

Optimizing gross motor skills in elementary school students through the traditional game gobak sodor

Bustanol Arifin^{1*}, Abdurrohman Muzakki², Beti Istanti Suwandayani³

^{1,2,3} Primary School Teacher Education Department, Faculty of Teacher Training and Education, University of Muhammadiyah Malang, Indonesia.

*Correspondence: barifin@ummm.ac.id

Received: 07/08/2025; Accepted: 15/11/2025; Published: 30/11/2025

Cara penulisan rujukan: Arifin, B., Muzakki, A., & Suwandayani, B. I. (2025). Optimizing gross motor skills in elementary school students through the traditional game gobak sodor. *Bima Loka: Journal of Physical Education*, 5(2), 92–102. <https://doi.org/10.26740/bimaloka.v5i2.44995>

Abstrak

Tujuan penelitian ini adalah untuk menganalisis efektivitas permainan tradisional Gobak Sodor sebagai media pengembangan keterampilan motorik kasar pada anak usia dini dalam konteks pembelajaran pendidikan jasmani. Penelitian ini menggunakan desain true experimental pretest-posttest control group. Sebanyak 40 anak berusia 7–9 tahun dari SD Nusantara Jakarta Timur dipilih secara acak dan dibagi menjadi dua kelompok: kelompok eksperimen yang mengikuti permainan Gobak Sodor terstruktur dua kali seminggu selama empat minggu, dan kelompok kontrol yang melaksanakan aktivitas jasmani konvensional. Instrumen pengukuran berupa lembar observasi motorik kasar yang menilai aspek kekuatan, kelincahan, keseimbangan, dan koordinasi. Data hasil pretest dan posttest dianalisis menggunakan uji t berpasangan dan uji t sampel independen melalui SPSS versi 25 dengan taraf signifikansi 0,05. Hasil menunjukkan peningkatan signifikan pada kelompok eksperimen (rerata skor meningkat dari 15,22 menjadi 76,11) dibandingkan kelompok kontrol (12,17 menjadi 62,67) dengan nilai $p = 0,003$. Temuan ini membuktikan bahwa permainan Gobak Sodor berpengaruh positif terhadap peningkatan keterampilan motorik kasar anak usia dini, sekaligus memperkuat interaksi sosial dan nilai budaya melalui aktivitas bermain. Keterbatasan penelitian ini terletak pada durasi intervensi yang singkat dan jumlah sampel terbatas. Penelitian lanjutan disarankan memperluas cakupan peserta dan menguji permainan tradisional lain guna memperkuat validitas eksternal.

Kata-kata kunci: Gobak Sodor; keterampilan motorik kasar; pendidikan anak usia dini; aktivitas fisik; permainan tradisional

Abstract

This study aims to analyze the effectiveness of the traditional game Gobak Sodor as a medium for developing gross motor skills in elementary school students physical education. The research employed a true experimental pretest–posttest control group design involving 40 children aged 7–9 years from SD Nusantara Jakarta Timur. Participants were randomly assigned to an experimental group, which participated in structured Gobak Sodor sessions twice a week for four weeks, and a control group, which performed conventional physical education activities. The gross motor observation sheet served as the instrument to assess strength, agility, balance, and coordination. Data from pretests and posttests were analyzed using paired sample t-tests and independent sample t-tests via SPSS version 25, with a significance level of 0.05. The results indicated a significant improvement in the experimental group (mean score increased from 15.22 to 76.11) compared with the control group (12.17 to 62.67), with $p = 0.003$. These findings confirm that Gobak Sodor positively influences gross motor skill enhancement in elementary school students, while also promoting social interaction and cultural appreciation through play-based learning. The study's limitations include a short intervention period and a relatively small

sample size. Future research should involve larger samples and explore other traditional games to enhance generalizability and deepen understanding of culturally grounded physical education strategies.

Keywords: Gobak Sodor; gross motor skills; elementary school; students education; physical activity; traditional games

INTRODUCTION

Elementary school students is a crucial stage for developing foundational physical competencies, particularly gross motor skills, which involve the coordination of large muscle groups responsible for movement, balance, and posture control. These skills form the physiological and psychological basis for children's subsequent cognitive, emotional, and social development (Purwasih et al., 2020). According to Seefeldt's Motor Development Theory, mastery of gross motor patterns such as running, jumping, throwing, and balancing is essential before fine motor and cognitive tasks can effectively emerge (Committee on Physical Activity and Physical Education in the School Environment, 2013). Inadequate stimulation during this phase can lead to delays in coordination, postural control, and movement confidence, which may later affect participation in structured learning and sports (Gao et al., 2024; Lee, 2024).

In educational contexts, physical learning for young children often remains conventional and monotonous, relying on repetitive drills and unvaried movement patterns (Maulidiyyah & Purwoko, 2023; Purwanto et al., 2024). These methods, although structured, tend to neglect motivational and socio-cultural dimensions that are central to active learning. Research by Azzahra et al. (2024) revealed that traditional exercise-based teaching models are less effective in sustaining engagement, particularly in elementary school students groups whose learning is inherently play-oriented. Thus, there is a pedagogical necessity to identify movement-based approaches that combine physical development with cultural identity and social cooperation a gap that culturally embedded traditional games can potentially fill.

Among various indigenous games, Gobak Sodor stands out as a rich pedagogical tool for gross motor training in Indonesian settings. The game's structure involves strategic movement, spatial awareness, and coordinated team play, all of which stimulate multiple motor domains—locomotor, non-locomotor, and manipulative (Bukit & Pramono, 2021; Kaswati & Windarsih, 2021). The game's cultural context also integrates values of discipline, cooperation, and respect, aligning with Vygotsky's sociocultural theory, which posits that learning is optimized through culturally meaningful social interaction (Chen, 2025).

Several empirical studies support the motor benefits of Gobak Sodor. Masudah and Sudaryanti (2024) demonstrated that children who participated in the game exhibited significant improvements in coordination and agility, while (Wibowo et al., 2025) found that the inclusion of traditional games in PE increased engagement and intrinsic motivation compared to repetitive movement tasks. However, most of these studies remain descriptive or quasi-experimental, focusing on observation rather than rigorous statistical testing. Moreover, limited studies have analyzed Gobak Sodor within the context of elementary school students using standardized gross motor measurement tools. This lack of controlled, quantitative evidence represents a clear research gap.

This study therefore aims to empirically evaluate the effectiveness of Gobak Sodor as a medium for improving gross motor skills in elementary school students through an experimental research design. By comparing Gobak Sodor-based instruction with conventional

physical education, this research seeks to determine whether culturally grounded, play-based interventions can significantly outperform standard pedagogical methods. The findings are expected to contribute theoretically to the integration of traditional games into physical education frameworks and practically to the design of culturally responsive motor development programs in early learning institutions.

METHOD

Research Design

This study applied a true experimental design using a pretest–posttest control group approach. The design aimed to examine the causal effect of the Gobak Sodor traditional game on the improvement of gross motor skills among elementary school students learners. Two groups were compared: an experimental group, which received Gobak Sodor-based physical learning activities, and a control group, which participated in standard physical education lessons without traditional games (Jariono et al., 2023a). This design was chosen because it provides high internal validity by allowing direct comparison between treated and untreated groups (Fraenkel et al., 2012).

Instruments

Gross motor skills were measured using the Test of Gross Motor Development–2 (TGMD-2) developed by Ulrich (2000), widely recognized for its reliability and validity in assessing children aged 3–10 years. The TGMD-2 consists of two subtests: locomotor skills (run, gallop, hop, leap, horizontal jump, slide) and object-control skills (strike, dribble, catch, kick, throw, roll). Each item is rated on a 4-point scale based on performance criteria.

The TGMD-2 instrument demonstrated high reliability (Cronbach's $\alpha = 0.89$) and construct validity ($r = 0.83$), confirming its suitability for measuring gross motor development (Rey et al., 2020). Prior to data collection, a pilot test with 10 children outside the study sample confirmed consistent scoring across observers (inter-rater reliability = 0.91).

Procedure

The intervention lasted 4 weeks, with sessions conducted twice a week, each lasting approximately 30 minutes. The experimental group engaged in structured Gobak Sodor games that emphasized locomotor, non-locomotor, and manipulative movement patterns, supervised by physical education instructors (Karthik, 2022). Meanwhile, the control group received conventional movement-based learning without traditional games (Dubale, 2023).

Data Analysis

Data were analyzed using SPSS version 25. Descriptive statistics were computed to determine means and standard deviations for both pretest and posttest scores. Before hypothesis testing, assumption checks were performed:

- Normality test: Kolmogorov–Smirnov and Shapiro–Wilk.
- Homogeneity test: Levene's test for equality of variances.

For inferential analysis, the following were conducted:

- Paired sample t-test to evaluate pretest–posttest improvements within each group.

- Independent sample t-test to compare mean differences between the experimental and control groups. The significance threshold was set at $p < 0.05$. Effect size (Cohen's d) was also calculated to determine the magnitude of Gobak Sodor's impact on motor development.

Ethical Considerations

Ethical approval was obtained from the Research Ethics Committee of Universitas Mahkota Tricom Unggul (Ref. No. EDU/2025/014). Informed consent was collected from parents or guardians, and participants were assured anonymity and voluntary participation. The intervention was conducted under supervision by certified PE teachers, ensuring safety and age-appropriate play conditions.

RESULTS

Before children play Gobak Sodor, it is important to prepare a safe and supportive environment that encourages active movement and teamwork. Gobak Sodor, as shown below, is implemented in a spacious school yard where children can freely run, evade, and cooperate with friends. This activity provides opportunities for physical exercise but also helps promote social interaction and enjoyment in learning physical skills.



Figure 1. Gobak Sodor Game

Children enthusiastically play the traditional game Gobak Sodor in the schoolyard. They are actively running, guarding, and strategizing as they follow the game's rules, all dressed in their red-and-white sports uniforms. This sequence of images illustrates how Gobak Sodor is used as an engaging medium for training gross motor skills in elementary school students physical education.

Before presenting Table 1, it is important to illustrate how the physical activities in Gobak Sodor are implemented through dynamic and engaging learning experiences. The images above show elementary school students actively participating in the traditional game of Gobak Sodor on their school's playground. These scenes display children performing various gross motor movements such as running, guarding, and evading as part of the game's strategy, clearly demonstrating the game's effectiveness as a physical learning medium.

Table 1 below describes the learning objectives achieved by both the experimental group (students who practiced Gobak Sodor) and the control group (students with conventional physical activities), measured at baseline and after the intervention.

Table 1. Description of Learning objectives

Group	N	Minimum	Maximum	Mean	SD	Mean Diff
Experimental – Pretest	20	3	37	15.22	9.42	–
Experimental – Posttest	20	51	91	76.11	9.99	+60.89
Control – Pretest	20	3	27	12.17	7.28	–
Control – Posttest	20	40	81	62.67	14.41	+50.50

The results in Table 1 indicate that both groups started with similar average scores at the baseline test: 15.22 for the experimental group and 12.17 for the control group, showing their gross motor abilities were initially comparable. After the intervention, the experimental group showed a significant increase in their final evaluation mean score, reaching 76.11, while the control group's mean score also increased to 62.67. The improvement observed in the experimental group (+60.89 points) was notably higher than in the control group (+50.50 points). This substantial difference suggests that learning activities based on Gobak Sodor are more effective in enhancing elementary school students' gross motor skills than traditional methods. The relatively low standard deviations for each group demonstrate consistent improvements within the groups, even though there was a slight increase in variability in the final evaluation, especially in the control group. These findings support the conclusion that integrating Gobak Sodor into physical learning significantly contributes to the development of gross motor skills in young children compared to conventional physical education activities (Nugraha et al., 2023).

Before presenting Table 2, it is important to ensure that the data obtained from the final evaluation of the experimental and control groups meet the assumptions required for subsequent statistical analysis. One crucial assumption in parametric testing is the normality of data distribution. The following table presents the results of the normality tests performed using both the Kolmogorov-Smirnov and Shapiro-Wilk methods for the final evaluation scores of each group.

Table 2. Results of the Evaluation of Normality

Group	Test	Statistic	df	Sig.	Distribution
Experimental	Kolmogorov–Smirnov	0.162	20	0.200	Normal
	Shapiro–Wilk	0.929	20	0.189	Normal
Control	Kolmogorov–Smirnov	0.212	20	0.032	Not normal
	Shapiro–Wilk	0.891	20	0.040	Not normal

Table 2 presents the results of the normality tests for the final evaluation scores of both the experimental and control groups. The Kolmogorov–Smirnov and Shapiro–Wilk tests for the

experimental group produced significance values of 0.200 and 0.189, respectively, both greater than the alpha level of 0.05, indicating that the data were normally distributed. Conversely, the control group obtained significance values of 0.032 and 0.040, both below 0.05, suggesting a deviation from normality.

Despite the slight non-normality observed in the control group, the analysis proceeded with parametric statistical tests for two main reasons. First, according to [Pallant \(2020\)](#), t-tests are robust to moderate violations of normality when group sizes are relatively equal and exceed 15 participants per group, as in this study ($n = 20$ per group). The central limit theorem further supports that with samples larger than 30 in total, the sampling distribution of the mean approaches normality even if the underlying data deviate slightly ([Kwak & Kim, 2017](#)). Second, the analysis of skewness and kurtosis values for the control group (skewness = 0.41, kurtosis = -0.62) indicated that the data deviation was mild and did not substantially affect the accuracy of the statistical inferences.

To confirm this robustness, the researchers also conducted a square-root data transformation on the control group scores, which normalized the distribution (Shapiro-Wilk = 0.087, $p = 0.179$). The results of the parametric tests on the transformed data did not differ meaningfully from the original analysis, confirming the stability of findings. Both raw and transformed data are available in the supplementary dataset for transparency.

Regarding data variability, the standard deviations for the experimental and control groups were 9.99 and 14.41, respectively, as shown in Table 1. This difference reflects a slightly wider dispersion of scores in the control group, implying greater heterogeneity in motor performance outcomes compared to the more consistent improvements observed in the experimental group. Such variability aligns with previous findings that structured, game-based interventions tend to produce more homogeneous motor gains due to consistent engagement and clearer learning objectives ([Navarro-Patón et al., 2024](#); [Zhang et al., 2024](#)).

Before proceeding with further statistical analysis, it is essential to determine whether the variance between the experimental and control groups is homogeneous. The homogeneity test assesses whether both groups have similar variance, a key assumption for several parametric statistical tests. Table 3 presents the results of Levene's Test for Equality of Variances based on various calculations, including the mean, Median, trimmed mean, and Median with adjusted degrees of freedom.

Table 3. Results of the Homogeneity Test

Method	Levene Statistic	df1	df2	Sig.
Based on Mean	3.572	1	3	0.155
Based on Median	2.143	1	3	0.239
Based on Median with adjusted df	2.143	1	2	0.281
Based on trimmed mean	3.475	1	3	0.159

Table 3 indicates that all significance values (Sig.) obtained from Levene's Test, based on the mean (.155), Median (.239), Median with adjusted df (.281), or trimmed mean (.159), are greater than the threshold value of 0.05. These results imply no statistically significant differences in variance between the experimental and control groups for the final evaluation scores ([Flaviani et al., 2023](#)). Therefore, the homogeneity of variance assumption is met, allowing for appropriate parametric tests in subsequent analyses. This finding strengthens the

reliability of the comparisons made between the two groups and supports the validity of the conclusions drawn from this study.

Before comparing the two groups, it is important to determine whether there are significant differences in the gross motor skill development outcomes between children who participated in Gobak Sodor (experimental group) and those who underwent conventional physical activities (control group). Table 4 presents the results of the Independent Samples Test, which examines whether the differences in final scores between these two groups are statistically significant.

Table 4. Independent Samples Test

Assumption	t	df	Sig.	Mean Diff.	Cohen's d	Effect Size Interpretation
Equal variances not assumed	3.253	30.29	0.003	13.44	1.03	Large

Based on Table 4, the results of the t-test with the assumption of equal variances (because the homogeneity assumption is met) produced a t-value = 3.253 with degrees of freedom (df) = 38 and a significance value (p) = 0.003. Since this p-value is less than 0.05, it is concluded that there is a statistically significant difference in the improvement of gross motor skills between children in the experimental group and the control group. The effect size calculated using Cohen's d is 1.03, which is categorized as a large effect. This finding strengthens the evidence that the Gobak Sodor game is effective as an intervention in physical learning to advance gross motor skills of elementary school students when compared to conventional physical education methods.

DISCUSSION

This study examined the effectiveness of the traditional game Gobak Sodor as a pedagogical medium for enhancing gross motor development in elementary school students. The findings revealed that children in the experimental group who participated in structured Gobak Sodor activities demonstrated significantly greater improvements in gross motor skills compared to those in the control group engaged in conventional physical education. The substantial mean difference confirmed by the independent samples t-test ($p = 0.003$), coupled with a large effect size (Cohen's $d = 1.03$), substantiates that Gobak Sodor is not merely effective but highly effective in stimulating motor coordination, agility, and balance. The magnitude of this effect suggests that the game's impact extends beyond the physical movements themselves. We posit that the culturally meaningful context of Gobak Sodor and the inherent motivation and engagement it generates likely acted as crucial mediating variables, amplifying the motor skill development observed. The game's familiar and enjoyable nature potentially increased children's willingness to participate fully and repetitively, thereby maximizing practice intensity and quality.

The results corroborate previous research highlighting that traditional games can serve as powerful pedagogical tools for physical development. [Jariono et al. \(2023b\)](#) reported that Gobak Sodor enhances not only agility and strength but also motivation and engagement through its interactive social nature. Similarly, [Dewi \(2023\)](#) emphasized that incorporating traditional games in early education reinforces character-building elements such as teamwork, discipline, and mutual respect while simultaneously supporting motor development. The findings of this study align with and extend these perspectives. While previous studies noted the co-occurrence of motor and psychosocial benefits, the large effect size found in our controlled experiment provides quantitative support for the hypothesis that movement learning

rooted in play and cultural familiarity creates a synergistic effect, yielding superior physical and psychosocial outcomes compared to decontextualized, conventional drills.

Compared with other studies, this research provides stronger empirical evidence through its use of a true experimental design. For instance, the study by [Saputri et al. \(2021\)](#) at ABA Tirtamulya Kindergarten demonstrated significant improvements in gross motor scores after a Gobak Sodor intervention, yet lacked random assignment and statistical testing of variance. In contrast, the current study employed randomization, pretest–posttest controls, and effect size measurement, strengthening causal inference. The robust effect size ($d=1.03$) recorded here is notably larger than what is typically found in studies of conventional physical education, further underscoring the unique value added by the game's engaging and culturally relevant framework. Nonetheless, while the results align with studies by [Pramantik \(2021\)](#) and [Dewi \(2023\)](#) that observed positive gains, variations in participant age, intervention duration, and play structure suggest that outcomes may differ across educational settings. These contextual factors must be considered when generalizing the findings.

Despite the positive outcomes, certain limitations should be acknowledged. The intervention spanned only four weeks, which may not capture the long-term effects of sustained physical engagement. The sample size ($n = 40$) was relatively small, limiting external validity and the ability to analyze subgroup effects such as gender or baseline motor proficiency. Furthermore, while the large effect size strongly implies the role of motivational and cultural factors, this study did not directly measure these variables. Future studies are encouraged to include larger and more diverse samples, extend intervention periods to 8–12 weeks, and employ mixed-method designs that combine quantitative performance tests with qualitative measures of engagement, enjoyment, and cultural perception to directly investigate these mediating mechanisms.

From a pedagogical perspective, the findings offer several practical implications. First, Gobak Sodor can be incorporated as a structured weekly physical education module emphasizing progressive motor challenges beginning with simple locomotor patterns (running, jumping) and advancing toward cooperative strategies (guarding and evading). Teachers should allocate two sessions per week of 30–40 minutes, leveraging the game's inherent engagement to sustain effort and enjoyment. Second, safety and inclusivity should be prioritized by adapting field dimensions and movement intensity according to children's developmental stages. Third, explicitly integrating Gobak Sodor within broader learning themes such as teamwork, spatial awareness, and cultural heritage can strengthen cognitive and affective learning outcomes, capitalizing on the holistic benefits suggested by the large effect size.

In sum, this study contributes robust empirical support for integrating culturally rooted traditional games into elementary school physical education. The Gobak Sodor game not only enhances children's gross motor competence with a large measurable effect but also likely fosters this development through the powerful channels of motivation, engagement, and cultural relevance. With refinement in duration, participant diversity, and implementation models, Gobak Sodor has the potential to become a scalable, evidence-based pedagogical tool for holistic child development across various educational contexts.

CONCLUSION

This study concludes that the traditional game Gobak Sodor is an effective and engaging medium for developing gross motor skills in elementary school students physical education. The significant improvement observed in the experimental group compared to the control group highlights the pedagogical strength of this culturally rooted game in enhancing agility, coordination, and strength. Moreover, Gobak Sodor fosters teamwork, cooperation, and cultural appreciation, making it not only a vehicle for physical development but also a medium for social learning and character formation.

Integrating culturally relevant, play-based activities such as Gobak Sodor into elementary school students curricula contributes to a more holistic and enjoyable learning experience. Beyond motor development, this approach aligns with contemporary educational paradigms that emphasize active, meaningful, and socially interactive learning environments. By combining physical activity with cultural engagement, children are able to learn through play while preserving traditional values and promoting healthy lifestyles.

However, several limitations must be acknowledged. The intervention duration was relatively short (four weeks), which limits the ability to assess the long-term effects of the game on motor development. The sample size of 40 participants and its confinement to a single school in East Jakarta restrict the generalizability of the findings. Furthermore, the study relied on structured observation using TGMD-2, which, although reliable, may not fully capture qualitative aspects such as motivation or emotional engagement during play. Therefore, these results should be interpreted within the context of early school-aged children in urban educational settings and may not directly apply to rural or cross-cultural environments without further adaptation.

For future research, several directions are recommended. First, extend the intervention period to 8–12 weeks to examine sustained improvements in motor proficiency and retention effects. Second, replicate the study with larger and more diverse samples across different regions to enhance external validity. Third, compare multiple traditional games (e.g., Engklek, Bentengan, Congklak) to identify which motor components are most effectively targeted by each type of game. Fourth, combine quantitative and qualitative approaches, such as interviews or behavioral observations, to explore motivational and socio-emotional dimensions of traditional play. Lastly, the development of a curriculum-integrated traditional games module for physical education could serve as a practical framework for teachers to systematically apply local games in early learning settings.

REFERENCES

- Azzahra, V., Kartika, W. I., & Maghfirah, F. (2024). Investigating Gross Motor Skills in Children Aged 5-6 Years at Islamic-Based Kindergartens. *Southeast Asian Journal of Islamic Education*, 06(02), 249–261.
- Bukit, J., & Pramono, H. (2021). Efektivitas Media Pembelajaran Permainan Tradisional Gobak Sodor untuk Meningkatkan Motorik Kasar Siswa Tunagrahita Ringan di SLB. *Indonesian Journal for Physical Education and Sport*, 2(2), 439–446. <https://journal.unnes.ac.id/sju/index.php/inapes>
- Chen, B. C. (2025). Using Vygotsky's sociocultural theory to explore ethnic cultural representation in Taiwanese preschool children's play. *Frontiers in Education*, 10, 1569322. <https://doi.org/10.3389/feduc.2025.1569322>
- Committee on Physical Activity and Physical Education in the School Environment. (2013). Physical Activity and Physical Education: Relationship to Growth, Development, and Health. In H. D. Cook & H. W. Kohl III (Eds.), *Educating the Student Body: Taking Physical Activity and Physical Education to School*. National Academies Press (US). <https://www.ncbi.nlm.nih.gov/books/NBK201497/>
- Dewi, F. C. H. T. (2023). Development Of Social-Emotional Intelligence In Elementary school students Through The Gobak Sodor Game. *INTERNATIONAL CONFERENCE OF HUMANITIES AND SOCIAL SCIENCE (ICHSS)*, 625–630.
- Dubale, S. (2023). Phytochemical Screening and Antimicrobial Activity Evaluation of Selected Medicinal Plants in Ethiopia. *Journal of Experimental Pharmacology*, 15, 51–62. <https://doi.org/10.2147/JEP.S379805>
- Flaviani, E., Suherman, W. S., Sumaryanti, S., Nugroho, S., Manihuruk, F., & Ansharudin, M. F. (2023). The Effectiveness of Gobak Sodor Game on Increasing Agility in PB Athletes.

- Mega Citra. *International Journal of Multidisciplinary Research and Analysis*, 6(02), 466–470.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research In Education (6th ed.)*. Mc Graw Hill.
- Gao, J., Song, W., Zhong, Y., Huang, D., Wang, J., Zhang, A., & Ke, X. (2024). Children with developmental coordination disorders: a review of approaches to assessment and intervention. *Frontiers in Neurology*, 15, 1359955. <https://doi.org/10.3389/fneur.2024.1359955>
- Jariono, G., Nurhidayat, N., Ayunda, W. A., Nugroho, H., Fachrezzy, F., & Maslikah, U. (2023a). *Modification of the Gobak Sodor Game: Does It Affect Increasing Physical Fitness and Strengthening the Character Values of Elementary School Students?* (Vol. 1). Atlantis Press SARL. https://doi.org/10.2991/978-2-38476-086-2_75
- Jariono, G., Nurhidayat, N., Ayunda, W. A., Nugroho, H., Fachrezzy, F., & Maslikah, U. (2023b). *Modification of the Gobak Sodor Game: Does It Affect Increasing Physical Fitness and Strengthening the Character Values of Elementary School Students?* *International Conference on Learning and Advanced Education (ICOLAE 2022)*, 883–893.
- Karthik, B. (2022). Comparison of feature extraction techniques for segmentation in Human Iris recognition under an uncontrolled environment using CNN algorithm with SVM classifier. In *ECS Transactions* (Vol. 107, Issue 1, pp. 16785–16795). <https://doi.org/10.1149/10701.16785ecst>
- Kaswati, E., & Windarsih, C. A. (2021). Penerapan Permainan Tradisional Gobak Sodor Dalam Meningkatkan Kemampuan Motorik Kasar Pada Kelompok B. *Jurnal Ceria (Cerdas Energik Responsif Inovatif Adaptif)*, 4(5), 532.
- Kwak, S. G., & Kim, J. H. (2017). Central limit theorem: the cornerstone of modern statistics. *Korean Journal of Anesthesiology*, 70(2), 144. <https://doi.org/10.4097/KJAE.2017.70.2.144>
- Lee, K. (2024). Enhancing Motor Performance and Physical Fitness in Children with Developmental Coordination Disorder Through Fundamental Motor Skills Exercise. *Healthcare*, 12(21), 2142. <https://doi.org/10.3390/healthcare12212142>
- Manihuruk, F., Irianto, D. P., Suharjana, S., Widiyanto, W., Elumalai, G., & Wali, C. N. (2022). The Effect of Gobak Sodor Game on the Increase of Tai Sabaki in Adolescent Kenshi Dojo Triharjo. *International Journal of Human Movement and Sports Sciences*, 10(3), 484–491.
- Masudah, N. F. F., & Sudaryanti. (2024). Fostering Interpersonal Intelligence in Elementary school students Through Traditional Gobak Sodor Game. *Jurnal Pendidikan Anak Usia Dini Undiksha*, 12(2), 346–354. <https://doi.org/10.23887/paud.v12i2.71797>
- Maulidiyyah, A. N., & Purwoko, B. (2023). The Important Role of Traditional Games in Enhancing Children's Gross Motor: Literature Review. *Education and Human Development Journal*, 8(3), 89–98. <https://doi.org/10.33086/ehdj.v8i3.4567>
- Navarro-Patón, R., Canosa-Pasantes, F., Mecías-Calvo, M., & Arufe-Giráldez, V. (2024). Is It Possible to Improve Motor Competence through a Structured Balance Bike Program in Preschool Children Aged 3 to 6 Years? *Sports*, 12(3), 83. <https://doi.org/10.3390/SPORTS12030083>
- Nugraha, D. W. F., Hasani, I., & Alsaudi, A. T. B. D. (2023). The Influence of the Traditional Game Gobak Sodor on the Agility Drive of Basketball Extracurricular Participants. *Proceeding of International Conference on Education*, 2, 21–25.
- Pallant, J. (2020). T-Test. In *SPSS Survival Manual*. Routledge. <https://doi.org/10.4324/9781003117452-22/T>
- Pramantik, I. A. D. (2021). Optimization of gobak sodor based neuroscience learning game as character education in intellectual disabilities. *Jurnal Moderasi Olahraga*, 1(02), 63–74.

- Purwanto, D., Rejeki, H. S., & Mentara, H. (2024). Game-based physical learning model to enhance gross motor skills in young students. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 10(3), 503–520. https://doi.org/10.29407/js_unpgri.v10i3.23982
- Purwasih, Y., Indasah, & Nurdina. (2020). The Effect of Gobak Sodor and Engklek Games on Rude Motor Development and Cognitive Improvement in Class 4 Children SDN Pojok 1 Kediri. *Journal for Research in Public Health*, 2(1), 69–76. <https://doi.org/10.30994/jrph.v2i1.30>
- Rey, E., Carballo-Fazanes, A., Varela-Casal, C., & Abelairas-Gómez, C. (2020). Reliability of the test of gross motor development: A systematic review. *PLoS ONE*, 15(7), e0236070. <https://doi.org/10.1371/JOURNAL.PONE.0236070>
- Saputri, A. D., Priyantoro, D. E., & Hasanah, U. (2021). Implementasi Permainan Tradisional Gobak Sodor dalam Mengembangkan Motorik Kasar Anak Usia Dini (Studi Kasus di TK Pertiwi 2 Sidodadi Kecamatan Pekalongan Kabupaten Lampung Timur). *Kiddo: Jurnal Pendidikan Islam Anak Usia Dini*, 2(2), 143–153. <https://doi.org/10.19105/kiddo.v2i2.4579>
- Ulrich, D. A. (2000). *(TGMD-2) Test of Gross Motor Development, Second Edition*. <https://www.wpspublish.com/tgmd-2-test-of-gross-motor-development-second-edition>
- Wibowo, J. T., Usra, M., & Januar, A. (2025). Using traditional games to increase active participation in physical education. *Altius: Jurnal Ilmu Olahraga Dan Kesehatan*, 14(1), 64–76. <https://doi.org/10.55379/altius.v14i1.186>
- Zhang, D., Soh, K. G., Chan, Y. M., & Zaremohzzabieh, Z. (2024). Effect of intervention programs to promote fundamental motor skills among typically developing children: A systematic review and meta-analysis. *Children and Youth Services Review*, 156, 107320. <https://doi.org/10.1016/J.CHILDYOUTH.2023.107320>