

Nofriyandi Nofriyandi

2 ES April 2026 OKE Arif Rohman Hakim 16_29

 Artikel Rugaiyah

Document Details

Submission ID

trn:oid::3618:136833734

Submission Date

Apr 28, 2026, 7:59 AM GMT+7

Download Date

Apr 28, 2026, 8:06 AM GMT+7

File Name

2 ES April 2026 OKE Arif Rohman Hakim 16_29.pdf

File Size

1.3 MB

14 Pages

6,229 Words

39,091 Characters

20% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.





Filtered from the Report

- ▶ Bibliography




Exclusions

- ▶ 10 Excluded Sources

Match Groups

-  **55 Not Cited or Quoted** 19%
Matches with neither in-text citation nor quotation marks
-  **4 Missing Quotations** 1%
Matches that are still very similar to source material
-  **0 Missing Citation** 0%
Matches that have quotation marks, but no in-text citation
-  **0 Cited and Quoted** 0%
Matches with in-text citation present, but no quotation marks

Top Sources

- 17%  Internet sources
- 11%  Publications
- 14%  Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Match Groups

- **55 Not Cited or Quoted** 19%
Matches with neither in-text citation nor quotation marks
- **4 Missing Quotations** 1%
Matches that are still very similar to source material
- **0 Missing Citation** 0%
Matches that have quotation marks, but no in-text citation
- **0 Cited and Quoted** 0%
Matches with in-text citation present, but no quotation marks

Top Sources

- 17% Internet sources
- 11% Publications
- 14% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

| | | | |
|----|----------------|---|-----|
| 1 | Student papers | Munster Technological University (MTU) on 2025-12-01 | 1% |
| 2 | Internet | www.frontiersin.org | 1% |
| 3 | Internet | www.researchsquare.com | 1% |
| 4 | Internet | cahaya-ic.com | <1% |
| 5 | Internet | journal.igiinsight.com | <1% |
| 6 | Internet | siducat.org | <1% |
| 7 | Internet | spj.science.org | <1% |
| 8 | Internet | journal.uir.ac.id | <1% |
| 9 | Internet | repository.uir.ac.id | <1% |
| 10 | Internet | competitor.idjournal.eu | <1% |

| | | | |
|----|----------------|--|-----|
| 11 | Internet | brieflands.com | <1% |
| 12 | Internet | ejournal.uinsalatiga.ac.id | <1% |
| 13 | Internet | pjms.org.pk | <1% |
| 14 | Internet | doaj.org | <1% |
| 15 | Internet | jech.umsha.ac.ir | <1% |
| 16 | Internet | pure.rug.nl | <1% |
| 17 | Internet | www.researchgate.net | <1% |
| 18 | Internet | ijvlms.sums.ac.ir | <1% |
| 19 | Internet | www.tandfonline.com | <1% |
| 20 | Student papers | Graduate Studies on 2026-03-10 | <1% |
| 21 | Student papers | Universitas Muhammadiyah Surakarta on 2025-10-14 | <1% |
| 22 | Internet | link.springer.com | <1% |
| 23 | Internet | shsu-ir.tdl.org | <1% |
| 24 | Internet | public-pages-files-2025.frontiersin.org | <1% |


| | | | |
|----|----------------|---|-----|
| 25 | Internet | www.alice.cnptia.embrapa.br | <1% |
| 26 | Internet | journal.univetbantara.ac.id | <1% |
| 27 | Publication | Hanoi National University of Education | <1% |
| 28 | Student papers | Higher Education Commission Pakistan on 2024-01-26 | <1% |
| 29 | Student papers | Universitas Negeri Jakarta on 2025-03-05 | <1% |
| 30 | Internet | docplayer.info | <1% |
| 31 | Internet | repositorio.pucrs.br | <1% |
| 32 | Internet | revista-apunts.com | <1% |
| 33 | Publication | Markel Rico-González. "Physical Education in Early Childhood - Movement and De..." | <1% |
| 34 | Student papers | Charles University in Prague on 2026-04-27 | <1% |
| 35 | Publication | Omer Ali Hassan. "Construction of a Social Avoidance Scale for Football Players", ... | <1% |
| 36 | Student papers | The Hong Kong Polytechnic University on 2021-12-03 | <1% |
| 37 | Student papers | University of Hull on 2024-08-31 | <1% |
| 38 | Internet | aassjournal.com | <1% |


| | | | |
|----|----------------|---|-----|
| 39 | Internet | athenaeumpub.com | <1% |
| 40 | Internet | www.omicsdi.org | <1% |
| 41 | Publication | "Handbook of Intellectual Disabilities", Springer Science and Business Media LLC, ... | <1% |
| 42 | Student papers | Coventry University on 2021-04-28 | <1% |
| 43 | Student papers | Edge Hill University on 2022-04-04 | <1% |
| 44 | Student papers | Higher Education Commission Pakistan on 2025-01-27 | <1% |
| 45 | Publication | Teddy Giolanda Pratama, Subagyo Subagyo, Ngatman Ngatman, Muhamad Ichsa... | <1% |
| 46 | Student papers | University of Western Sydney on 2022-06-19 | <1% |
| 47 | Publication | Youngdeok Kim, Ilhyeok Park, Minsoo Kang. "Examining Rater Effects of the TGM..." | <1% |



A boccia-based adaptive physical education model for supporting gross motor skill development in students with quadriplegia

^{1abc}Arif Rohman Hakim* , ^{1abc}Agustanico Dwi Muryadi , ^{1cd}Slamet Santoso, ^{1ab}Karlina Dwijayanti, & ^{2cd}Sigit Fredi Hartanto

 Department of Physical Education, Faculty of Teacher Training and Education, Universitas Tunas Pembangunan (UTP) Surakarta, Surakarta, Indonesia¹

 Sekolah Luar Biasa (SLB) D, Yayasan Pembinaan Anak Cacat (YPAC), Surakarta, Indonesia²

Received 10 July 2025; Accepted 16 April 2026; Published 28 April 2026

OPEN ACCESS

ABSTRACT

Background: Students with quadriplegia often encounter significant barriers to participation in physical education due to limited mobility and the lack of structured adaptive learning models. Despite the potential of boccia as an inclusive sport, its use as a pedagogical tool in school-based physical education remains underexplored. **Objectives:** This study aimed to develop and evaluate a modified boccia-based learning model to support gross motor skill development among students with quadriplegia in special education settings. **Methods:** A research and development (R&D) approach based on the Borg and Gall model was implemented in six stages. Participants were recruited from a special education school in Surakarta, Indonesia, involving five students in the small-group trial and 20 students in the field trial. The intervention was conducted over eight sessions. Data were collected using expert validation sheets and a modified version of the Test of Gross Motor Development–Second Edition (TGMD-2). Pre–post differences were analysed using paired-samples t-tests, and effect size was calculated using Cohen’s d. **Results:** The developed model demonstrated acceptable content validity (CVR = 0.50-1.00; mean = 0.60) and satisfactory reliability ($r > 0.50$; $p < 0.05$). Gross motor skill scores increased from 48.78 (pretest) to 85.78 (posttest), with a statistically significant difference ($p < 0.001$) and a very large effect size ($d = 3.70$). However, these findings should be interpreted cautiously due to the absence of a control group and the small sample size. **Conclusion:** The modified boccia-based learning model shows potential as a feasible and practical approach for supporting motor skill development in students with quadriplegia. Further research using controlled experimental designs is required to confirm its effectiveness.

Keywords: Boccia; adaptive physical education; gross motor skills; quadriplegia; learning model

*Corresponding Author

 arif.hakim@lecture.utp.ac.id

 [10.25299/es:ijope.2026.vol7\(1\).23869](https://doi.org/10.25299/es:ijope.2026.vol7(1).23869)

Copyright © 2026 Arif Rohman Hakim, Agustanico Dwi Muryadi, Slamet Santoso, Karlina Dwijayanti, Sigit Fredi Hartanto

How to Cite: Hakim, A. R., Muryadi, A. D., Santoso, S., Dwijayanti, K., & Hartanto, S. F. (2026). A boccia-based adaptive physical education model for supporting gross motor skill development in students with quadriplegia. *Edu Sportivo: Indonesian Journal of Physical Education*, 7(1), 16-29. [https://doi.org/10.25299/es:ijope.2026.vol7\(1\).23869](https://doi.org/10.25299/es:ijope.2026.vol7(1).23869)

Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection



INTRODUCTION

Adaptive physical education (APE) plays a crucial role in ensuring meaningful participation for students with physical disabilities, supporting the development of

motor, cognitive, and social competencies (An et al., 2024; Jariono et al., 2025). For students with quadriplegia, structured PE activities stimulate essential motor domains such as object control, eye-hand coordination, and postural stability (Cornejo et al., 2023). However, research shows that PE programmes in many schools still rely heavily on passive, individualised exercises with minimal opportunities for game-based engagement (Azlan et al., 2021; Ferraz et al., 2024). This creates a need for adaptive PE models that are active, participatory, and developmentally appropriate.

Boccia, an official Paralympic precision sport, is widely recognised for its suitability for individuals with severe motor impairments, particularly those with cerebral palsy and quadriplegia (Koper et al., 2020; Suárez-Iglesias et al., 2020). Studies indicate that boccia supports fine-motor control, tactical decision-making, and functional movement patterns relevant to educational settings (Roldan et al., 2017; Shieh et al., 2025). Although primarily used in rehabilitation and elite sports, its task characteristics—grasping, reaching, aiming, and releasing—align directly with curricular motor-skill outcomes, making it highly adaptable as a school-based learning medium (Huang et al., 2014; Sufitriyono et al., 2025).

Despite its potential, most global research focuses on boccia from competitive or therapeutic perspectives. Previous studies have examined athlete classification, biomechanical performance, and intervention-rehabilitation outcomes (Ferreira et al., 2025; Shieh et al., 2025). However, very few studies have explored boccia as a structured pedagogical tool within school-based PE, especially for students with severe impairments (Fazari et al., 2023). In addition, existing educational models emphasise general motor play rather than game-specific, goal-directed models such as boccia (Barus et al., 2025). This highlights a major research gap in the development of boccia-based instructional frameworks for improving basic motor skills among quadriplegic students.

This gap becomes more critical in the Indonesian context. According to the Ministry of Education, Culture, Research, and Technology (Habibah, 2024), more than 330,000 students are identified as having special educational needs, with 12-15% experiencing physical impairments requiring adaptive PE. Studies show that PE in Indonesian special schools remains dominated by static drills, limited motor tasks, and teacher-centred instruction (Mahendra et al., 2020; Nugrohowati & Raharjo, 2023). Meanwhile, research indicates that boccia can enhance coordination, ball-handling accuracy, and social interaction in children with severe motor limitations (Andamarisa et al., 2025; Sufitriyono et al., 2025). Although boccia has been explored in rehabilitation and sport performance contexts, evidence concerning structured pedagogical models for its integration into school-based physical education, particularly within Indonesian special education settings, remains limited.

To address these gaps, this study develops and evaluates a modified Boccia learning model tailored to the needs of quadriplegic students in special education settings. The model follows structured instructional stages and uses simplified rules and adaptive equipment to ensure accessibility and skill progression. Its effectiveness is measured with the Test of Gross Motor Development-2 (TGMD-2), widely validated for children with disabilities (Capio et al., 2016; Houwen et al., 2010). This study is among the first to systematically develop and empirically evaluate a boccia-based instructional model within school-based adaptive physical education settings for students with quadriplegia.

This study offers both theoretical and practical contributions. Theoretically, it expands the adaptive PE framework by integrating game-based learning with inclusive sports adaptation. Practically, it produces an evidence-based model that is easy for teachers to apply, enhances participation, and supports measurable improvements in motor

development. Therefore, the aim of this research is to develop and test a modified boccia game model to improve basic motor skills among quadriplegic students in special schools.

METHOD

Research Design

This study employed a research and development (R&D) design adapted from Borg and Gall's educational product development framework (Gall, 2007), streamlined into six major stages: (i) needs analysis, (ii) initial product development, (iii) expert validation, (iv) revision, (v) small-group try-out, and (vi) field trial. This simplified model was adopted to ensure practical implementation within a school-based adaptive physical education setting while maintaining the essential components of systematic product development and evaluation.

The first stage (needs analysis) involved observations and informal interviews with teachers and students to identify existing limitations in adaptive physical education practices. The second stage focused on designing the initial prototype of the boccia-based learning model based on literature review and contextual needs. The third stage involved expert validation to assess content relevance and feasibility. Based on expert feedback, revisions were made in the fourth stage. The fifth stage consisted of a small-group trial to evaluate feasibility, safety, and practicality, while the final stage (field trial) aimed to examine the preliminary effectiveness of the developed model in improving students' gross motor skills.

Participants

Participants were recruited from a special education school for students with physical disabilities (SLB D YPAC Surakarta), Indonesia. The study involved two groups reflecting early-phase R&D procedures in adaptive physical education. A small-group trial included five students, followed by a field trial involving 20 students aged 8-12 years. All participants were diagnosed with quadriplegia and were enrolled in the school's adaptive physical education programme. Purposive sampling was applied using the following inclusion criteria: (i) ability to participate in modified boccia activities with minimal assistance; (ii) regular attendance in physical education sessions; and (iii) confirmation of medical readiness from the school. Students with progressive neurological disorders, recent musculoskeletal injuries, or limited ability to follow instructions were excluded. The sample size reflects the limited and specialised nature of the target population in adaptive physical education research. Descriptive characteristics of participants are presented in Table 1.

Table 1. Participant Characteristics in the Small-Group and Field Trials

| Characteristic | Small-Group Trial (n = 5) | Field Trial (n = 20) | Total (N = 25) |
|------------------------|------------------------------|-------------------------|-------------------|
| Age (years), Mean ± SD | 10.2 ± 1.1 | 10.4 ± 1.3 | 10.3 ± 1.2 |
| Gender (Male/Female) | 3/2 | 12/8 | 15/10 |
| Grade Level | 3-5 | 3-6 | 3-6 |
| Type of Disability | Quadriplegia | Quadriplegia | Quadriplegia |

Instrument

Data were collected using three instruments: (i) expert validation sheets, (ii) observation checklists, and (iii) a modified version of the Test of Gross Motor Development–Second Edition (TGMD-2). The TGMD-2 was selected due to its widespread use in assessing gross motor skills and its strong psychometric properties across diverse child populations (Ulrich, 2000; Aliriad et al., 2024; Tun et al., 2023).

Considering the limited locomotor abilities of students with quadriplegia, the original TGMD-2 tasks were adapted to ensure feasibility and measurement fairness. The adaptation followed a simplified framework consisting of domain review, task modification, expert consultation, and pilot feasibility testing. Locomotor tasks that required independent lower-limb movement (e.g., running, hopping, and galloping) were removed or replaced with seated balance and upper-body coordination activities. Object-control tasks were retained but modified using assistive devices such as boccia ramps and lightweight balls.

The preliminary instrument was reviewed by four experts in adaptive physical education, physiotherapy, child motor development, and special education. Content validity was assessed using the Content Validity Ratio (CVR) and Content Validity Index (CVI). A pilot test involving five students was conducted to examine task feasibility and scoring clarity. Items that were considered impractical for students with quadriplegia were excluded, while the remaining indicators were mapped conceptually to the original TGMD-2 domains. Consequently, the adapted instrument was treated as a modified TGMD-2 framework rather than a direct replication of the original scale. Inter-rater reliability was evaluated during the small-group trial and showed high agreement (ICC = 0.87). A summary of the modified TGMD-2 indicators is presented in Table 2.

The adapted instrument underwent expert review by four specialists (adaptive physical education, physiotherapy, child motor development, and PE teachers). Content validity was assessed using the Content Validity Index (CVI) and Content Validity Ratio (CVR), with all items meeting acceptable thresholds (CVI ≥ 0.80; CVR ≥ 0.75). Item validity was further examined using item-total correlation analysis (Pearson correlation), comparing each item score with the overall scale score based on expert ratings. Items with correlation coefficients above 0.30 were considered acceptable indicators of construct validity. Inter-rater reliability was tested during the small-group trial and yielded high agreement (ICC = 0.87), indicating that the scoring rubric was consistent and dependable for use in special school settings. A summary of the adapted TGMD-2 indicators used in this study is presented in Table 2.

Table 2. Modified TGMD-2 Indicators for Students with Quadriplegia

| No | Domain | Skill Indicator | Performance Description | Score Range |
|----|----------------------------|-----------------------------|---|-------------|
| 1 | Balance / Postural Control | Seated or supported balance | Maintains a stable position during play | 0-2 |
| 2 | Body Adjustment | Positional shifting | Adjusts body or chair orientation to prepare for throwing | 0-2 |
| 3 | Non-locomotor | Trunk rotation | Rotates trunk or adjusts direction in a controlled manner | 0-2 |
| 4 | Manipulative | Ball release toward target | Initiates throw manually or using assistive ramp | 0-2 |
| 5 | Manipulative | Force control | Adjusts throwing force to prevent over/under shooting | 0-2 |
| 6 | Assistive tool use | Ramp manipulation | Uses ramp independently or with minimal assistance | 0-2 |
| 7 | Affective (Adaptation) | Engagement | Shows interest and participation during the game | 0-2 |
| 8 | Social (Adaptation) | Cooperative interaction | Communicates or collaborates with peers during activity | 0-2 |

Notes: Each item was scored on a 3-point scale (0 = not performed, 1 = partially performed, 2 = performed correctly).

Procedures

6 This study followed six stages of the research and development (R&D) process adapted from the Borg and Gall model (Gall et al., 2007). The stages included: (i) needs analysis conducted through observations and interviews with teachers and students at a special education school for students with physical disabilities (SLB D YPAC Surakarta), Indonesia; (ii) literature review and initial product development, resulting in the first prototype of the modified boccia learning model; (iii) expert validation involving four specialists in adaptive physical education, physiotherapy, motor development, and special education teaching; (iv) product revision based on expert feedback; (v) a small-group trial with five students to evaluate feasibility, safety, and instructional practicality; and (vi) a field trial with 20 students to examine intervention effectiveness.

33 The intervention during the field trial lasted eight weeks and was integrated into the school's physical education schedule. Students participated in two sessions per week, each lasting 30-40 minutes. Each session consisted of: (i) a 5-minute warm-up adapted for seated or assisted participation; (ii) a 20-25-minute modified boccia activity incorporating adapted equipment, adjustable throwing distances, and optional assistive ramps; and (iii) a 5-10-minute cool-down focusing on breathing and relaxation.

All sessions were supervised by a physical education teacher and supported by the researcher to ensure fidelity of implementation and participant safety. Motor skill assessments were conducted before and after the intervention using the modified TGMD-2 instrument. Two trained observers independently scored performance, and inter-rater discrepancies were resolved through consensus discussion to maintain scoring consistency. While the small-group trial primarily focused on feasibility and safety evaluation, the field trial followed identical instructional procedures to assess intervention effectiveness.

Data Analysis

25 Quantitative pretest and posttest data were analysed using parametric procedures. Normality of difference scores was assessed with the Shapiro-Wilk test ($p > 0.05$), indicating that assumptions for paired-samples analysis were met. Differences in motor skill scores were examined using paired-samples t-tests, with statistical significance set at $p < 0.05$. Effect size was calculated using Cohen's d to estimate the magnitude of change. Content validity of the instrument was evaluated using the Content Validity Index (CVI) and Content Validity Ratio (CVR) based on expert judgements ($CVI \geq 0.80$, $CVR \geq 0.75$). Item validity was assessed using item-total correlation ($r > 0.30$), and inter-rater reliability showed high agreement ($ICC = 0.87$). All analyses were conducted using SPSS version 26.

Ethical Considerations

4
5 Ethical approval was obtained from the relevant institutional review body. Written informed consent was secured from parents/guardians, and assent was obtained from participating students. All procedures complied with ethical standards for research involving vulnerable populations.

RESULTS AND DISCUSSION

Results

Content Validity of the Boccia-Based Learning Model

3 Content validity was assessed using the Content Validity Ratio (CVR) based on expert judgement from four specialists in adaptive physical education. According to Lawshe's criteria, items with CVR values below the minimum threshold (0.75 for $N = 4$) were considered for revision.

Table 3. Content Validity Ratio (CVR) Results

| Item | CVR | Decision |
|----------|------|----------------|
| 1 | 1.00 | Valid |
| 2 | 0.50 | Needs revision |
| 3 | 0.50 | Needs revision |
| 4 | 0.50 | Needs revision |
| 5 | 0.50 | Needs revision |
| 6 | 1.00 | Valid |
| 7 | 1.00 | Valid |
| 8 | 1.00 | Valid |
| 9 | 0.50 | Needs revision |
| 10 | 0.50 | Needs revision |
| Mean CVR | 0.60 | Acceptable |

As shown in **Table 3**, four items achieved full expert agreement (CVR = 1.00), indicating strong relevance. However, six items fell below the minimum threshold (CVR = 0.50), suggesting the need for refinement. The overall mean CVR of 0.60 indicates moderate content validity, meaning that while the model is generally acceptable, several components required revision before implementation.

Instrument Validity

The validity of the evaluation instrument was examined using item-total correlation analysis with Pearson's correlation coefficient. All retained items demonstrated statistically significant correlations ($p < 0.05$) and exceeded the acceptable threshold ($r > 0.50$).

Table 4. Summary of Instrument Validity

| Aspect | Range of r | Interpretation |
|-----------------------|---------------|----------------|
| Content validity | 0.602 - 0.803 | Acceptable |
| Design feasibility | 0.563 - 0.790 | Acceptable |
| Practicality | 0.685 - 0.718 | Acceptable |
| Effectiveness | 0.678 - 0.801 | Acceptable |
| Innovation & novelty | 0.579 - 0.832 | Acceptable |
| Evaluation & feedback | 0.567 - 0.754 | Acceptable |

As shown in **Table 4**, all instrument components demonstrated acceptable validity across all aspects. The highest correlation values were observed in content validity and innovation, indicating strong alignment between the instrument and the conceptual framework of the model.

Expert Feedback and Model Refinement

Qualitative feedback from experts led to several refinements to improve the feasibility, accessibility, and safety of the learning model.

Table 5. Summary of Expert Feedback and Revisions

| Aspect | Key Revision |
|-------------------|--|
| Field | Visual markers added for orientation |
| Ball | Lightweight balls with size variations |
| Assistive tools | Non-slip ramp and stable device |
| Playing position | Optional safety support |
| Target | Use of varied and engaging targets |
| Throwing distance | Gradual progression (1-3 m) |
| Game structure | Balanced rotation system |
| Scoring | Visual and simplified system |

| Aspect | Key Revision |
|----------|--------------------------|
| Duration | 10–15 min with time cues |

As summarised in **Table 5**, expert feedback led to key revisions aimed at improving the usability and accessibility of the learning model. These refinements primarily focused on safety, adaptive equipment, and structured gameplay, ensuring alignment with the functional needs of students with quadriplegia.

Changes in Gross Motor Skills (TGMD-2)

To evaluate changes in gross motor performance following the implementation of the boccia-based learning model, descriptive statistics were calculated for TGMD-2 scores at both pretest and posttest stages. This analysis provides an initial overview of score distribution, central tendency, and variability prior to inferential testing. Descriptive statistics of TGMD-2 scores are presented in **Table 6**.

Table 6. Descriptive Statistics of TGMD-2 Scores

| Variable | N | Mean | SD | Min | Max |
|----------|----|-------|------|------|------|
| Pretest | 20 | 48.78 | 2.58 | 43.0 | 55.0 |
| Posttest | 20 | 85.78 | 2.98 | 79.5 | 90.5 |

As shown in **Table 6**, the mean TGMD-2 score increased substantially from pretest (48.78) to posttest (85.78), indicating improved performance following the intervention. Additionally, Table 6 shows a slight increase in standard deviation (from 2.58 to 2.98), suggesting greater variability in posttest scores and indicating that participants responded differently to the intervention.

Inferential Analysis (Paired Sample t-test)

To further examine whether the observed changes in gross motor skills were statistically significant, a paired-samples t-test was conducted to compare pretest and posttest TGMD-2 scores.

Table 7. Paired Sample t-test Results

| Variable | Mean (Pre) | Mean (Post) | Mean Difference | t | df | p | Cohen's d |
|----------|------------|-------------|-----------------|-------|----|---------|-----------|
| TGMD-2 | 48.78 | 85.78 | 37.00 | 16.55 | 19 | < 0.001 | 3.70 |

As shown in **Table 7**, there was a statistically significant increase in TGMD-2 scores, $t(19) = 16.55$, $p < 0.001$, with a mean difference of 37.00. The effect size ($d = 3.70$) indicates a very large practical impact. However, these findings should be interpreted cautiously due to the absence of a control group.

Discussion

The findings of this study indicate that the modified boccia-based learning model was associated with improvements in gross motor performance among students with quadriplegia. These results suggest that structured game-based activities can provide meaningful motor stimulation within adaptive physical education settings, consistent with prior evidence highlighting the benefits of adaptive sport modifications for motor development in students with disabilities (Rifki & Susanto, 2022; Astuti et al., 2023).

However, several methodological considerations warrant careful attention when interpreting the quantitative results. The effect size obtained in this study (Cohen's $d = 3.70$) was substantially larger than those typically reported in comparable motor intervention research ($d = 0.2-1.5$), which may reflect the relatively small sample size (n

36 = 20), the narrow score distribution (SD = 2.58-2.98), and the absence of a control group rather than an unusually strong intervention effect. These statistical characteristics should be interpreted with caution, as they may overestimate the true magnitude of change. Furthermore, the adapted TGMD-2 instrument, while reviewed by four experts and demonstrating adequate content validity (CVR = 0.50-1.00; mean = 0.60) and inter-rater reliability (ICC = 0.87), relied on simplified expert-rating procedures rather than full psychometric standardisation. The CVR values for several items fell below the conventional threshold of 0.75, indicating that those components required revision before final use. These limitations underscore the importance of replicating this study with larger samples, a control group, and more robust psychometric procedures to confirm the reliability and validity of findings.

37 From a motor learning perspective, the observed improvement may be explained through task-specific practice and adaptive task design. The modified boccia activities incorporated graded difficulty, assistive equipment, and individualised movement demands, aligning with motor control principles emphasising variability, repetition, and goal-directed movement (Yudaparmita, 2022). Such adaptations likely facilitated motor planning, coordination, and trunk stability, which are essential for functional motor development in students with severe physical impairments (Pitchford et al., 2021).

46
32 The integration of game-based learning also provides motivational and engagement benefits that may indirectly enhance motor outcomes. Interactive play contexts promote sustained attention, self-regulation, and exploratory movement behaviour, thereby supporting sensorimotor learning processes (Burhaein, 2017; Maryanti et al., 2021). This interpretation is consistent with studies demonstrating that adaptive play environments can improve participation and motor competence among children with disabilities (Férriz-Valero et al., 2020; Astuti et al., 2023).

The findings further support the conceptual framework of adaptive physical education, which emphasises environmental modification and individualised instructional strategies to optimise participation and skill acquisition (Obrusnikova & Block, 2020). The boccia modifications implemented in this study—such as adjustable throwing distances, assistive ramps, and simplified rules—can be viewed as task constraints enabling successful performance while progressively challenging motor abilities. Task constraint manipulation has been recognised as an effective approach for promoting motor adaptation and skill transfer in adaptive physical activity settings (Ospankulov et al., 2023; Sukriadi & Arif, 2020).

In addition to motor improvements, structured boccia activities may contribute to broader developmental outcomes, including social interaction, motivation, and emotional engagement. Adaptive play environments have been shown to foster cooperative behaviour and participation, which are central to inclusive physical education practices (Endrawan et al., 2023; Lang, 2023).

24
5 Despite these promising findings, several limitations should be considered. The absence of a control group limits causal inference regarding intervention effectiveness. Furthermore, the small sample size and single-school setting restrict generalisability. The relatively short intervention duration also prevents evaluation of long-term motor learning effects. Future research should employ controlled experimental designs, include larger and more diverse samples, and examine longitudinal outcomes to strengthen evidence for boccia-based adaptive learning models.

CONCLUSION

This study indicates that the modified boccia-based learning model shows potential to support gross motor skill development among students with physical disabilities; however, causal conclusions cannot be established. The model provides structured and adaptable learning activities that may assist teachers in delivering inclusive physical education tailored to students' functional abilities. However, the absence of a control group, small sample size, and limited duration restrict the generalisability of the findings. Future studies should employ controlled designs with larger samples to further examine its effectiveness.

ACKNOWLEDGEMENTS

We gratefully thank all respondents.

CONFLICT OF INTEREST

The authors declare that they have no competition.

REFERENCES

- Aliriad, H., Adi S, Manullang, J. G., Endrawan, I. B., & Satria, M. H. (2024). Improvement of Motor Skills and Motivation to Learn Physical Education Through the Use of Traditional Games. *Physical Education Theory and Methodology*, 24(1), 32–40. <https://doi.org/10.17309/tmfv.2024.1.04>
- An, M., Tanaka, R., Hirota, N., Sasai, T., Takahashi, H., Ogawa, Y., Horai, S., Inoue, M., Rakwal, R., & Kato, T. (2024). A Scoping Review of Adapted Physical Activity Interventions for Children and Youth with Disabilities using International Classification of Functioning, Disability and Health: Children and Youth Version as a Reference. *International Journal of Developmental Disabilities*, 70(7), 1127–1152. <https://doi.org/10.1080/20473869.2022.2161987>
- Andamarisa, S. S., Iyakrus, Ramadhan, A., Bayu, W. I., Usra, M., Yusfi, H., & Solahuddin, S. (2025). Development of Boccia Ball for Children with Disabilities. *Jurnal Sains Sukan & Pendidikan Jasmani*, 14(1), 27–35. <https://doi.org/10.37134/jsspj.vol14.1.4.2025>
- Amorim, A., Travassos, B., Monteiro, D., Baptista, L., & Duarte-Mendes, P. (2022). Effects of an Imagery Programme on the Performance of Federated and Non-Federated Boccia Athletes. *Cuadernos De Psicologia Del Deporte*, 22(3), 68–78. <https://doi.org/10.6018/cpd.498351>
- Angel-Lopez, J., Castellanos-Ruiz, J., Rojas-Lopez, L., Restrepo, D., Alzate, A., Orozco-Ocampo, Y., Aguirre-Ospina, C., & Hoyos-Restrepo, M. (2020). Boccia Assistant Biomechanics: A Case Study. *VIII Latin American Conference on Biomedical Engineering and XLII National Conference on Biomedical Engineering. CLAIB 2019 Ifmbe Proceedings*, 75, 884–893). https://doi.org/10.1007/978-3-030-30648-9_115
- Arruda, S. F. d., Oliveira, J. I. V. d., Dantas, M. J. B., Costa, M. d. C., Oliveira, L. I. G. L. d., & Oliveira, S. F. M. d. (2022). Mood States and Quality of Life in Paralympic Boccia Athletes in the Covid-19 Pandemic. *Revista Brasileira De Medicina Do Esporte*, 28(4), 300–305. https://doi.org/10.1590/1517-8692202228042020_0131

- Arruda, S. F., Vasconcelos de Oliveira, J. I., Winckler, C., Costa, A. S., Paes Neto, P. P., Moura Simim, M. A., & Melo Oliveira, S. F. (2023). ¿Puede El Entrenamiento Domiciliario Influir En El Estado De Ánimo Y La Calidad De Vida De Los Deportistas Paralímpicos De Bocha? (Can Home-Based Training Influence Mood States and Quality of Life in Paralympic Boccia Athletes?). *Retos*, 50, 943-949. <https://doi.org/10.47197/retos.v50.99779>
- Astuti, Y., Erianti, E., Amsari, D., & Novita Sari, D. (2024). El Efecto De Las Modificaciones Deportivas Y Los Minijuegos Para Mejorar La Condición Física De Los Estudiantes Del Curso De Educación Física Adaptativa (The Effect of Sports Modifications and Mini Games to Improve Students' Physical Fitness in the Adaptive Physical Education Course). *Retos*, 51, 519-525. <https://doi.org/10.47197/retos.v51.99975>
- Auriemma, M., & Luigi, A. J. De. (2023). *Adaptive Throwing Sports: Discus, Javelin, Shot Put, and Boccia*. Adaptive Sports Medicine, Springer, Cham. 347–359. https://doi.org/10.1007/978-3-319-56568-2_24
- Azlan, A., Ismail, N., Fauzi, N. F. M., & Talib, R. A. (2021). Playing Traditional Games vs. Free-Play during Physical Education Lesson to Improve Physical Activity: a Comparison Study. *Pedagogy of Physical Culture and Sports*, 25(3), 178–187. <https://doi.org/10.15561/26649837.2021.0306>
- Barus, O. P., Hidayanto, A. N., Handri, E. Y., Sensuse, D. I., Yaiprasert, C. (2025). Shaping Generative AI Governance in Higher Education: Insights from Student Perception, *International Journal of Educational Research Open*, 8, 100452, <https://doi.org/10.1016/j.ijedro.2025.100452>
- Burhaein, E. (2017). Aktivitas Permainan Tradisional Berbasis Neurosainslearning Sebagai Pendidikan Karakter bagi Anak Tunalaras. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 3(1), 55-68. https://doi.org/10.29407/js_unpgri.v3i1.580
- Capio, C. M., Eguia, K. F., & Simons, J. (2016). Test of Gross Motor Development-2 for Filipino Children with Intellectual Disability: Validity and Reliability. *Journal of Sports Sciences*, 34(1), 10–17. <https://doi.org/10.1080/02640414.2015.1033643>
- Carballo-Fazanes, A., Rey, E., Valentini, N. C., Rodríguez-Fernández, J. E., Varela-Casal, C., Rico, J., Barcala-Furelos, R., & Abelairas-Gómez, C. (2021). Intra-Rater (Live vs. Video Assessment) and Inter-Rater (Expert vs. Novice) Reliability of the Test of Gross Motor Development—Third Edition. *International Journal of Environmental Research and Public Health*, 18(4), 1652. <https://doi.org/10.3390/ijerph18041652>
- Clarsen, B., Bahr, R., Myklebust, G., Andersson, S. H., Docking, S. I., Drew, M., Finch, C. F., Fortington, L. V., Harøy, J., Khan, K. M., Moreau, B., Moore, I. S., Møller, M., & Nabhan, D. (2020). *Improved reporting of overuse injuries and health problems in sport: an update of the Oslo Sport Trauma Research Center questionnaires*. 390–396. <https://doi.org/10.1136/bjsports-2019-101337>
- Cornejo, M. I., Roldan, A., & Reina, R. (2023). What Is the Relationship between Trunk Control Function and Arm Coordination in Adults with Severe-to-Moderate Quadriplegic Cerebral Palsy? *International Journal of Environmental Research and Public Health*, 20(1), 141. <https://doi.org/10.3390/ijerph20010141>

- Endrawan, I. B., Aliriad, H., Apriyamto, R., Da'I, M., Adi, S., Cahyani, O. D., Santoso, S., Muryadi, A. D. (2023). The Relationship Between Sports and Mental Health: Literature Analysis and Empirical Study. *Health Education and Health Promotion, 11*(2), 215-222. <https://doi.org/10.58209/hehp.11.2.215>
- Fazari, B. S., Komariyah, L., Rahmat, A., & Carsiwan, C. (2023). Efektivitas Penggunaan Permainan Olahraga Bocce dalam Pembelajaran Penjas pada Siswa Tunagrahita: Systematic Literature Review. *Gelombang Olahraga: Jurnal Pendidikan Jasmani Dan Olahraga (JPJO), 7*(1), 135-144. <https://doi.org/10.31539/jpjo.v7i1.8085>
- Ferraz, R., Ribeiro, D., Alves, A. R., Teixeira, J. E., Forte, P., & Branquinho, L. (2024). Using Gamification in Teaching Physical Education: a Survey Review. *Montenegrin Journal of Sports Science and Medicine, 13*(1), 31-44. <https://doi.org/10.26773/mjssm.240304>
- Ferreira, C., Gamonales, J. M., Aleluia, M., Oliveira, A., Pardana, F., Santos, F., Espada, M., Muñoz-Jiménez, J. M. (2022). Boccia in Paralympic Games: the Evolution from 1984 to 2016 and Future Perspectives. *Cuadernos De Psicologia Del Deporte, 22*(1), 205-214. <https://doi.org/10.6018/CPD.492031>
- Ferreira, C., Gamonales, J., da Cunha Espada, M. A., & Muñoz-Jiménez, J. (2023). Estado Actual Del Rendimiento Deportivo En Boccia: Revisión Sistemática De La Literatura (Current Status of Sport Performance in Boccia: Systematic Review of the Literature). *Retos, 48*, 1070-1077. <https://doi.org/10.47197/retos.v48.95110>
- Ferreira, C. C., Hernández-Beltrán, V., Gamonales, J. M., Espada, M. C., & Muñoz-Jiménez, J. (2025). Evolution of Documents Related to Performance in Boccia: a Paralympic Sport Bibliometric Analysis. *Frontiers in Sports and Active Living, 7*. <https://doi.org/10.3389/fspor.2025.1560803>
- Férriz-Valero, A., Østerlie, O., Martínez, S. G., & García-Jaén, M. (2020). Gamification in Physical Education: Evaluation of Impact on Motivation and Academic Performance Within Higher Education. *International Journal of Environmental Research and Public Health, 17*(12), 4465. <https://doi.org/10.3390/ijerph17124465>
- Gall, M., Gall, J., & Borg, R. (2007). *Educational Research: An Introduction (8th ed.)*. New York, NY: Pearson Education.
- Gontara, S. Y., & Doewes, R. (2023). Sebelasmaret Boccia Throw Test (SBTT) Instrument Development. *International Journal of Disabilities Sports and Health Sciences, 6*(2), 261-267. <https://doi.org/10.33438/ijdsbs.1286793>
- Habibah, A. S. (2024). *Kemendikbudristek: 40.164 Sekolah Miliki Siswa Berkebutuhan Khusus*. Antara. <https://www.antaranews.com/berita/4038030/kemendikbudristek-40164-sekolah-miliki-siswa-berkebutuhan-khusus>
- Hendarto, S. (2023). Gender Differences in Boccia Underhand Throw Biomechanics. *Revista Iberoamericana De Psicologia Del Ejercicio Y El Deporte, 18*(2), 228-234.
- Holland, K., & Haegele, J. A. (2021). Perspectives of Students with Disabilities Toward Physical Education: A Review Update 2014-2019. *Kinesiology Review, 10*(1), 78-87. <https://doi.org/10.1123/KR.2020-0002>
- Houwen, S., Hartman, E., Jonker, L., & Visscher, C. (2010). Reliability and Validity of the TGMD-2 in Primary-School-Age Children with Visual Impairments. *Adapted Physical Activity Quarterly, 27*(2), 143-159. <https://doi.org/10.1123/apaq.27.2.143>

- Huang, P. C., Pan, P. J., Ou, Y. C., Yu, Y. C., & Tsai, Y. S. (2014). Motion Analysis of Throwing Boccia Balls in Children with Cerebral Palsy. *Research in Developmental Disabilities*, 35(2), 393–399. <https://doi.org/10.1016/j.ridd.2013.11.017>
- Ichiba, T., Okuda, K., Miyagawa, T., Kataoka, M., & Yahagi, K. (2020). Relationship between Pulmonary Function, Throw Distance, and Psychological Competitive Ability of Elite Highly Trained Japanese Boccia Players Via Correlation Analysis. *Heliyon*, 6(3), e03581. <https://doi.org/10.1016/j.heliyon.2020.e03581>
- Jariono, G., Nurhidayat, N., Sudarmanto, E., Nugoho, H., & Umar, F. (2025). The Impact of Adaptive Physical Education on the Physical and Cognitive Development of Children with Special Needs: A Literature Review. *Physical Education Theory and Methodology*, 25(3), 705–718. <https://doi.org/10.17309/tmfv.2025.3.28>
- Kesumawati, S. A. K. S. A., Hardiyono, B. H. B., Marselly, V., & Fahritsani, H. F. H. (2022). The Development of V2 Playmat Game to Increase Movement Skill Children with Intellectual Disability (ID). *Kinestetik Jurnal Ilmiah Pendidikan Jasmani*, 6(1), 190–197. <https://doi.org/10.33369/jk.v6i1.18185>
- Koper, M., Nadolska, A., Urbański, P., & Wilski, M. (2020). Relationship Between Pre-Competition Mental State and Sport Result of Disabled Boccia Athletes. *International Journal of Environmental Research and Public Health*, 17(21), 1–11. <https://doi.org/10.3390/ijerph17218232>
- Kwon, H., & Maeng, H. (2022). The Impact of a Rater Training Program on the TGMD-3 Scoring Accuracy of Pre-Service Adapted Physical Education Teachers. *Children*, 9(6), 881. <https://doi.org/10.3390/children9060881>
- Lang, C. (2023). Rehabilitation after Injuries of the Musculoskeletal System Sustained During Fitness Training TT-Rehabilitation nach Verletzungen des Bewegungssystems durch Fitnesstraining. *Physikalische Medizin, Rehabilitationsmedizin, Kurortmedizin*, 34(04), 207–213. <https://doi.org/10.1055/a-2092-8485>
- Mahendra, A., Budiman, D., Stephani, M. R., Suntoda, A., Budiana, D., Lubay, L. H., Slamet, S., Sumarno, G., Wibowo, R., Putri, W., Anira, A., & Nugroho, W. A. (2020). Adaptive Physical Education Teachers' Profile in Indonesia: The Opportunity of Improving Adaptive Physical Education Status. *TEGAR: Journal of Teaching Physical Education in Elementary School*, 4(1), 11–18. <https://doi.org/10.17509/tegar.v4i1.28971>
- Makaruk, H., Porter, J. M., Webster, E. K., Makaruk, B., Bodasińska, A., Zieliński, J., Tomaszewski, P., Nogal, M., Szyszka, P., Starzak, M., Śliwa, M., Banaś, M., Biegajło, M., Chaliburda, A., Gierczuk, D., Suchecki, B., Molik, B., & Sadowski, J. (2023). The Fus Test: a Promising Tool for Evaluating Fundamental Motor Skills in Children and Adolescents. *BMC Public Health*, 23(1), 1912. <https://doi.org/10.1186/s12889-023-16843-w>
- Martínez-Santos, R., Founaud, M. P., Aracama, A., & Oiarbide, A. (2020). Sports Teaching, Traditional Games, and Understanding in Physical Education: a Tale of Two Stories. *Frontiers in Psychology*, 11, 581721. <https://doi.org/10.3389/fpsyg.2020.581721>
- Maryanti, E., Egok, A. S., & Febriandi, R. (2021). Pengembangan Media Board Games Berbasis Permainan Tradisional Egrang Batok untuk Siswa Sekolah Dasar. *Jurnal Basicedu*, 5(5), 4212–4226. <https://doi.org/10.31004/basicedu.v5i5.1486>

- McKenney, S., & Reeves, T. C. (2025). Educational Design Research for Relevant & Robust Scholarship. *Journal of Computing in Higher Education*, 37(2), 614–638. <https://doi.org/10.1007/s12528-025-09456-2>
- Naveen, G., Ashraf, Y., & Mahesh, R. (2024). Effectiveness of Movement Control Exercise and Core Stability Exercise on Reducing Pain, Improving Range of Motion and Functional Activities in Patients with Mechanical Low Back Pain. *International Journal of Health Sciences and Research*, 14(7), 408-416. <https://doi.org/10.52403/ijhsr.20240753>
- Nugrohowati, U. D., & Raharjo, H. P. (2023). Survei Pelaksanaan Pembelajaran Pendidikan Jasmani Adaptif SMPLB di Kabupaten Semarang. *Indonesian Journal for Physical Education and Sport*, 4(1), 266–276. <https://doi.org/10.15294/inapes.v4i1.50262>
- Obrusnikova, I., & Block, M. E. (2020). *Historical Context and Definition of Inclusion* (1st Ed.). Routledge Handbook of Adapted Physical Education.
- Ospankulov, Y., Zhumabayeva, A., & Nurgaliyeva, S. (2023). The Impact of Folk Games on Primary School Students. *Journal of Education and E-Learning Research*, 10(2), 125–131. <https://doi.org/10.20448/jeelr.v10i2.4473>
- Pitchford, E. A., Leung, W., & Webster, E. K. (2021). Fundamental Motor Skill Delays in Preschool Children with Disabilities: 2012 National Youth Fitness Survey. *Frontiers in Public Health*, 9, 758321. <https://doi.org/10.3389/fpubh.2021.758321>
- Putro, B. N., Liskustyawati, H., Nugroho, D., Sabarini, S. S., Sunardi, S., & Satyawan, B. (2023). Practice-Based Learning Method to Improve Physical Education Teacher Understanding of TGMD-2 Usage. *Proceedings of the 8th ACPEs (ASEAN Council of Physical Education and Sport) International Conference*, 28-30. <http://dx.doi.org/10.4108/eai.28-10-2022.2327478>
- Rahmat, R. A., Saidi, S. B., & Nasir, N. S. M. (2024). Content Validity of Digital Knowledge using CVI Method. *Environment-Behaviour Proceedings Journal*, 9(SI20), 21–28. <https://doi.org/10.21834/e-bpj.v9iSI20.6092>
- Rifki, M. S., & Susanto, N. (2022). Pengembangan Model Pembelajaran Olahraga Adaptif Berbasis Top Play. *Jurnal Patriot*, 4(3), 225-232. <https://doi.org/10.24036/patriot.v4i3.871>
- Roldan, A., Sabido, R., Barbado, D., Caballero, C., & Reina, R. (2017). Manual Dexterity and Intralimb Coordination Assessment to Distinguish Different Levels of Impairment in Boccia Players with Cerebral Palsy. *Frontiers in Neurology*, 8, 582. <https://doi.org/10.3389/fneur.2017.00582>
- Roldan, A., Barbado, D., Vera-Garcia, F. J., Sarabia, J. M., & Reina, R. (2020). (2020). Inter-Rater Reliability, Concurrent Validity and Sensitivity of Current Methods to Assess Trunk Function in Boccia Player with Cerebral Palsy. *Brain Sciences*, 10(3), 130. <https://doi.org/10.3390/brainsci10030130>
- da Luz dos Santos, E., de Fátima Fernandes Vara, M., Ranciaro, M., Zelaga, G. T., Gomes, A. M. P., Bini, I. C., Neto, G. N. N., Krueger, E., & Nohama, P. (2020). Mechanomyography Spasticity Assessment of Flexor and Extensor Wrist Muscles for the Classification of Boccia Athletes in Para Sports: A Pilot Study. *Ifmbe Proceedings*, 75, Springer, Cham, 1184–1190. https://doi.org/10.1007/978-3-030-30648-9_154

- Satria, M. H., Aliriad, H., Kesumawati, S. A., Fahritsani, H., Endrawan, I. B., & Adi, S. (2023). Model Pengembangan Keterampilan Motorik My Home Environment terhadap Anak Disabilitas Intelektual. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7(2), 2336-2347. <https://doi.org/10.31004/obsesi.v7i2.4415>
- Shieh, W. Y., Ju, Y. Y., Yang, S. Y., Chen, I. C., & Cheng, H. Y. K. (2025). Evaluating Assistive Technology Outcomes in Boccia Athletes with Disabilities Using AI-Based Kinematic Analysis. *Bioengineering*, 12(7), 684.. <https://doi.org/10.3390/bioengineering12070684>
- Suárez-Iglesias, D., Ayán Perez, C., Mendoza-Laiz, N., & Villa-Vicente, J. G. (2020). Boccia as a Rehabilitation Intervention for Adults With Severe Mobility Limitations Due to Neuromuscular and Other Neurological Disorders: Feasibility and Effects on Upper Limb Impairments. *Frontiers in Psychology*, 11, 581. <https://doi.org/10.3389/fpsyg.2020.00581>
- Sufitriyono, Suherman, W. S., Rismayanthi, C., Irvan, Juhanis, Sudirman, Arga, Agusman, M., Gandasari, M. F., Rejeki, H. S., Zainuddin, E., & Usbah, M. (2025). Exploring the Effects of Hand-Eye Coordination Training on Boccia Throwing Accuracy in Cerebral Palsy Athletes: A Study of BC1, BC4, and BC5 Categories at the Makassar Student Boccia Club. *International Journal of Human Movement and Sports Sciences*, 13(3), 608–614. <https://doi.org/10.13189/saj.2025.130315>
- Sukriadi, S., & Arif, M. (2020). Survei Pelaksanaan Pembelajaran Pendidikan Jasmani Adaptif Di SLB C Provinsi DKI Jakarta Tahun 2019. *Jurnal Ilmiah Sport Coaching and Education*, 4(1), 1–7. <https://doi.org/10.21009/jsce.04101>
- Tun, N. N., Smithuis, F., Tun, N.L., Min, M., Hlaing, M. M. M., van Olmen, Lynen, L., & Gils, T. (2023). Correction: Near Point-of-Care HIV Viral Load Testing: Cascade after High Viral Load in Suburban Yangon. *Plos One*, 20(8), e0331295. <https://doi.org/10.1371/journal.pone.0331295>
- Ulrich, D. A. (2000). *TGMD-2 Test Of Gros Motor Development*. Pro-Ed. Texas.
- Yudaparmita, G. N. A. (2022). Keterampilan Gerak Dasar Anak Usia Dini dalam Pendidikan Jasmani Berdasarkan Sudut Pandang Merdeka Belajar. *Widya Kumara: Jurnal Pendidikan Anak Usia Dini*, 3(1), 21-30. <https://doi.org/10.55115/widyakumara.v3i1.2069>