execution. The awareness phase included two sessions to inform participants about the study, distribute the consent form, and allow one week for responses. The first session targeted athletes through the wheelchair basketball coach, while the second targeted non-athletes.

After obtaining consent, two groups were formed: the experimental group (athletes) and the control group (non-athletes). One session was used to present the tests, followed by three trials with a 24-hour rest interval.

The third phase began with the collection of anthropometric data and wheelchair characteristics, followed by equipment setup. Participants performed a five-minute low-intensity warm-up and supervised stretching. They then completed an individual 30-second sprint over 24 metres, with cones placed every two metres, and the distance covered was measured to the nearest metre [25]. Participants performed three maximal 20-metre wheelchair sprints, with an additional 2 metres to avoid deceleration at the end of the course. A 120-second recovery period was allowed between each sprint to return to the starting point [26]. Participants started 0.5 m behind the starting line on the signal, with the timer automatically starting as they passed 0 m, and split times recorded at 5 m and 20 m [26]. For each test, the mean of three repetitions was recorded for each participant

A ZZG-101 scale was used to weigh the wheelchairs, a *TECHWOOD TPP-520L* mechanical scale for body mass, and a tape measure and stadiometer to measure participants seated height.

2.3. Ethical Considerations

This research was conducted in accordance with the ethical principles of the Declaration of Helsinki. It respected the rights, dignity, and well-being of the participants, without compromising their physical or moral integrity. All study participants were informed about the research protocol, its objectives, and its potential benefits. They were assured that, at the end of the study, the results would be communicated to them confidentially and in a timely manner. They were also guaranteed that the data collected would be anonymised and used solely for the purposes of this research.

2.4. Statistical Analysis

The data were processed using the Statistical Package for the Social Sciences (SPSS, version 27). For each variable, the normality of the distribution was assessed using the Shapiro-Wilk test. Descriptive statistics—including mean, percentage, sample size, and standard deviation—were calculated. The Mann–Whitney U test and the Wilcoxon W test were used to determine differences between the two groups. For all tests, the significance level was set at $p < 0.05$.

3. Results

3.1. Population Characteristics

The athletes had a mean age of 29.8 ± 5.2 years compared to 33 ± 4.2 years for non-athletes, with a BMI of 21.4 ± 0.7 kg/m^2 versus 23.5 ± 1 kg/m^2. The duration of disability was similar between the groups, and no significant differences were observed (Table 1).

Table 1 Population Characteristics (n = 16)

	Experimental Group (EG)		**Control Group (CG)**		**p Value (Mann Whitney)**
	Mean ± SD	*Max-Min*	*Mean ± SD*	*Max-Min*	
Age (years)	29.8 ± 5.2	39-19	33 ± 4.2	40-28	0.28
Height (m)	1.6 ± 0.1	1.8-1.4	1.6 ± 0.06	1.8-1.6	
Body Mass (kg)	58.8 ± 7.9	67-40	60.1 ± 4.4	75.4-54	
BMI (kg/m^2)	21.4 ± 0.7	22.7-20.4	23.5 ± 1	24.8-22.2	0.13
Duration of Disability	20.9 ± 5.6	31-11	21 ± 5.5	25-11	

S.D: Standard Déviation; Min: Minimum; Max: Maximum; BMI: Body Mass Index; p>0,05, No significant difference between the two groups

3.2. Wheelchair Characteristics

The wheelchair used had four wheels, including two large and two small, in accordance with standards. The backrest height was 27 cm, meeting the minimum and maximum requirements. However, the maximum diameter of the large wheel (50 cm), the wheelchair height (67 cm), and its mass (17 kg) did not comply with the standards (Table 2).

Table 2 Wheelchair Features

	Mean	**Max**	**Min**	**Standards Range Min-Max**
Wheelchair Basketball				
Number of Wheels (cm)	04	04	04	3-6
Maximum Diameter (cm)	50	50	50	69
Maximum Seat Height from Floor (cm)	11	11	11	-
Horizontal Bar (cm)	17	27	27	-
Maximum Wheelchair Height (cm)	67	67	67	58 – 63
Cushion Thickness (cm)	7	7	7	
Backrest Height (cm)	27	27	27	20-35
Wheelchair Mass (kg)	17	17	17	≤ 6.2

Min : Minimum Max : Maximum

3.3. Anaerobic Capacity Measurements

The mean times for the 30-second sprint were 7.2 s for athletes compared to 8.3 s for non-athletes, while the mean distances in the 20-metre test were 69.8 m and 65.3 m, respectively. A significant difference was observed between the two groups for both tests (Table 3).

Table 3 Performance in the 30-Second and 20-Metre Tests of Athletes and Non-Athletes

	20 m (s) test			**30 s (m) test**	
	EG	CG		CG	EG
Mean	7.16	8.32		69.84	65.3
Min	6.01	7.73		66.84	62
Max	8.15	8.8		76.40	67.8
p-value (*Mann Whitney*)	*0.002**			*0.001†*	

EG: Experimental Group;CG: Control Group;Min: Minimum; Max: Maximum;* Significant difference in the 20-metre test; †Significant difference in the 30-second test

4. Discussion

This study aimed to assess the anaerobic capacity of individuals with motor disabilities using the 20-metre and 30-second sprint tests. Eight active athletes and eight non-athletes were evaluated under identical conditions using validated tests. To ensure reliability, the same operator conducted the tests, and the mean of three repetitions per participant was used.

4.1. Population Characteristics

The athletes and non-athletes had a mean age of 29.8 ± 5.2 years and 33 ± 4.2 years, respectively. A study by Marszałek et al. (2019) reported a mean age of 28.5 ± 6.7 years for European national wheelchair basketball teams [27]. Natan et al. (2018) reported a mean age of 31.4 ± 9.5 years among ten wheelchair basketball players from Pelotas, Rio Grande do Sul [28]. It is therefore important to note that the age of wheelchair basketball athletes and non-athletes falls within the elite senior category (20 years and older).

The BMI of wheelchair basketball athletes was 21.4 ± 0.7 kg/m² compared to 23.5 ± 1 kg/m² in non-athletes, indicating a more favourable BMI among the athletes. Romarate et al. (2015) reported a similar BMI of 21.7 ± 6.83 kg/m² [29]. Similarly, a study by Shimizu et al. (2018) reported a mean BMI of 21.9 ± 4.7 kg/m² [30]. According to the classification table of the French National Authority for Health (HAS), these BMI values are considered ideal for an individual deemed to be within the normal range [31]. The comparison of results shows that the athletes, non-athletes, and players studied by Romarate et al. (2015) meet the HAS standards and are not obese [31]. The mean duration of disability was 20.9 ± 5.6 years for athletes and 21 ± 5.5 years for non-athletes. Fabricio et al. (2018) reported a mean duration of 22.55 ± 24.83 years among wheelchair basketball players [32]. The results suggest that the duration of disability among participants is linked to conditions occurring in early childhood, with the majority having an early-acquired disability, likely due to health issues during the first years of life.

4.2. Wheelchair Characteristics

The wheelchair studied had four wheels, large wheels with a diameter of 50 cm, a backrest height of 27 cm, a mass of 17 kg, and a maximum height of 67 cm. According to IWBF standards, the mass should be 6.2 kg, the maximum height 53 cm, and the backrest at least 22 cm [33]. Compared to IWBF standards, the wheelchairs of the Lions Handisport Club of Cotonou are more than twice as heavy and have smaller wheels. Masson et al. (2012) showed that players' effort decreases as wheel diameter increases [34]. Similarly, physiological expenditure decreases through a reduction in VO_2 max for 25-inch (63.5 cm) wheels [34]. Comparison with IWBF standards shows that larger wheels facilitate player mobility. The mean mass of the wheelchairs in the study was 17 kg. According to Hurd et al., (2008) and Ouedraogo et al. (2022), players often have to manage double handling [35,36]. Players must manage both the mass of the wheelchair and their own body weight. With wheelchairs weighing nearly twice the IWBF standard (6.8 kg), their energy expenditure is higher, which reduces their propulsion speed [37]. According to Requejo et al. (2008), prolonged wheelchair propulsion can cause upper limb pain, such as tendinitis, bursitis, or subacromial impingement [38].

4.3. Test Battery

Vanlandewijck et al., (1999) demonstrated a correlation between the 20-metre and 30-second sprint tests in wheelchair basketball players [25]. Since the 30-second sprint test is valid, the 20-metre test is recommended to assess the anaerobic capacity of wheelchair athletes [39]. The 20-metre sprint test confirmed the reliability of the 30-second test. Wheelchair basketball athletes achieved an average sprint time of 7.2 s.

Yanci et al. (2015) studied sprint capacity in 16 wheelchair basketball players, reporting a mean 20-metre sprint time of 5.70 ± 0.43 s [40]. The mean sprint time reported by Yanci et al. (2015) was better than that in our study, likely due to the wooden court versus cement in Cotonou and measurement using photocells versus manual timing. De Groot et al. (2012) also reported a mean sprint time of 5.80 ± 0.40 s in 19 players, confirming the reliability of the tests [26]. This value was better than ours, likely due to the wheelchair configuration, handling, and propulsion technique. Vanlandewijck reported a mean close to our results [25]. The mean sprint duration of wheelchair basketball players from Cotonou appears suitable for simulating the 20-metre effort. Athletes covered a significantly greater distance than non-athletes ($p = 0.002$). This difference can be explained by a slower reaction time at the start and reduced propulsion due to insufficient muscular strength in non-athletes, which affects their performance.

Wheelchair basketball athletes covered an average distance of 69.84 ± 3.09 m during the 30-second sprint. Vanlandewijck reported a higher mean distance of 90 ± 6.7 m over the same duration [25]. In the study by Jolanta Marszałek et al. (2019), elite wheelchair basketball players covered an average of 99.12 m in 30 seconds [27]. The players from the Lions Handisport Club achieved lower results, likely due to wheelchair weight, wheel quality, and individual technique. Moreover, athletes covered a greater distance than non-athletes, the latter decelerating quickly during the 30-second sprint, likely due to their lack of physical activity, a key performance factor.

The results show no significant differences in age or BMI between the groups, indicating that these factors do not influence performance in the 30-second and 20-metre sprint tests. In contrast, wheelchair basketball athletes achieved better results than non-athletes, with significant differences ($p = 0.001$ for the 30-second sprint and $p = 0.002$ for the 20-metre sprint), attributable to improved speed, reaction time, and muscular power associated with regular practice [41].

5. Conclusion

This study falls within the field of Adapted Physical and Sports Activities (APSA) and focuses specifically on wheelchair basketball, a rapidly developing discipline in Africa that represents an important tool for the social inclusion of persons with disabilities (PWDs). The main objective was to assess and compare the anaerobic capacity of wheelchair basketball players from the Lions Handisport Club of Cotonou with that of PWDs not practising any adapted sport, using the 20-metre and 30-second sprint tests.

The data collected reveal no significant differences between the two groups in terms of age and body mass index (BMI). In contrast, performance in anaerobic effort tests shows a notable superiority among wheelchair basketball players. These results confirm the hypothesis that regular practice of wheelchair basketball significantly improves anaerobic capacity, even when the wheelchairs used do not meet the required technical standards.

Furthermore, sedentary behaviour among PWDs appears to be a worsening factor, increasing the risk of overweight and cardiovascular diseases, thereby compromising their mobility and quality of life. In this regard, it is recommended to encourage the practice of adapted physical activities among sedentary PWDs.

Finally, considering the relatively advanced age of players from the Lions Handisport Club of Cotonou, it is necessary to develop policies for talent identification and youth training to ensure sustainable succession. Future research could also focus on other components of physical fitness, such as agility, endurance, and muscular strength, to provide a more comprehensive functional profile of athletes with disabilities.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that they have no conflicts of interest.

Statement of ethical approval

This study strictly adhered to the ethical principles of the Declaration of Helsinki. The research was conducted with full respect for the rights, dignity, and well-being of the participants, without compromising their physical or moral integrity.

Statement of informed consent

All participants were informed of the research protocol, its objectives, and its potential benefits. They were assured that the results would be communicated to them promptly and confidentially. Before participating, they were also assured that all data collected would be anonymized and used solely for research purposes.

AI Statement

In preparing this work, the authors used Chat GPT to translate the content into English. After using this tool/service, the authors reviewed and modified the content as needed and take full responsibility for the content of the publication.

Author Contributions

- ODA designed the research, organized the data, conducted the analyses, proposed the methodology, validated the data, and wrote the original version.
- CM designed the research, organized the data, conducted the analyses, proposed the methodology, validated the data, and reviewed and edited the manuscript.
- MD supervised, reviewed, and validated the final version.
- MCG organized the data, proposed the methodology, and wrote the original version.
- FDK conducted the analysis, survey, and revised the original version.
- BA supervised, reviewed, and validated the final version.

All authors read and approved the final version of the manuscript and agreed on the order of presentation of the authors.

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Data Availability Statement

The anonymized dataset generated and analyzed during the study is available from the corresponding author upon reasonable request.

Disclaimer

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