



Ethnic differences in gross motor skills among indigenous Dayak children in Indonesia: a cross-sectional comparative study

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ABSTRACT

Background: Cultural movement exposure has been suggested as a potential factor influencing children's motor development; however, empirical evidence on ethnic variation in gross motor skills among Indonesian children—particularly within indigenous Dayak sub-ethnic groups—remains limited. **Objectives:** This study aimed to examine differences in gross motor skills between Dayak Ngaju and Dayak Bakumpai children aged 8-11 years. **Methods:** A cross-sectional comparative design was employed involving 94 elementary school children (48 boys and 46 girls) from eight schools. Gross motor skills were assessed using the Indonesian-adapted TGMD-3, with established content validity (CVI = 0.91) and inter-rater reliability (ICC = 0.89). Performances were video-recorded and evaluated by trained raters blinded to participant identity. Two-way ANOVA was used to examine the effects of ethnicity and gender, with non-parametric tests applied when assumptions were violated. **Results:** No significant main effects of ethnicity or gender were found for locomotor, object control, or total TGMD-3 scores ($p > 0.05$). However, a significant ethnicity \times gender interaction was observed for locomotor skills ($p < 0.05$). At the task level, a significant difference was identified only in boys' horizontal jump performance, with Dayak Bakumpai boys scoring higher than their Ngaju counterparts. No other significant differences were observed across skill domains. **Conclusion:** Ethnic differences in gross motor skills among Dayak children appear to be limited and task-specific rather than consistent across domains. Cultural movement exposure may be associated with certain aspects of motor performance; however, causal interpretations cannot be established. These findings highlight the importance of context-sensitive physical education approaches that consider local movement practices without assuming generalised group differences.

Keywords: Gross motor skills; TGMD-3; indigenous children; ethnic variation; physical education

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INTRODUCTION

Gross motor skill development is foundational to elementary physical education, facilitating children's physical, cognitive, and social maturation (Piotrowski et al., 2025). While biological and environmental determinants are well-documented (Cerit et al.,

2020; Cheung & Zhang, 2020; Wälti et al., 2022), emerging evidence highlights the critical impact of socio-cultural contexts—including ethnicity, cultural norms, and habitual movement practices—on motor proficiency (Adeyemi-Walker et al., 2018; Hu et al., 2021; Jakiwa & Suppiah, 2020; Xia et al., 2022). Global studies confirm that exposure to traditional, community-specific physical routines drives ethnic variation in motor outcomes (Tesler et al., 2019), underscoring that motor development is not culturally neutral.

Despite this, the literature remains skewed toward Western populations (Karasik et al., 2010; Nielsen et al., 2017; Valentini et al., 2022; Wang et al., 2025; Wong & Cowden, 2022), leaving highly diverse regions like Indonesia underexamined. Although Indonesia comprises over 1,300 ethnic groups (Saepulmilah et al., 2025) — with Kalimantan alone hosting more than 100 Dayak sub-ethnic communities maintaining distinct movement and ritual traditions (Kuri et al., 2018) - there is a lack of empirical comparative studies examining intra-ethnic variations in motor skill development within Indonesian indigenous populations (Koh et al., 2025). This gap restricts both theoretical advancement and the implementation of culturally responsive physical education frameworks (Haridison et al., 2024; Sada et al., 2019).

Central Kalimantan provides a relevant context to address this empirical gap. The Dayak Ngaju are known to engage in the Manasai dance, a traditional activity involving rhythmic coordination and balance, whereas the neighbouring Dayak Bakumpai are reported to have different patterns of cultural physical activity (Missesa, 2022; Riyadi, 2021; Surya et al., 2022). Given their shared ecological and environmental conditions, comparing these groups offers a useful context to examine potential differences associated with cultural movement exposure. This distinction is particularly important in rural Kalimantan, where participation in structured physical activity is relatively limited (Andriyani et al., 2022), and traditional movement practices may play a meaningful role in shaping motor experiences (Hidayati et al., 2022; Misyuwe, 2018).

This study is among the first to examine intra-ethnic variation in motor skills within an indigenous Indonesian context. Accordingly, this study aims to compare the gross motor performance of Dayak Ngaju and Dayak Bakumpai elementary school children using the Test of Gross Motor Development-Third Edition (TGMD-3). By evaluating whether habitual exposure to traditional movement practices is associated with variation in locomotor and object control skills, this research provides context-specific evidence to advance culturally embedded motor development theory and inform responsive educational policies in Indonesia.

METHOD

Study Design

This study employed a cross-sectional comparative design to examine differences in gross motor skill proficiency between children from two Dayak sub-ethnic groups in Central Kalimantan. The design enables comparison of motor performance across groups within a natural, non-experimental setting.

Participants

A total of 94 elementary school children aged 8-11 years (48 boys and 46 girls) participated in this study. Participants were recruited using convenience sampling due to geographical and logistical constraints; however, efforts were made to include schools representing both peri-urban and rural contexts. The sample was drawn from eight elementary schools, comprising five peri-urban schools and three rural coastal schools

along the Barito River.

Of the total sample, 68 children were identified as Dayak Ngaju and 26 as Dayak Bakumpai. The unequal group sizes were taken into account during data analysis, and appropriate statistical procedures were applied to ensure the robustness of the findings. Cultural movement practices differ between groups, with Dayak Ngaju children commonly engaging in traditional activities such as the Manasai dance, while Dayak Bakumpai children are reported to have different patterns of cultural physical activity.

Inclusion and Exclusion Criteria

Participants were included if they: (i) were enrolled in Grades 2-5; (ii) were aged between 8 and 11 years; (iii) were physically healthy and able to perform all test items independently; and (iv) had written parental or guardian consent. Participants were excluded if they: (i) had neurological, orthopaedic, or medical conditions affecting motor performance; (ii) were absent during testing; or (iii) did not complete all assessment items or declined video recording.

Participant Flow

The participant recruitment and screening process is summarised in **Table 1**. This table provides a transparent overview of the inclusion and exclusion process, ensuring methodological clarity and reproducibility.

Table 1. Participant Inclusion–Exclusion Flow

| Stage | Number of Children | Description |
|---------------------------------|---------------------------|---|
| Children initially screened | 108 | Eligible students from eight schools |
| Excluded at screening | 9 | Age mismatch (n = 6); no parental consent (n = 3) |
| Eligible after screening | 99 | Met inclusion criteria |
| Excluded during data collection | 5 | Absent (n = 3); incomplete assessment (n = 2) |
| Final sample | 94 | Ngaju (n = 68); Bakumpai (n = 26) |

As shown in **Table 1**, a systematic screening process resulted in a final sample of 94 participants, ensuring that all included children met the study criteria.

Instrumentation

Gross motor proficiency was assessed using the Test of Gross Motor Development–Third Edition, a standardised instrument designed to evaluate fundamental movement skills in children (Ulrich, 2019). The TGMD-3 assesses two domains: locomotor skills (running, galloping, hopping, skipping, horizontal jumping, and sliding) and object control skills (striking, dribbling, catching, kicking, throwing, and underhand rolling). Each skill comprises 3-5 performance criteria scored dichotomously (1 = correct, 0 = incorrect) across two trials. Total scores were calculated by summing performance criteria across all skills, with higher scores indicating better motor proficiency.

The instrument was adapted for use in the Indonesian context through a forward–backward translation process and expert review. The adapted version demonstrated strong content validity (CVI = 0.91) and inter-rater reliability (ICC = 0.89), indicating its suitability for assessing motor skills among Indonesian children. Previous studies have also reported strong psychometric properties of TGMD-3 in diverse populations (Ulrich, 2019; Webster & Ulrich, 2016).

Procedure

Data collection was conducted on-site at participating schools in standardised outdoor flat-surfaced areas. Participants received uniform instructions and demonstrations prior to testing. Each child performed each skill twice, and all performances were video-recorded.

Two trained assessors independently evaluated performance using standardised scoring procedures. Calibration sessions were conducted prior to data collection to ensure scoring consistency. A random subsample (15%) was re-evaluated, yielding high inter-rater reliability (ICC = 0.89). Performance levels were categorised based on established criteria (Kelly et al., 2019).

Bias Minimization Procedures

Several strategies were implemented to minimise potential bias, including standardised administration, assessor training, video-based scoring, and blinded evaluation. Assessors were not informed of participants' ethnic classification during scoring. Testing environments were kept as consistent as possible across locations.

Ethical Considerations

Ethical approval was obtained from the Faculty of Sport Science Ethics Committee. Written informed consent was obtained from parents or guardians. Participation was voluntary, and all data were treated confidentially.

Statistical Analysis

Prior to analysis, assumptions of normality and homogeneity of variance were assessed using the Shapiro–Wilk test, Q–Q plots, and Levene's test. A two-way ANOVA was conducted to examine the main and interaction effects of ethnicity (Dayak Ngaju vs. Dayak Bakumpai) and gender (boys vs. girls) on locomotor, object control, and total scores. Effect sizes were reported using eta-squared (η^2).

When assumptions were violated, non-parametric tests (Mann–Whitney U and Kruskal–Wallis) were used to verify robustness. Statistical significance was set at $p < 0.05$. Given unequal group sizes, additional robustness checks were conducted to ensure that results were not biased. All analyses were performed using IBM SPSS Statistics version 22.0.

RESULTS AND DISCUSSION

Results

Participant Characteristics

A total of 94 children aged 8-11 years participated in this study, including 48 boys and 46 girls. The sample comprised 68 Dayak Ngaju (72.3%) and 26 Dayak Bakumpai (27.7%) participants. Gender distribution was balanced across ethnic groups, with no significant difference ($p = 0.728$). As shown in **Table 2**, the proportion of Dayak Ngaju participants was higher than that of Dayak Bakumpai, reflecting sampling accessibility. This imbalance was accounted for in the statistical analysis.

Table 2. Participant Characteristics by Ethnicity and Gender

| Variable | Total (n = 94) | Boys (n = 48) | Girls (n = 46) | Test Statistic | p-value |
|------------------|----------------|---------------|----------------|-----------------|---------|
| | n (%) | n (%) | n (%) | | |
| Ethnicity | | | | $\chi^2 = 0.12$ | 0.728 |
| Ngaju | 68 (72.3) | 34 (70.8) | 34 (73.9) | | |
| Bakumpai | 26 (27.7) | 14 (29.2) | 12 (26.1) | | |

Two-Way ANOVA Results

A two-way ANOVA was conducted to examine the main and interaction effects of ethnicity and gender on locomotor, object control, and total TGMD-3 scores. Levene's test confirmed that the assumption of homogeneity of variances was met for all variables ($p > 0.05$). As presented in **Table 3**, no significant main effects of ethnicity or gender were found across all TGMD-3 domains (all $p > 0.05$). However, a significant ethnicity \times gender interaction effect was identified for locomotor scores ($F = 4.207$, $p = 0.043$, $\eta^2 = 0.046$). In contrast, no interaction effects were observed for object control or total TGMD-3 scores ($p > 0.05$), indicating that overall motor proficiency was comparable across groups.

Table 3. Two-Way ANOVA Results for TGMD-3 Scores

| Variable | Factor | F | p-value | η^2 |
|----------------|---------------------------|-------|---------|----------|
| Locomotor | Ethnicity | 1.840 | 0.178 | 0.020 |
| | Gender | 0.960 | 0.330 | 0.011 |
| | Ethnicity \times Gender | 4.207 | 0.043* | 0.046 |
| Object Control | Ethnicity | 0.880 | 0.351 | 0.010 |
| | Gender | 2.309 | 0.132 | 0.025 |
| | Ethnicity \times Gender | 1.171 | 0.282 | 0.013 |
| Total TGMD-3 | Ethnicity | 1.260 | 0.264 | 0.014 |
| | Gender | 1.410 | 0.238 | 0.016 |
| | Ethnicity \times Gender | 2.084 | 0.152 | 0.023 |

Notes: * $p < 0.05$

Task-Specific Locomotor Performance

Task-level analysis was conducted to further examine locomotor skill differences between groups. As summarised in **Table 4**, no significant ethnic differences were observed among girls across all locomotor skills (all $p > 0.05$). Similarly, most locomotor variables among boys were not significantly different between groups. However, a statistically significant difference was found in horizontal jump performance among boys ($p = 0.009$), with Dayak Bakumpai boys achieving higher scores than Dayak Ngaju boys. No other locomotor skills (running, galloping, hopping, skipping, and sliding) showed significant differences.

Table 4. Task-Specific Locomotor Skill Differences by Ethnicity and Gender

| Skill | Female (p-value) | Male (p-value) | Significant Difference |
|-----------------|------------------|----------------|------------------------------|
| Run | 0.474 | 0.867 | No |
| Gallop | 0.931 | 0.325 | No |
| Hop | 0.764 | 0.739 | No |
| Skip | 0.600 | 0.967 | No |
| Horizontal Jump | 0.707 | 0.009* | Yes (Bakumpai > Ngaju, boys) |
| Slide | 0.470 | 0.183 | No |

Notes: * $p < 0.05$

Task-Specific Object Control Performance

Object control skills were also analysed at the task level. As shown in **Table 5**, no significant ethnic differences were identified for any object control variables in either boys or girls (all $p > 0.05$). These findings indicate that object control performance was generally comparable between Dayak Ngaju and Dayak Bakumpai children across all assessed skills.

Table 5. Task-Specific Object Control Skill Differences by Ethnicity and Gender

| Skill | Female (p-value) | Male (p-value) | Significant Difference |
|-----------------|------------------|----------------|------------------------|
| Two-hand Strike | 0.978 | 0.495 | No |
| Forehand Strike | 0.858 | 0.897 | No |
| Dribble | 0.633 | 0.830 | No |
| Two-hand Catch | 0.705 | 0.579 | No |
| Kick | 0.844 | 0.303 | No |
| Overhand Throw | 0.406 | 0.948 | No |

Gender-Based Performance Patterns

Descriptive comparisons revealed consistent gender-related patterns. Boys tended to achieve higher scores in object control tasks, while girls showed relatively stronger performance in selected locomotor skills. However, as indicated in **Table 4**, these differences did not reach statistical significance ($p > 0.05$). Across both ethnic groups, dribbling performance was consistently low, suggesting a common area requiring further development.

Discussion

Key Findings

This study investigated gross motor skill performance among Dayak Ngaju and Dayak Bakumpai children aged 8-11 years in Central Kalimantan. Overall, the findings indicate that ethnic differences were limited, selective, and domain-specific rather than generalised across motor skill domains. At the domain level, no significant main effects of ethnicity or gender were observed for locomotor, object control, or total TGMD-3 scores. However, a significant ethnicity \times gender interaction was identified for locomotor performance, suggesting that group differences were conditional rather than uniform. At the task level, the only significant difference was observed in boys' horizontal jump performance, with Dayak Bakumpai boys outperforming their Ngaju peers. No significant differences were found across object control skills. Taken together, these results suggest that motor skill variation between the two groups is better characterised as context-specific rather than indicative of systematic ethnic disparities.

Theory-Based Explanation

These findings may be interpreted using Newell's constraints framework (Newell & Rovegno, 2021), which proposes that motor development emerges from the interaction of individual, task, and environmental constraints. Within this perspective, differences in children's motor performance are shaped not only by biological maturation but also by the sociocultural and physical environments in which movement is practised. This interpretation is also consistent with evidence showing that fundamental motor skills are influenced by environmental conditions, access to learning opportunities, and physical activity exposure (Cerit et al., 2020; Cheung & Zhang, 2020; Wälti et al., 2022). In the present study, the Dayak Ngaju and Dayak Bakumpai groups shared a broadly similar regional setting yet differed in cultural movement traditions. This may help explain why some variation appeared in locomotor performance, particularly in a task such as a horizontal jump that relies on lower-limb coordination and movement experience. However, because the observed pattern was limited to a single locomotor task and was not reflected across other locomotor or object control variables, the findings are better interpreted as context-specific variation rather than evidence of a broad ethnic advantage.

Comparison with Previous Studies

The present findings are broadly consistent with previous research showing that children's motor skill development may vary across cultural and ethnic contexts, although the extent of those differences is often uneven and highly dependent on the local movement environment. Studies conducted in England, Malaysia, and China have reported associations between ethnicity, environment, and fundamental movement skills, suggesting that children's motor development is shaped by habitual movement exposure, opportunity structures, and social context rather than ethnicity alone (Adeyemi-Walker et al., 2018; Hu et al., 2021; Jakiwa & Suppiah, 2020; Xia et al., 2022). Similarly, cross-cultural studies have emphasised that motor development is not culturally neutral and that movement proficiency may differ between populations exposed to distinct developmental environments (Karasik et al., 2010; Nielsen et al., 2017; Valentini et al., 2022; Wang et al., 2025; Wong & Cowden, 2022). The present study extends this literature by focusing on intra-ethnic variation within an Indonesian indigenous population, a topic that remains under-represented in the motor development literature. At the same time, the limited number of significant differences observed here contrasts with reports of broader group disparities in some international settings, indicating that cultural distinction does not necessarily translate into consistent differences across all gross motor domains.

Possible Mechanisms

Several mechanisms may help explain the selective pattern observed in this study. First, culturally specific movement activities may contribute to children's motor experiences in ways that are skill-specific rather than generalisable across all domains. For example, movement traditions may provide repeated exposure to rhythm, balance, and lower-limb coordination, which are more closely related to some locomotor tasks than to object control tasks. Second, children's motor development is also shaped by broader environmental opportunities, including school-based physical education, informal play, available space, and access to equipment. Third, the locomotor interaction effect observed in the ANOVA suggests that the relationship between ethnicity and motor performance may differ by gender, possibly reflecting differences in participation patterns, play preferences, or movement exposure between boys and girls. However, these mechanisms remain tentative in the present study because physical activity levels, participation frequency in cultural practices, anthropometric factors, and socioeconomic background were not directly measured. Therefore, the current results should be interpreted as showing association rather than causation.

Implications

The findings have several important implications. Theoretically, they reinforce the view that motor development should be understood within a multidimensional and sociocultural framework, while cautioning against essentialist interpretations of ethnic differences. The limited and inconsistent differences observed in this study suggest that ethnicity alone is an insufficient explanatory variable without considering environmental and contextual factors. Practically, the results highlight the potential value of culturally relevant movement practices as pedagogical resources in physical education. Rather than assuming inherent group differences, educators may integrate local traditions—such as Manasai dance—as contextually meaningful approaches to enhance engagement and movement learning. Such strategies may be particularly beneficial in under-resourced settings where structured physical activity opportunities are limited. At the same time, the findings underscore the importance of equity-based approaches, ensuring that all

children have access to diverse movement experiences regardless of cultural background.

Limitations and Future Directions

Several limitations should be considered. First, the unequal sample size between ethnic groups may have reduced statistical balance, although appropriate analyses were applied. Second, the absence of key covariates—such as physical activity levels, nutritional status, anthropometric characteristics, and socioeconomic background—limits the ability to explain underlying mechanisms. Third, the cross-sectional design precludes causal inference. Future research should adopt more comprehensive and integrative designs, including balanced sampling, longitudinal approaches, and the inclusion of relevant covariates. In addition, mixed-method studies incorporating qualitative insights into cultural practices may provide a deeper understanding of how sociocultural and environmental factors interact to shape motor development.

CONCLUSION

Thus, we highlight the importance of implementing long-term SADL programmes in PE classes as an effort to improve PAE and PF among students with disabilities. Our current research will contribute as an important innovation in PE teaching sessions by involving the use of SADL. In addition, it is hoped that the results of this study can change the paradigm of teachers to not always use traditional teaching methods and start trying to apply a new and interesting teaching model such as SADL. This study examined gross motor skill performance among Dayak Ngaju and Dayak Bakumpai children and found that ethnic differences were limited, selective, and not consistent across motor skill domains. No significant main effects of ethnicity or gender were observed for locomotor, object control, or total TGMD-3 scores, although a significant interaction effect indicated that locomotor performance varied conditionally across groups. At the task level, only boys' horizontal jump showed a significant difference, while all other skills were comparable. These findings suggest that motor development is context-dependent rather than inherently determined by ethnic background, emphasising the role of environmental exposure, movement opportunities, and sociocultural context.

From a theoretical perspective, this study contributes to the literature by providing evidence from an under-represented Indigenous population and demonstrating that cultural differences do not necessarily translate into generalised motor skill disparities. Practically, the findings support the integration of culturally relevant movement practices, such as traditional dance, into physical education to enhance engagement and contextual learning. Future research should adopt longitudinal and intervention-based designs and incorporate key covariates, including physical activity, nutritional status, and socioeconomic factors, to better understand the mechanisms underlying motor skill development.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to the publication of this article.

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