



Original Article

Throwing distance and competitive performance of Boccia players

MASATAKA KATAOKA, PhD^{1)*}, KUNIHARU OKUDA, PhD¹⁾, AKIRA IWATA, PhD¹⁾, SHUJI IMURA, MS¹⁾, KOSUKE YAHAGI, MS¹⁾, YOHEI MATSUO²⁾

¹⁾ Graduate School of Comprehensive Rehabilitation, Osaka Prefecture University: 3-7-30 Habikino, Habikino-city, Osaka 583-8555, Japan

²⁾ Fukushima Rehabilitation Center for Children, Japan

Abstract. [Purpose] This study aimed to clarify the relationship between throwing distance and competitive performance in Boccia players in order to establish a training program based on this evidence. [Participants and Methods] In total, 40 athletes, who competed in the Japan Boccia Championships and are certified players of the Japan Boccia Association, participated in the study. Participants threw the Boccia ball as far as possible, and throwing distances were compared between certified players (Group I, n=8), those who participated in the final round (Group II, n=9), and those who lost in the preliminary round (Group III, n=23). [Results] The maximum throwing distances were 16.38 ± 5.17 m (Group I), 10.67 ± 2.66 m (Group II), and 8.34 ± 2.73 m (Group III). Group I threw the ball significantly farther than Groups II and III. [Conclusion] Boccia is a target sport and throwing farther distances requires more effort. In addition, being able to throw at a longer distance means that Boccia players can throw a stronger ball and use this for various tactics. The results of this study suggest that long-distance throwing training would be effective in improving the competitive performance of Boccia players.

Key words: Cerebral palsy, Boccia, Performance

(This article was submitted Apr. 30, 2020, and was accepted Jun. 3, 2020)

INTRODUCTION

Boccia is a Paralympic medal sport that has been devised so that individuals with severe physical disabilities, such as those with cerebral palsy (CP), can participate. Boccia is played in a court similar to badminton courts, and players are required to throw a colored ball (6 red balls or 6 blue balls) close to the target, which is a white ball called a jack. The type of disease and severities of the disabilities will classify players into 1 of 4 classes: BC1, BC2, BC3, or BC4. If the players are quadriplegic by a disease of cerebral origin, such as CP, they will be classified as BC1, BC2, or BC3. If players are quadriplegic or functionally impaired in all four limbs by a disease of non-cerebral origin, such as muscular dystrophy, they will be classified as BC3 or BC4. BC1, BC2, and BC4 players can throw or kick the Boccia balls. BC3 players use an assistive device to propel the Boccia ball, called a ramp, and direct their sports assistant, and so they have difficulty throwing their Boccia balls. In Japan, representative players competed for the first time in the Beijing Paralympic Games in 2008, and 5 Boccia players participated in the London Paralympic Games in 2012 and Rio De Janeiro Paralympic Games in 2016. In the future, it is very important to strengthen Boccia players and to train up younger players. However, the training methods to create strong players have not been clarified currently.

Although Boccia is a target sport, it is necessary to throw the ball at various distances in the court as well as control the ball. If players can throw the ball further or throw a heavier ball and repel the opponent's ball, their tactics will expand greatly. It is thought that high-performance players need not only good control but also the ability to throw a heavier ball.

*Corresponding author. Masataka Kataoka (E-mail: kataoka@rehab.osakafu-u.ac.jp)

©2020 The Society of Physical Therapy Science. Published by IPEC Inc.



This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License. (CC-BY-NC-ND 4.0: <https://creativecommons.org/licenses/by-nc-nd/4.0/>)

Boccia is not a competition for distance: it is a target sport, and it is considered to be important to improve one's ability to throw a long distance to strengthen players. However, no studies have focused on the practice method or training for Boccia players to improve their performance.

The majority of Boccia players have CP and are severely quadriplegic. Since the 1990s, research into the effects of muscle strengthening exercises on CP^{1, 2)} in particular have reported that training the gastrocnemius or quadriceps femoris muscles were effective in improving walking ability. However, in sports for severely disabled persons, such as those with CP. There is no study to improve for competitiveness. There are a few scientific studies in the literature that explore Boccia³⁻⁶⁾, but no studies on Boccia clarify the method of training to improve performance. However, one study analyzed muscular activity while throwing³⁾. The purpose of the present study was to verify the indicators of competition performance of Boccia athletes to establish a training method. Therefore, we aimed to clarify the relationship between throwing distance and competition performance to establish a training program based on the evidence.

PARTICIPANTS AND METHODS

The participants were 40 Boccia players that could throw Boccia balls by themselves (BC1 and BC2 class). They had participated in the Japan Boccia Championships Qualifying Events and are certified athletes for the Japan Boccia Association (28 males and 12 females). BC1 and BC2 class players include those with CP. Their average age was 31.9 ± 13.4 years (Table 1). Players were divided into three groups: Japan Boccia Association Certified players (Group I), the players who qualified for the Japan Boccia Championships finals (Group II), and those who lost in the qualifying round (Group III). The exclusion criteria were as follows: players who have pain their upper limbs due to orthopedic disease and cannot throw the ball with their own hands, that is, players who kick the ball with their feet or who use the assistant device such as ramp. This study was non-invasive to participants-and was carried out with the approval of players and Japan Boccia Association to which the players belong. The purpose of this study was explained to the participants orally and in writing, and written consent was obtained. The participants were informed that there would be no disadvantage of withdrawing from the study.

Participants threw the Boccia balls as far as possible in a gymnasium. All participants used the same ball, and their throwing form was not specified. The throwing distance was measured as the linear distance from the nearest portion of the Boccia ball thrown by participants to the midpoint of the grounding point of their wheelchair's front caster after it was confirmed that the Boccia ball had stopped. The measurement was centered on a straight line from the midpoint between both casters. If the ball fell outside of a 3-m width of the caster, it was considered a failure (Fig. 1). The throwing distance used for data analysis was the maximum value of three successful trials.

After checking normality with the Kolmogorov-Smirnov test, a one-way ANOVA followed by Bonferroni's least significant comparison was used to examine differences between the throwing distance of the three groups. The level of statistical significance was set at $p < 0.05$.

RESULTS

There was no significant difference in age between the groups. The maximum throwing distances of Groups I, II, and III were 16.38 ± 5.17 m, 10.67 ± 2.66 m, and 8.34 ± 2.73 m, respectively (Table 2). There were significant differences between Group I and Groups II and III, but no significant difference between Group II and III. Group I was distributed over 10 m.

DISCUSSION

This study aimed to clarify the relationship between throwing distances and competition performance of Boccia players establish a training program based on the evidence. From the results of this study, it was found that the players who performed in the competition had a longer throw distance.

Boccia is a target sport that takes place in a court size of 12.5 m \times 6 m. However, because it is a sport with less movement, athletes just throw the balls and spend a lot of time practicing how close they can throw a Boccia ball to a jack. Training methods to improve the performance of Boccia athletes have not been reported, including for those with CP. Some studies on Boccia players have analyzed their muscle activity, seating pressure, and motion during throwing³⁻⁶⁾. However, these studies have not defined training methods to improve Boccia athletes' performance.

The results showed that players who won the tournament (high-performance players) had a significantly longer throwing distance. In Boccia, which is a target sport, it is expected that those who can throw further will require less effort to throw a ball at a shorter distance, when their throwing accuracy would increase. In a study of handball players, it was also reported that experienced players could throw accurately at relatively high velocities⁷⁾. This means that the smaller the load on the player, the more accurately the ball can be thrown when the ball is thrown at the same velocity. In other words, this suggests that players with a stronger throw have higher accuracy over a limited distance. Also, Reina et al. reported that positive correlations were found between throwing speed and accuracy at a medium distance, about 5 m⁸⁾. To throw a fast ball, players need the ability to throw far. In this study, we did not verify the relationship between throwing distance and accuracy; however, it has been reported that there is a relationship between ball speed and accuracy at a certain distance⁸⁾; thus, the

Table 1. Participants characteristics

	Class	Gender		Age (years)	
		Male	Female		
Group I	BC1	3	-	32.5 ± 15.4	
	BC2	5	-		
Group II	BC1	2	1	37.1 ± 13.2	31.9 ± 13.4
	BC2	4	2		
Group III	BC1	6	3	29.7 ± 12.7	
	BC2	8	6		

Table 2. The results of maximum throw distance in three groups

	Group I	Group II	Group III	F	p
Age (years)	32.5 ± 15.4	37.1 ± 13.2	29.7 ± 12.7	-	>0.05
Maximum thrown distance (m)	16.38 ± 5.17 ^{a,b}	10.67 ± 2.66	8.34 ± 2.73	17.435	<0.001*

Mean ± SD.

*p<0.05.

^aSignificant difference between Group I and Group II.

^bSignificant difference between Group I and Group III.

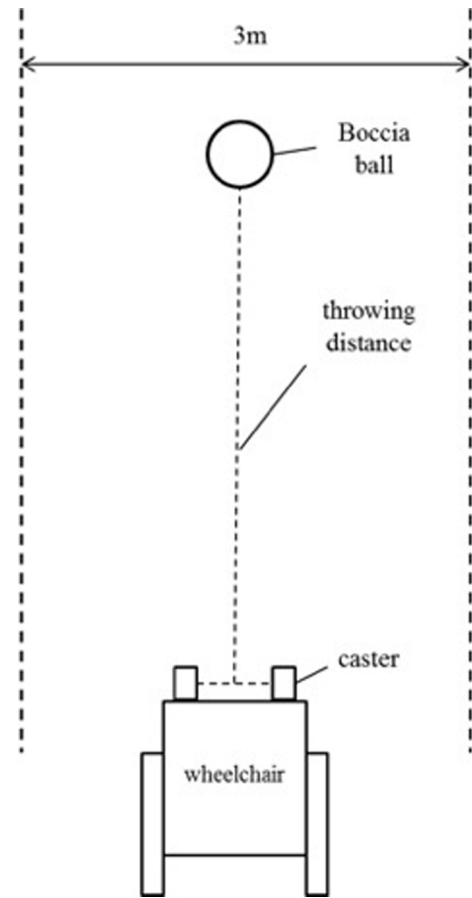


Fig. 1. Measurement method of throwing distance.

training for throwing longer distances is considered to be related to competitive performance.

Since Boccia is a sport originally devised for CP, many players have CP. In the case of players with CP, excessive efforts may increase their muscle tone and encumber smooth throwing. Furthermore, Boccia spreads the range of tactics by moving both the balls thrown by other players and the jack. The ability to throw at a longer distance, or the throwing strength, is thought to lead to higher performance.

In studies comparing several kinds of Boccia balls, it has been reported that soft balls are more accurate and reproducible than rigid balls⁹). A soft ball is hard to move even when an external force is applied, so it is necessary to throw a strong ball to push or move that ball. In recent years, many players use soft balls in international Boccia competitions. To win among international players, it is necessary to throw with both accuracy and power.

From the results of this study, it was suggested that players with longer throwing distances have higher performance. Furthermore, from the distribution of distances between Groups I, II, and III, it was found that a throwing distance of 10 m may be a good goal. The Boccia court is 10 m from the throwing box to the end line. It was suggested that it is useful to extend the throwing distance to 10 m or more in improving the performance of Boccia players.

Boccia is a Paralympic sport designed for people with severe physical disabilities and is an opportunity for social participation for these individuals. Recently, the level of competitiveness has increased, but training methods are unclear because the players are people with severe physical disabilities. From the results of this study, it was found that training to increase throwing distance is important for Boccia players to improve their performance. Furthermore, it was suggested that a throwing distance of 10 m, which is the size of a Boccia court, could be a goal as a result of their training.

This study could not investigate the player's detailed athletic history and training frequency. Also, the throwing method (overarm throw or underarm throw) is not unified. To provide clearer training programs and practice method, it is necessary to investigate these data and the physical function, that is spasticity, coordination, range of motion, etc. of players in the future.

Funding

This study was supported by JSPS KAKENHI Grant Number 17K01730.

Conflict of interest

The authors declare that there are no conflicts of interest.

REFERENCES

- 1) Damiano DL, Vaughan CL, Abel MF: Muscle response to heavy resistance exercise in children with spastic cerebral palsy. *Dev Med Child Neurol*, 1995, 37: 731–739. [[Medline](#)] [[CrossRef](#)]
- 2) Andersson C, Grooten W, Hellsten M, et al.: Adults with cerebral palsy: walking ability after progressive strength training. *Dev Med Child Neurol*, 2003, 45: 220–228. [[Medline](#)] [[CrossRef](#)]
- 3) Fong DT, Yam KY, Chu VW, et al.: Upper limb muscle fatigue during prolonged Boccia games with underarm throwing technique. *Sports Biomech*, 2012, 11: 441–451. [[Medline](#)] [[CrossRef](#)]
- 4) Tsai YS, Yu YC, Huang PC, et al.: Seat surface inclination may affect postural stability during Boccia ball throwing in children with cerebral palsy. *Res Dev Disabil*, 2014, 35: 3568–3573. [[Medline](#)] [[CrossRef](#)]
- 5) Huang PC, Pan PJ, Ou YC, et al.: Motion analysis of throwing Boccia balls in children with cerebral palsy. *Res Dev Disabil*, 2014, 35: 393–399. [[Medline](#)] [[CrossRef](#)]
- 6) Reina R, Caballero C, Roldan A, et al.: Electromechanical delay in a ball release activity with time- and non-time constrained situations performed by Boccia players. *Eur J Hum Mov*, 2015, 35: 125–136.
- 7) van den Tillaar R, Ettema G: Influence of instruction on velocity and accuracy of overarm throwing. *Percept Mot Skills*, 2003, 96: 423–434. [[Medline](#)] [[CrossRef](#)]
- 8) Reina R, Dominguez-Diez M, Urban T, et al.: Throwing distance constraints regarding kinematics and accuracy in high-level boccia players. *Sci Sports*, 2018, 33: 299–306. [[CrossRef](#)]
- 9) Dickson MJ, Fuss FK, Wong KG: Benchmarking of boccia balls: roll distance, accuracy, stiffness, rolling friction, and coefficient of restitution. *Sports Technol*, 2010, 3: 131–140. [[CrossRef](#)]