

# Development of Boccia Throw Test Instrument for Athletes with Cerebral Palsy

Rumi Iqbal Doewes\*, Islahuzzaman Nuryadin, Singgih Hendarto and Sapta Kunta Purnama

*Faculty of Sport, Sebelas Maret University, Surakarta, Central Java, Indonesia*

**Abstract:** *Background:* Boccia is an accuracy game for athletes with cerebral palsy. In a Boccia game, the players throw a red- or blue-colored leather ball towards a white-colored target ball called the jack. Points are awarded to the colored balls with the closest distance to the jack.

*Aims:* This development research aims to design a Boccia throw test instrument for novice athletes with cerebral palsy and test the instrument's validity and reliability.

*Methods:* We use research and development with a 6-step instrument development method by Gall, Gall, and Borg. The subject of this research was 20 novice Boccia athletes who completed six trials to test the validity and reliability of the test instrument. Analysis was conducted through corrected item-total correlation and Cronbach's Alpha using SPSS.

*Results:* This research has produced a boccia throwing test instrument for cerebral palsy athletes with a throwing target in the form of a circle diameter of 25 cm, which is placed 5 meters from the ball throwing area. This instrument has proven its validity and reliability based on the validity value on the corrected item-total correlation  $> 0.05$  and the reliability value on Cronbach's alpha  $> 0.80$ .

*Conclusion:* The resulting test instrument is valid and reliable to assess the Boccia throwing accuracy skill in novice players.

**Keywords:** Boccia, development, throw.

## INTRODUCTION

Boccia is a parasport designed for athletes with severe impairment of exercise capacities [1]. In line with this, Paulo stated that the manual on functional classification boccia ensures that athletes meet physical criteria in the sport and evaluates functional effects of athletes with a disability on sports performances [2]. The sport of Boccia is similar to petanque and is included in the sport of precision [3] for athletes with cerebral palsy. Boccia is also a modified form of indoor bowls; it is done by throwing colored balls to the target ball (jack) in a sitting position [4]. The players throw a red- or blue-colored leather ball towards a white-colored target ball called a *jack*. In line with this, Fong stated that scoring is calculated based on the proximity of the ball thrown to the jack [5]. This game can be played in single, double, or team (group) categories.

In the game boccia, a point is awarded to the colored ball with the closest distance to the jack. It is observed that athletes often have problems with throwing accuracy in approaching the jack so that a Boccia throwing technique exercise is deemed necessary. Implementation of the Boccia throwing technique exercise should be carried out in a planned,

regular, and repeated manner. These principles are manifested in exercise frequency, overload, exercise specifications, individualization, exercise quality, exercise variations, exercise models, training methods, targets, and monitoring or evaluation. Exercise results should be evaluated periodically and continually. This is useful to understand whether or not the exercise program implemented gets optimal results, and therefore a Boccia throw test instrument is needed to measure throwing exercise results.

The previously designed test instrument is conducted in three steps: jack ball positioning test, throwing test approaching the jack as close as possible from 3, 5, and 9 meters of distance and throwing test pushing the jack as far as possible from 3, 5, and 9 meters of distance. Players are given 12 attempts for each test, so the total number of tests is 84 times. The scoring is determined from the proximity of balls thrown to the jack: three, two, one, and zero points are awarded to each ball landing on 9, 18, 27, and more than 27 centimeters from the jack, respectively [6].

Limitations are found in this test instrument. The high number of repetitions in the test is potentially ineffective to Boccia athletes with cerebral palsy because they have weakness in movement and are prone to fatigue when doing excessive movements. Fatigue is influential to individuals' functional and motoric capacities with cerebral palsy [7]. Therefore, a development on Boccia throw test instrument is

\*Address correspondence to this author at the Faculty of Sport, Sebelas Maret University, Surakarta, Central Java, Indonesia;  
E-mail: king.doewes@staff.uns.ac.id

necessary to suit the characteristics of Boccia players with cerebral palsy and the number of balls thrown. The test developed was conducted with six repetitions according to the number of Boccia balls thrown. This research developed the three categories of distance (9, 18, and 27 cm) present in the previously developed test instrument into five (5, 10, 15, 20, and 25 cm).

An instrument is a tool that conforms to academic provisions to measure a measuring object or collect data on a variable. In designing test instruments, validity and reliability tests are necessary. Validity means that the instrument must be able to measure [8]. Tests and retests, inter-and intra-raters, and the internal consistency of the test's reliability are described as the level of independence from measurement error [9]. Meanwhile, reliability refers to the state in which an instrument can produce similar results if used several times to measure similar objects. Hence, this research aims to design Boccia throw test instrument for novice players as a research instrument in Boccia skill studies.

## **MATERIALS AND METHODS**

### **Study Design**

Development research is used in this study to identify and investigate feasible ideas to be used as a practical solution or as a product [10]. The research design used was pretest-posttest (test-retest) to test the validity and reliability.

### **Participants**

Twenty novice players with cerebral palsy at  $17 \pm 1.7$  years participated in this study to evaluate the instrument. The inclusion criteria for participants are BC1 and BC2 players. The evaluation was conducted by performing a throwing test using the developed instrument. The research was conducted at the Sports Center of Universitas Sebelas Maret for January-April 2021. The study had the approval of the Health Research Ethics Committee, Dr. Moewardi. Each subject signed written consent.

### **Procedure**

This research procedure uses stages for measurement development by Gall, Gall, and Borg [11] are as follows: (1) Defining the product; (2) Defining the target population; (3) Explaining why the product is needed; (4) Developing product and writing items that

need assessment; (5) Field test; (6) Revision or final product.

As a validity and reliability test, the field test stage begins with a warm-up, and the subject is given time to get used to the testing environment. The test is carried out when the subject is in the throwing box position. Subjects were instructed to throw a red or blue leather ball towards a target circle with a diameter of 25 cm consisting of 5 colors placed 5 meters from the ball throwing area. Each color has its own value. Each subject is allowed to make six throws. Scoring is done by the accumulation of the total throws according to the stop of the red or blue boccia ball on the color circle of the target. After the pretest was carried out, a retest was carried out on another day. Subjects carried out the same test as to when the pretest was carried out.

### **Statistical Analysis**

Validity measurement was conducted through correction item-total correlation. Inspection of the test's internal structure could give proof of the validity of the test. The test was examined by using correlational statistics. Reliability degree was stated with reliability coefficient ranging from 0.00 to 1.00, with 1.00 showing perfect reliability. As a practical rule, measurement was considered reliable if the reliability coefficient was equal to or greater than 0.80. Reliability measurement used Cronbach's Alpha to measure how far individual scores in different items remained consistent [11].

## **RESULTS**

### **Product Definition**

The developed test instrument was a test instrument of Boccia throwing accuracy with differently-colored circle-shaped targets. In the instrument, each color had its own score, signifying the proximity of the ball thrown to the midpoint of the circle. The closer the ball thrown to the midpoint was, the higher the points obtained.

### **Target Population**

This test instrument is targeted for novice Boccia athlete use.

### **Need Analysis**

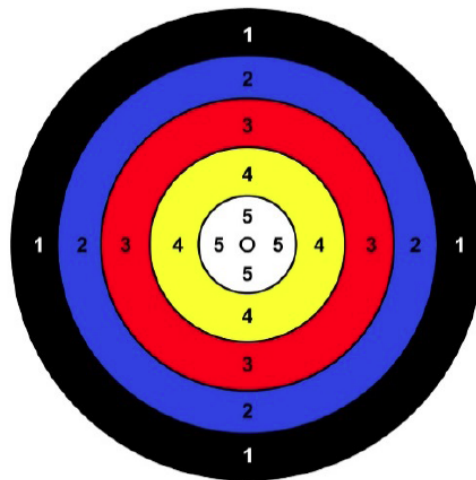
Athletes have problems with throwing accuracy in approaching the jack, and as a result, exercise is necessary. Exercise results are measured through a

test instrument. A limitation was found in the test instrument by Morris and Wittmannova [6] in the high number of test repetitions which signifies the test ineffectiveness to athletes with cerebral palsy. This was considered a limitation because Boccia players with cerebral palsy have weaknesses in movement and are thus prone to fatigue if they do excessive movements.

**Product Development**

Figure 1 shows the layout of the designed Boccia throw test instrument. The test was conducted in a Boccia field measuring 12.5 x 6m<sup>2</sup> with six ball throwing areas (2.5 x 1m<sup>2</sup>) and colored circle-shaped targets (25cm diameter) in a position as illustrated in the Figure. The target position was distanced as far as five meters from the position of the ball throwing area. Figure 2 illustrates the five target colors (black, blue, red, yellow, and white) with distances of 5, 10, 15, 20, and 25cm, respectively. The test was conducted by throwing Boccia ball to the colored circle targets. Testee positioned himself/herself in the ball throwing area, ready to throw. The testee threw Boccia balls towards the circle targets on the tester call. Each testee

was randomly selected and given six attempts to throw the ball. Scoring was conducted based on the landing position of the ball thrown. Each ball landing on the white, yellow, red, blue, and black tracks was given a score of five, four, three, two, and one, respectively.



**Figure 2:** The target for the designed Boccia throw test instrument.

**Field Test**

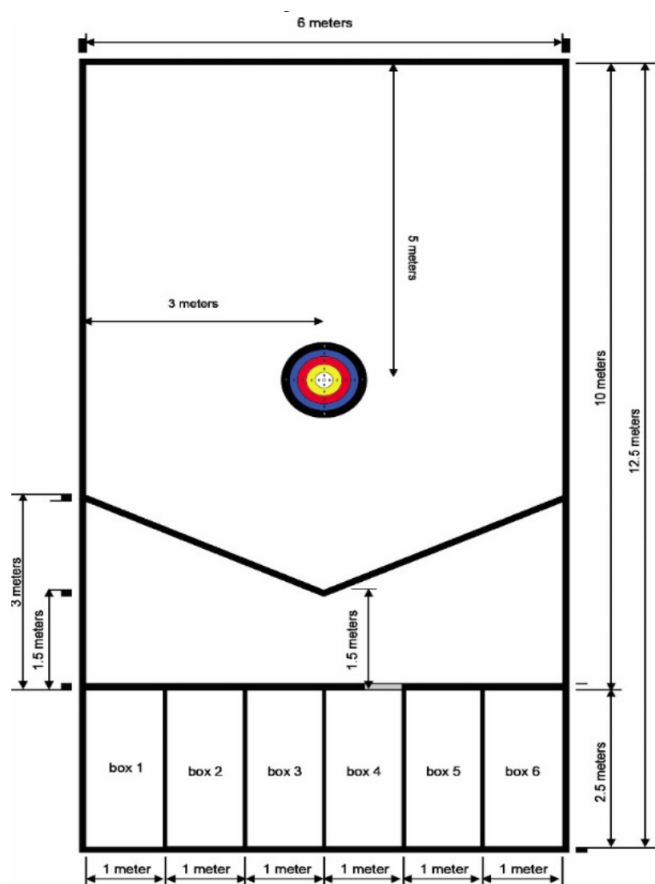
The researcher used 20 novice Boccia athletes to evaluate the designed instrument by giving six throwing trials to each athlete. The test results were used to measure the instrument's validity and reliability.

**Table 1: Validity Test Results**

	Corrected Item Total Correlation	Cronbach Alpha
Throw 1	0.754	0.907
Throw 2	0.828	0.903
Throw 3	0.859	0.893
Throw 4	0.742	0.914
Throw 5	0.789	0.901
Throw 6	0.779	0.902

Validity inspection used the test's internal structure. Table 1 shows the validity test results of the instrument with six throwing trials. The score of instrument validity is shown in the corrected item-total correlation column, showing that each throw produced a validity score greater than 0.05, which means that the instrument developed was considered valid.

The test-retest results show instrument reliability which is shown in Table 2. The reliability score



**Figure 1:** Systematics for the designed Boccia throw test instrument.

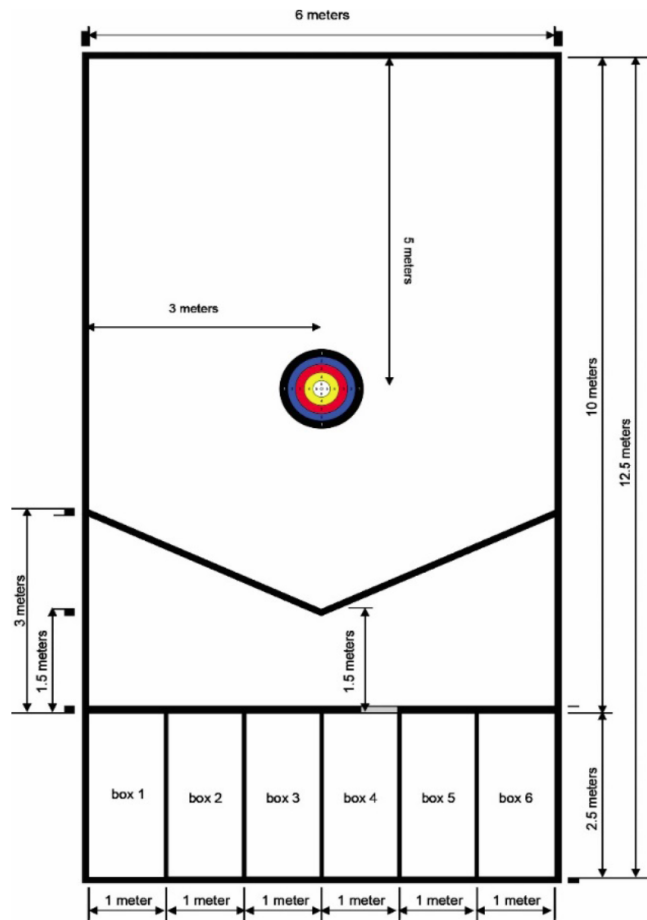
observed by Cronbach's Alpha was 0.918, which was more significant than 0.80, meaning that the instrument developed was considered consistent to measure Boccia throwing skill in repeated measurement.

**Table 2: Reliability Test Result**

Cronbach Alpha	N of Items
0.918	2

**Final Product**

Figure 3 shows the final product of the Boccia throw test instrument for novice players with the implementation guide and assessment criteria as follows:



**Figure 3: Final Produk Instrumen Tes Lemparan Boccia.**

Test purposes measuring Boccia throwing accuracy for novice players. Boccia throwing test kit: (1) A Boccia field of 12.5 x 6 square meters; (2) Circle-shaped targets; (3) 6 Boccia balls; (4) Gauge; (5) Chalk for lines; and (6) Stopwatch. Implementing officer is one turner and concurrent starter; one person as target supervisor; one results recorder. The testee is in the

box, prepared, and ready to throw the ball in the implementation. Subjects were instructed to throw a red or blue leather ball towards a target circle with a diameter of 25 cm consisting of 5 colors placed 5 meters from the ball throwing area. Each color has its own value. Each subject is allowed to make six throws. Scoring is done by the accumulation of the total throws according to the stop of the red or blue boccia ball on the color circle of the target.

- Five points were awarded to each red or blue ball landing on the white track.
- Four points were awarded to each red or blue ball landing on the yellow track.
- Three points were awarded to each red or blue ball landing on the red track.
- Two points were awarded to each red or blue ball landing on the blue track
- One point was awarded to each red or blue ball landing on the black track.

The Table 3 shows the scoring criteria of the cerebral palsy boccia throw test.

**Table 3: Assessment Criteria**

Category	Scores
Not good	<8
Less good	8-15
Adequately good	15-22
Good	22-28
Very good	> 28

**DISCUSSION**

The game of Boccia is not physically demanding as players only need to perform a throwing motion so individuals with different levels of disability can participate in this game [12]. Throwing is the primary movement in Boccia, and thus its techniques need to be practiced. Previous research developed simulation applications to assist Boccia athletes in mastering the game. The results show that the Boccia game simulator is the correct application for the practice of cerebral palsy patients. This application is up to expectation, convincing, fit for the primary purpose, and practical [13]. The Boccia game simulator was customized for all people with disabilities, integrating fundamental physical and social features. These

features can be used to improve the needs of non-practitioner of sports and exercise conditions. Boccia rules were present in the simulator design. In reality, the simulator's ability and approach were tested and validated based on performance tests and data collected by surveying users who had no motoric or psychological disorders. Realism and usability rating was deemed nearly excellent [14]. This previous research was only a simulation exercise to measure throwing skills without measuring exercise results.

This research designed a Boccia throw test instrument for novice players and tested the validity and reliability of the designed test instrument. This instrument is a Boccia throwing accuracy test instrument, in which its targets were in the form of circles with different colors. The instrument was designed based on internal logic and Boccia game rules which were then loaded. The data results' reliability was confirmed. Specific sports equipment usage was facilitated to understand the function of the equipment during manual assessment [15]. The research used 20 Boccia novice players to test the validity and reliability of the test instrument. A test instrument needs to display validity, which refers to the extent to which a test will be viewed subjectively as a technical measurement. An instrument is considered valid if it measures what it is supposed to measure [8].

Meanwhile, reliability refers to the capacity or measurement of replicability of an instrument on repeated occasions, meaning that it brings the same results in each trial [16]. The validity and reliability testing showed high scores. These were different than the result of previous research, in which the results of a pediatric test of participants with cerebral palsy showed poor throwing. Participants with cerebral palsy significantly showed, longer duration of movement, smaller elbow swing movements, greater shoulder abduction and flexion, slower maximum velocity of body flexion and forward linear movement of the wrist joint, faster head flexion maximum velocity, smaller swing ratio when throwing the ball. The participants generally use head and shoulder motion to bring the Boccia ball forward with little body movement [17].

This boccia throw test instrument proved to be a valid and reliable assessment method. However, there is a study limitation in this study, i.e., that this instrument can only be applied to amateur boccia players, so it is not appropriate to apply it to professional boccia players.

## CONCLUSION

Based on the validity and reliability tests carried out by test-retest, where the results are described in the field test section, it has been shown that the test instrument developed had been proven to be valid and reliable. The instrument was tested by novice Boccia players to be used as a normative reference to measure Boccia throwing accuracy skill on novice players.

## ACKNOWLEDGEMENT

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## REFERENCES

- [1] Kazushige I, Naoko N. Efforts towards Boccia at Tsukuba University of Technology 2018; 25(2): 67-71. [https://tsukuba-tech.repo.nii.ac.jp/?action=pages\\_view\\_main&active\\_action=repository\\_view\\_main\\_item\\_detail&item\\_id=141&item\\_no=1&page\\_id=13&block\\_id=21](https://tsukuba-tech.repo.nii.ac.jp/?action=pages_view_main&active_action=repository_view_main_item_detail&item_id=141&item_no=1&page_id=13&block_id=21)
- [2] Paulo S, Romano RG, De Arroxellas RD, Regina B, Saeta P, Hirota VB. The professionalization of disabled athletes of Boccia. *Int J Phys Educ Sport Heal* 2016; 3(3): 482-484.
- [3] Calado A, Leite P, Soares F, Novais P, Arezes P. Boccia court analysis for promoting elderly physical activity. *Lect Notes Electr Eng* 2019; 505: 158-164. [https://doi.org/10.1007/978-3-319-91334-6\\_22](https://doi.org/10.1007/978-3-319-91334-6_22)
- [4] Ovenden I, Denning T, Beer C. Here everyone is the same' - A qualitative evaluation of participating in a Boccia (indoor bowling) group: Innovative practice. *Dementia* 2019; 18(2): 785-792. <https://doi.org/10.1177/1471301216675988>
- [5] Fong DTP, Yam KY, Chu VWS, Cheung RTH, Chan KM. Upper limb muscle fatigue during prolonged Boccia games with underarm throwing technique. *Sports Biomech* 2012; 11(4): 441-451. <https://doi.org/10.1080/14763141.2012.699977>
- [6] Morriss L, Wittmannova J. The effect of blocked vs. random training schedules on boccia skills performance in experienced athletes with cerebral palsy. *Eur J Adapt Phys Act* 2010; 3(2): 17-28. <https://doi.org/10.5507/euj.2010.006>
- [7] Puce L, Pallecchi I, Chamari K, Marinelli L, Innocenti T, Pedrini R, Mori L, Trompetto C. Systematic review of fatigue in individuals with cerebral palsy. *Front Hum Neurosci* 2021; 15. <https://doi.org/10.3389/fnhum.2021.598800>
- [8] Ha JK, Kim JG, Yoon KH, Wang JH, Seon JK, Bae JH, Jang KM. Korean version of the anterior cruciate ligament-return to sport after injury scale: Translation and cross-cultural adaptation. *Clin Orthop Surg* 2019; 11(2): 164-169. <https://doi.org/10.4055/cios.2019.11.2.164>
- [9] Wen D, Robertson S, Hu G, Song B, Chen H. Measurement properties and feasibility of the Loughborough soccer passing test: A systematic review. *J Sports Sci* 2018; 36(15): 1682-1694. <https://doi.org/10.1080/02640414.2017.1409611>
- [10] Levin G, Green AR. Project management for research and development projects. New York, 2015. <http://library.lol/main/63134241A0D2F7C34206E50E187F4D01>
- [11] Borg JPGWR. Applying Educational Research: How to Read, Do, and Use Research to Solve Problems of Practice 2014.

- <http://library.lol/main/FDE90BEC8F81FED891BE80F1C5FEDE0E>
- [12] Leite P, Calado A, Soares F. Boccia court analysis for real-time scoring. In: Proceedings of the 15th International Conference on Informatics in Control, Automation and Robotics 2018; Volume 2: ICINCO, ISBN 978-989-758-321-6; ISSN 2184-2809, pages 511-516. <https://doi.org/10.5220/0006918305110516>
- [13] Diogo J, Ribeiro M, António D, Moreira P. Faculdade de engenharia da universidade do porto boccia game simulator-applications for training Cerebral Palsy Patients 2017. In mendeley: [https://www.mendeley.com/catalogue/43a8c892-ffe8-3895-b698-6af0ec623f81/?utm\\_source=desktop&utm\\_medium=1.19.4&utm\\_campaign=open\\_catalog&userDocumntId=%7B40ed85d6-2944-4dd7-b059-bb19d82fcd9c%7D](https://www.mendeley.com/catalogue/43a8c892-ffe8-3895-b698-6af0ec623f81/?utm_source=desktop&utm_medium=1.19.4&utm_campaign=open_catalog&userDocumntId=%7B40ed85d6-2944-4dd7-b059-bb19d82fcd9c%7D)
- [14] Faria BM, Ribeiro JD, Moreira AP, Reis LP. Boccia game simulator: Serious game adapted for people with disabilities. In Expert Systems 2019; 36. Blackwell Publishing Ltd. <https://doi.org/10.1111/exsy.12299>
- [15] Roldan A, Sabido R, Barbado D, Caballero C, Reina R. Manual dexterity and intralimb coordination assessment to distinguish different levels of impairment in boccia players with cerebral palsy. Front Neurol 2017; 8. <https://doi.org/10.3389/fneur.2017.00582>
- [16] Rico-González M, Los Arcos A, Clemente FM, Rojas-Valverde D, Pino-Ortega J. Accuracy and reliability of local positioning systems for measuring sport movement patterns in stadium-scale: A systematic review. Appl Sci 2020; 10(17): 1-17. <https://doi.org/10.3390/app10175994>
- [17] Huang PC, Pan PJ, Ou YC, Yu YC, Tsai YS. Motion analysis of throwing Boccia balls in children with cerebral palsy. Res Develop Disabil 2014; 35(2): 393-399. <https://doi.org/10.1016/j.ridd.2013.11.017>

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