Original Article

JER

https://doi.org/10.12965/jer.1938448.224

Journal of Exercise Rehabilitation 2019;15(5):663-666

Comparison of performance-related physical fitness and anaerobic power between Korean wheelchair badminton national and backup players

Ji-Tae Kim[1], Yun-A Shin[2], Keun-Ho Lee[3], Hyun-Seung Rhyu[4,*]

[1]Department of Recreation and Leisure Sport, Dankook University, Seoul, Korea
[2]Department of Exercise Prescriptions and Rehabilitation, Dankook University, Seoul, Korea
[3]Department of Icheon Training Center, Korea Paralympic Committee, Icheon, Korea
[4]Department of Physical Education, Jungwon University, Goesan, Korea

The purpose of this study was to compare performance-related physical fitness factors and anaerobic power between national and backup players to enhance the performance of wheelchair badminton players and to discover and foster new athletes. This study included 12 wheelchair badminton players divided into two groups: national players (n=7) and backup players (n=5). Collected data included cardiorespiratory endurance, muscle endurance, muscle strength, power, agility, and anaerobic power. Results indicated that the national players achieved a significantly higher level of muscle endurance, peak power, and mean power than the backup players. Although none of the parameters showed statistically significant differences, the performance levels of the national players were higher than those of the backup players. Because the physical fitness aspects of wheelchair players vary according to their ability and are essential factors, individualized training programs for enhancing performance and preventing injuries among wheelchair badminton players should be developed.

Keywords: Performance-related physical fitness, Anaerobic power, Wheelchair badminton, Athletic

INTRODUCTION

Wheelchair sports are the oldest and most representative of all disabled sports (Brittain, 2004). With recent advances in science and technology, wheelchair sports are receiving increasing attention, not only as means for facilitating rehabilitation and self-reliance but also as sporting events (Malone et al., 2000). Some well-known wheelchair sporting events include basketball, track and field, tennis, table tennis, dance sports, badminton, and boccia (Keogh, 2011). Most athletes in these sports acquire their disability from an accident or illness rather than from a congenital disorder (Brittain, 2004; Campbell and Jones, 1994; Li et al., 2018). Wheelchair athletes tend to be older because many of them begin participating in sports long after the onset of their disability (Blauwet and Willick, 2012). Therefore, national team players are older, and there are very few young athletes.

The number of registered athletes for wheelchair badminton in Korea is 10 times lower than those in China and Japan, as athletes on the national team tend to be in their late 40s and have >20 years of experience. Meanwhile, the mean age of reserves for the national team ranges from the late teens to the early 20s, indicating a generational gap within wheelchair athletics.

Despite such challenges, Korea has achieved excellent results in many international competitions for people with disability, thereby increasing its national prestige. Recently, the Korean team won two gold, three silver, and three bronze medals at the Thailand Para-Badminton International 2017; three gold, three silver, and six bronze medals at the World Championship held in Ulsan in the same year; and three gold, one silver, and three bronze medals at the Jakarta-Palembang 2018 Asian Games. This was made

*Corresponding author: Hyun-Seung Rhyu https://orcid.org/0000-0002-4987-7482
Department of Physical Education, Jungwon University, 85 Munmu-ro, Goesan-eup, Goesan 28024, Korea
E-mail: rhyuhs@jwu.ac.kr
Received: August 9, 2019 / Accepted: September 4, 2019

pISSN 2288-176X
eISSN 2288-1778

possible by the efforts of the athletes, coaches, and head coaches, as well as the various forms of sports science support.

The objective of this study was to compare performance-related physical fitness factors and anaerobic power between national and backup players in training programs for enhancing the performance of wheelchair badminton players in preparation for the 2020 Tokyo Paralympics.

Besides, this study was conducted to help the generational replacement of the aging wheelchair badminton players.

MATERIALS AND METHODS

Participants

Our study involved 12 wheelchair badminton players (five men and seven women) who had WH1 and WH2 disability ratings. Participants were currently all wheelchair badminton players belonging to the Icheon, Korea Paralympic Committee Training Center. The participants were divided into two groups: seven national players (mean age, 45.57±4.5 years) and seven backup players (mean age, 20.6±6.11 years). The physical characteristics of the subjects are shown in Table 1. Approval for the experimental protocol was obtained from the Ethics Committee of the Jungwon University, Korea (approval number: 100429-HR-201901-021-04).

Experimental procedures

Performance-related physical fitness tests

In this study, cardiorespiratory endurance (11-m shuttle run test: the protocol of the Korea Institute of Sports Science, rep), muscle endurance (Supine pull-up test, rep), muscle strength (hand-grip strength, kg), power (20-m wheelchair sprint test, sec; medicine ball throw test, cm), and agility (Illinois agility test, sec) were measured as items for measuring performance-related physical fitness.

Anaerobic power test (upper body Wingate test)

This test was performed on a Monark cycle ergometer adapted for the upper body (load of 0.05 kg/kg of body mass). Power was measured at each second by using the Wingate Test software, which allowed calculation of the following variables: mean power (average power during 30 sec), peak power (highest power during the test), time to reach peak power, and fatigue index (decrease rate of power during 30 sec).

Table 1. Characteristics of the study participants (n=12)

Variable	National players (n=7)	Backup players (n=5)
Age (yr)	45.57±4.5	20.6±6.11
DD (yr)	24.57±19.92	8.2±3.96
DS (yr)	11.86±3.81	2.4±0.5
BW (kg)	55.43±4.19	52.2±4.3

Values are presented as mean±standard deviation.
DD, duration of disability; DS, duration of sport; BW, body weight.

Statistical analyses

All data were presented as mean, standard deviation, and standard error. Statistical analyses were completed using SPSS ver. 18.0 (SPSS Inc., Chicago, IL, USA). For verifying differences in physical fitness between the national and backup wheelchair badminton players, the Mann–Whitney *U*-test, a nonparametric statistical method for sequencing raw data without assuming a normal distribution, was performed. The alpha value was set at 0.05.

RESULTS

Table 2 shows the comparison of performance-related physical fitness parameters between the national and backup players. Muscle endurance was significantly different between the groups (supine pull-up test: $U=3.00$, $P=0.047$). Cardiorespiratory endurance, muscle strength, power, and agility were not significantly different between the groups but were higher in the national players than in the backup players.

Table 3 shows the comparison of anaerobic power between the national and backup players. Peak and mean power values showed significant differences between the groups (peak power: $U=0.000$, $P=0.003$; mean power: $U=1.00$, $P=0.005$). No statistically significant differences in fatigue index were found, but the national players had lower values than the backup players.

Table 2. Comparison of performance-related physical fitness parameters

Parameter	National players (n=7)	Backup players (n=5)	Mann-Whitney *U*	*P*-value
11-m WSRT (rep)	118.4±14.01	105.2±24.27	15.00	7.55
SPUT (rep)	82.6±7.15	68.0±9.78	3.00	0.047*
LGS (kg)	38.9±5.25	32.1±2.36	15.00	0.755
RGS (kg)	37.3±5.36	29.0±2.78	13.00	0.530
20-m WST (sec)	6.20±0.24	6.9 ±0.63	23.00	0.432
MBTT (cm)	347.6±27.68	314.3±21.99	25.00	0.268
IAT (sec)	27.2±0.76	29.3±1.86	22.50	0.432

Values are presented as mean±standard error.
11-m WSRT, 11-m wheelchair shuttle run; SPUT, supine pull-up test; LGS, left grip strength; RGS, right grip strength; 20-m WST, 20-m wheelchair sprint test; MBTT, medicine ball throw test; IAT, Illinois agility test.
*$P<0.05$, statistically significant difference.

https://doi.org/10.12965/jer.1938448.224

Table 3. Comparison of anaerobic power

Parameter	National players (n=7)	Backup players (n=5)	Mann-Whitney *U*	*P*-value
PP (W/kg)	9.20±0.50	6.50±0.35	0.000	0.003**
MP (W/kg)	6.47±0.38	4.34±0.42	1.00	0.005**
FI (%)	46.16±1.33	49.74±2.52	25.00	0.268

Values are presented as mean±standard error.
PP, peak power; MP, mean power; FI, fatigue index.
**$P<0.01$, statistically significant difference.

DISCUSSION

In this study, differences in fitness levels between the wheelchair badminton national and backup players were measured to provide individualized training programs designed to enhance performance.

The results revealed that the national players showed a higher level of cardiorespiratory endurance than the backup players. These findings were not consistent with those of the studies conducted by Steinberg et al. (2000) and Morgulec et al. (2006), which reported little difference in cardiorespiratory endurance among athletes with disabilities because the activities of the sympathetic nervous system, which regulates cardiovascular responses, are restricted in cases involving spinal cord injuries at or above the T6 level. This restriction results in suppressed secretion of epinephrine, which limits the stimulating factors for increasing heart rate, stroke volume, and ventilation when exercise intensity is increased. By contrast, the findings in the present study support the results of the study by Soyupek et al. (2009), which showed that cardiorespiratory functions improve after exercise training in patients with spinal cord injuries. Therefore, enhancement of cardiorespiratory endurance is important for wheelchair badminton players, suggesting the need for continued training to enhance cardiorespiratory endurance in these athletes.

The national players showed a higher muscle strength than the backup players. In addition, the national players showed significantly greater muscle endurance than the backup players ($P>0.05$). These findings are in agreement with those of Yüksel (2018a; 2018b), who reported that muscle strength and endurance were higher in experienced athletes. Bernard et al. (2004) reported that most wheelchair athletes had a spinal cord injury accompanied by a brachial plexus injury; as a result, neurotransmission is blocked, resulting in the formation of less motor neurons that relay signals to the muscles and decreased muscle contraction. In particular, for wheelchair athletes who compete in sports that require open motor skills such as rugby, basketball, tennis, and badminton, building muscle strength and endurance is highly important to maintain power and strength to execute repetitive dynamic skills and movement within short intervals, while also operating the wheelchair (Goosey-Tolfrey et al., 2010). Therefore, individualized strategies for improving the strength and endurance of muscles essential for enhancing performance are needed.

The national players tended to show higher levels of quickness and agility than the backup players. This was possibly due to the difference in experience and ability in operating the wheelchair in response to various positional changes on the court and impacting the shuttlecock through fine manipulation of the racquet. Haff et al. (2001) and Hakkine (1994) showed the importance of individualized programs for building speed and agility in the upper extremity muscles in sports such as wheelchair badminton. Future studies based on such findings are needed to demonstrate the effects of training programs with different levels of intensity.

The national players also showed significantly higher levels of peak and mean power in the anaerobic power measurement and fatigue index than the backup players. Anaerobic power showed a large difference depending on the performance ability of the athletes (Franchini et al., 2005). The findings were consistent with the results of a study by Sucharitha et al. (2014) that compared anaerobic power between national and amateur female badminton players. They reported that the national players showed greater anaerobic power. Wheelchair badminton is a typical sport that requires anaerobic exercises, in which a rally to win a single point may last between 10 sec and 2 min. Therefore, anaerobic power can be viewed as an important factor for enhancing the performance of athletes; therefore, training programs designed to enhance anaerobic power, along with other fitness factors, should be promoted.

In summary, development of individualized training programs for enhancing performance and preventing injuries among wheelchair badminton players is needed. Also, national wheelchair badminton players are aging, and the low number of players is a problem. To solve these problems, efforts should be made to increase the number of white hope along with the revitalization of disabled sports for all to expand the base of wheelchair badminton, and double the camping training period of the backup player training center, so that they can grow into a national team by conducting continuous training and managing the athletes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGMENTS

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2018S1A5A8028188).

REFERENCES

Bernard PL, Codine P, Minier J. Isokinetic shoulder rotator muscles in wheelchair athletes. Spinal Cord 2004;42:222-229.

Blauwet C, Willick SE. The Paralympic Movement: using sports to promote health, disability rights, and social integration for athletes with disabilities. PM R 2012;4:851-856.

Brittain I. Perceptions of disability and their impact upon involvement in sport for people with disabilities at all levels. J Sport Soc Issues 2004;28:429-452.

Campbell E, Jones G. Psychological well-being in wheelchair sport participants and nonparticipants. Adapt Phys Activ Q 1994;11:404-415.

Franchini E, Takito MY, Kiss MAPDM, Strerkowicz S. Physical fitness and anthropometrical differences between elite and non-elite judo players. Biol Sport 2005;22:315-328.

Goosey-Tolfrey V, Foden E, Perret C, Degens H. Effects of inspiratory muscle training on respiratory function and repetitive sprint performance in wheelchair basketball players. Br J Sports Med 2010;44:665-668.

Haff GG, Whitley A, Potteiger JA. A brief review: explosive exercises and sports performance. Strength Cond J 2001;23:13-20.

Häkkinen K. Neuromuscular fatigue in males and females during strenuous heavy resistance loading. Electromyogr Clin Neurophysiol 1994;34:205-214.

Keogh JW. Paralympic sport: an emerging area for research and consultancy in sports biomechanics. Sports Biomech 2011;10:234-253.

Li GP, Wang XY, Zhang Y. Efficacy and safety of onabotulinumtoxina in patients with neurogenic detrusor overactivity caused by spinal cord injury: a systematic review and meta-analysis. Int Neurourol J 2018;22:275-286.

Malone LA, Nielsen AB, Steadward RD. Expanding the dichotomous outcome in wheelchair basketball shooting of elite male players. Adapt Phys Activ Q 2000;17:437-449.

Morgulec N, Kosmol A, Molik B, Hubner-Wozniak E, Rutkowska I. The effect of training on aerobic performance in wheelchair rugby players. Res Yearbook Stud Phys Ed Sport 2006;12:195-198.

Soyupek F, Savas S, Oztürk O, İlgün E, Bircan A, Akkaya A. Effects of body weight supported treadmill training on cardiac and pulmonary functions in the patients with incomplete spinal cord injury. J Back Musculoskelet Rehabil 2009;22:213-218.

Steinberg LL, Lauro FA, Sposito MM, Tufik S, Mello MT, Naffah-Mazzacoratti MG, Cavalheiro EA, Silva AC. Catecholamine response to exercise in individuals with different levels of paraplegia. Braz J Med Biol Res 2000;33:913-918.

Sucharitha BS, Reddy AV, Madhavi K. Effectiveness of plyometric training on anaerobic power and agility in female badminton players. Int J Pharma Bio Sci 2014;3:754-761.

Yüksel MF. Effects of badminton on physical developments of males with physical disability. Univers J Educ Res 2018a;6:701-709.

Yüksel MF. Examination of the physical profiles of physically handicapped female badminton players. Turk J Sport Exe 2018b;20:1-8.

 https://doi.org/10.12965/jer.1938448.224