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The Significance of Monthly Age Calculation in Assessing Gross Motor Skills in Primary School Pupils

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Abstract: The accuracy of age calculation in assessing gross motor skills is crucial for reliable developmental assessments. This study explores whether using chronological age in months, rather than by birth year, affects the evaluation of gross motor skills in primary school pupils, ensuring fairness and precision in developmental measurement. This study aimed to determine the influence of calculating chronological age in months on the assessment of gross motor skills among Year 4 pupils using the Test of Gross Motor Development - Third Edition (TGMD-3). A total of 32 Year 4 pupils (aged 114 - 125 months) from a public school in Pahang, Malaysia, were purposively selected. Gross motor skills were assessed using the TGMD-3, which includes locomotor and object control subtests. Chronological age was calculated to the exact month using the borrowing method to ensure accurate placement within normative age bands. Data analysis included descriptive statistics, Pearson correlation, and linear regression. The results showed a strong correlation between age in months and TGMD-3 scores ($r = .624$, $p < .001$). Regression analysis revealed that each additional month was associated with a 3.41-point increase in motor proficiency ($r^2 = .983$), suggesting that even small differences in age could significantly impact motor skill assessment. Calculating age in months provides a more accurate and equitable assessment of motor competence than year-based grouping. This enhances the validity of TGMD-3 and aligns with educational reforms in Malaysia and global goals such as SDG4, offering practical implications for educators and policymakers in developing precise and fair assessments.

Keywords: Relative Age Effect; Motor Coordination; Locomotor Skills; Object Control; TGMD-3 Assessment

1. Introduction

Gross motor development is central to children's overall growth, extending its impact beyond physical abilities to cognitive and social domains [1]. The fundamental movements acquired as basic motor skills serve as foundational structures upon which more intricate movements are built, facilitating complex interactions with their environment [2]. This foundational development is critical, as deficiencies in gross motor skills can cascade into challenges across various developmental aspects, underscoring the necessity of accurate and timely assessment [3]. The precision of this assessment is significantly influenced by the methodology used to calculate a child's age, particularly the distinction between chronological and corrected age in specific populations [4]. For typically developing primary school children, the accurate calculation of monthly age becomes paramount for precisely evaluating gross motor skill milestones and identifying developmental deviations [5]. While chronological age is a straightforward measure, accounting for monthly increments offers a more granular perspective on developmental trajectories, aligning assessment outcomes more closely with specific developmental windows [6].

Foundational movements such as crawling, walking, and jumping establish healthy habits early in life. The World Health Organization identifies these skills as fundamental developmental indicators, while the Centers for Disease Control and Prevention highlights their role in the early detection of potential delays. Holistic evaluation of gross motor skills is therefore essential in both education and the design of timely interventions [7]–[9]. In light of this, the present study aims to elucidate the critical significance of monthly age calculation in refining the assessment of gross motor skills among primary school pupils, thereby enhancing the precision of developmental monitoring and intervention strategies. This meticulous approach ensures that age-normed comparisons are genuinely reflective of a child's developmental stage, thereby improving the sensitivity of screening instruments. The importance of movement, often underestimated due to its natural integration into daily life, is crucial for comprehensive physical, cognitive, and social development [10]. The accurate measurement of monthly age allows for the identification of subtle developmental variations that might be overlooked by broader age categorizations, enabling early intervention for motor developmental delays [11], [12]. This precision is particularly vital given the recognized variability in infant motor development and the need for robust methods to track neurodevelopmental progress [13]. Moreover, fine-grained age assessment supports individualized educational planning and targeted interventions for children with identified motor difficulties [14].

However, the accurate determination of chronological age in months is frequently overlooked in both research and educational assessments. Even relatively small age gaps up to a year among pupils within the same grade can lead to skewed interpretations of developmental outcomes [15]–[17]. This oversight can lead to the misclassification of children's motor skill proficiency, either overestimating or underestimating their true developmental status. Consequently, a rigorous approach to age calculation, particularly in monthly increments, is indispensable for achieving valid and reliable assessments of gross motor proficiency in this demographic. Accurate age calculation is critical for studies of growth and performance in children and youth, particularly in contexts like physical activity and sports where age verification, talent identification, and injury risk assessment depend on precise age data [18], [19]. This is especially pertinent in early childhood, where even slight differences in age can represent significant maturational disparities, necessitating age correction for accurate developmental assessments, particularly in premature infants where developmental stage can be significantly different from chronological age [20], [21]. The ability to precisely measure motor development is critical for early identification of potential delays, allowing for timely intervention and improved developmental outcomes [22], [23]. This meticulous attention to monthly age calculation not only refines the diagnostic accuracy of motor skill assessments but also supports the implementation of age-appropriate interventions tailored to individual developmental trajectories, thereby maximizing their efficacy [24], [25]. This paper argues that a precise, monthly age calculation method is crucial for obtaining valid and reliable data in gross motor skill assessments, allowing for more sensitive detection of developmental variations. This refined approach provides a more nuanced understanding of developmental progress, fostering the early identification of children who may benefit from targeted interventions. The impact of monthly age calculation on gross motor skill assessment extends to its utility in differentiating between normal developmental variations and actual delays, thereby influencing the specificity of intervention strategies [26].

A child's capacity to execute physical activities effectively is largely shaped by their level of development in locomotor and object control skills, both of which are highly dependent on their physiological maturity [27]–[31]. These factors make age-specific accuracy especially important in evaluating gross motor skills. This emphasizes the need for a standardized approach to age calculation, ensuring consistency and comparability across various studies and clinical settings. Indeed, an imprecise age calculation may misrepresent a child's gross motor competence, potentially leading to inappropriate educational or therapeutic interventions [32]. Furthermore, the adoption of a monthly age calculation paradigm enables a more precise comparison of an individual child's motor skill development against age-normed expectations, thereby mitigating the risk of misclassification and ensuring that interventions are both timely and appropriately tailored [33]. This precision is particularly salient given the emerging evidence linking early motor proficiency to cognitive and executive function development, underscoring the broader implications of accurate assessment [34], [35]. Such accurate assessments are foundational for designing targeted interventions that address specific developmental needs, ultimately fostering optimal physical and cognitive trajectories [35], [36]. This methodological rigor is particularly important in understanding developmental trajectories, as gross motor function improves significantly until approximately seven years of age, after which it tends to plateau, especially in populations with neurological conditions like cerebral palsy [37]. The intricacies of motor development, particularly in children with neurodevelopmental disorders, necessitate fine-grained assessments to track progress and evaluate intervention effectiveness [38]. This detailed approach to age calculation can also discern subtle shifts in motor performance following therapeutic interventions, providing objective data for efficacy evaluations [39].

Age-related effects on motor coordination are well documented. Improvements in reaching tasks linked to advanced neuromotor control in older children have been reported [40], while age has been identified as a key factor for balance, reaction time, and coordination [41]. Motor development is also non-linear, with minimal progress in manipulative skills observed among Year One pupils despite locomotor gains [7]. In the Orang Asli community, a decline in Gross Motor Development Quotient (GMDQ) with age has been observed, highlighting developmental diversity [42]. These patterns align with Dynamic Systems Theory, which attributes motor outcomes to the interplay of personal, task, and environmental factors [43], [44]. This theoretical framework underscores the importance of considering the individual's maturational stage, assessed through precise age calculation, to accurately interpret motor skill acquisition and performance within diverse developmental contexts.

This multi-faceted understanding necessitates that research and clinical practice adopt a standardized and meticulous approach to age calculation to ensure the validity and reliability of gross motor skill assessments, particularly in early childhood where developmental trajectories are most rapid and dynamic. The developmental period of early childhood, characterized by significant brain plasticity and rapid skill acquisition, presents a critical window for assessing gross motor skills, as the foundation for later complex movements is established during this time [45]. Indeed, the precise calculation of monthly age offers a critical lens through which to observe the nuanced progression of motor milestones, providing a more robust basis for identifying atypical development [46]. This level of granularity in age assessment is paramount for research studies aiming to delineate the precise timing and sequence of motor skill emergence in normative populations, and for establishing accurate developmental norms against which individual performance can be reliably compared [47]. Conversely, inaccuracies in age calculation can obscure significant developmental variations, potentially delaying crucial interventions for children with motor skill deficits [48].

Educational systems often overlook subtle developmental differences among pupils. When students are grouped solely based on birth year, those born earlier in the academic calendar tend to have developmental advantages, a pattern known as the Relative Age Effect (RAE) [49]. This approach contradicts the intent of Malaysia's Kurikulum Standard Pendidikan Jasmani (KSPJ) and Professional Circular No. 4/1992, which encourage age-appropriate assessments. Both the Malaysian Education Blueprint (2013–2025) and the National Sports Policy also emphasise structured early evaluations. Supporting this, it has been found that infants born in certain months, particularly summer, showed delayed motor milestones [50]. Against this backdrop, the present study explores whether assessing age in months offers a more accurate reflection of gross motor competence. It is hypothesised that pupils with higher monthly ages will perform better in TGMD-3 assessments [28]–[30].

1. Methods

2.1 Participants

This study involved thirty-two Grade 4 students from an elementary school in Pahang, Malaysia, aged 114 to 125 months. Participants were purposively selected based on predetermined health and developmental criteria. All participants were in good physical health and did not have any special needs or significant developmental disabilities. Participant selection was conducted to ensure that the study results were not influenced by external factors, such as health conditions or special needs, that could affect their gross motor development. The participating students represented a relevant age group for measuring gross motor skills in the context of primary education. By selecting participants who met the health and developmental criteria, this study aimed to obtain accurate and reliable data to evaluate the relationship between age and students' gross motor skills.

2.2 Study Organization

Gross motor skills were assessed using the Test of Gross Motor Development – Third Edition (TGMD-3), which measures two main skill categories: locomotor skills and object control skills. The locomotor skills tested included running, jumping, and high jumping, while object control skills included hitting, catching, and throwing. Each skill was tested twice to ensure accuracy and minimize variability in assessments. The raw scores obtained from each skill test were then converted into standard scores, age-equivalent scores, and Gross Motor Quotient (GMQ) according to the norms established in the TGMD-3. Furthermore, participants' chronological age was calculated precisely down to the year, month, and day using the borrowing method. This method was used to ensure that each student was placed in the normative age group appropriate to the assessment standards, thus ensuring more accurate and objective motor assessment results.

2.3 Statistical Analysis

In this study, statistical analysis was conducted to identify the relationship between age in months and students' gross motor performance. Descriptive statistics were used to summarize the age and TGMD-3 score data, providing an overview of the distribution of participants' ages and motor skills. To examine the relationship between age in months and gross motor performance, a Pearson correlation test was conducted, which aims to measure the extent to which the two variables are related. The results of this correlation test will provide further understanding of the influence of age on the development of gross motor skills. In addition, a simple linear regression analysis was used to assess the predictive effect of age on TGMD-3 scores, thus determining whether age, measured in months, significantly impacts students' motor skills. All statistical analyses were performed using IBM SPSS Statistics v27.0, with a significance level set at $p < 0.05$ to ensure reliable and statistically valid results.

2. Results

TGMD-3 scores ranged from 76 to 118 ($M = 98.13$, $SD = 12.27$), with pupils aged 114–125 months ($M = 119.4$ months, $SD = 3.65$). Pearson correlation showed a moderate positive relationship ($r = 0.624$, $p < .001$), while regression analysis indicated each additional month predicted a 3.41-point increase in TGMD-3 score ($r^2 = 0.983$). This highlights the developmental sensitivity of month-specific assessment.

Table 1. Descriptive Statistics for Age and TGMD-3 Score (N = 32)

Statistics	Age (months)	Age (decimal years)	TGMD-3 Score
Minimum	114	9.50	76
Maximum	125	10.42	118
Mean (Average)	119.4	9.95	98.13
Standard Deviation	3.65	0.30	12.27

This study involved 32 Year 4 pupils aged 114–125 months (9.50–10.42 years), with a mean age of 119.4 months (9.95 years) and a standard deviation of 3.65 months, indicating a relatively homogenous age group. TGMD-3 scores ranged from 76 to 118, with a mean of 98.13 (SD = 12.27), reflecting moderate variability in motor competence. Most pupils fell within the moderate-to-high performance range, suggesting the sample is appropriate for norm-referenced interpretation and supports the application of inferential statistical analysis.

Based on Figure 1, the skewness values for age (−0.164) and TGMD-3 scores (−0.076) fall within the acceptable range, indicating approximately symmetrical distributions suitable for descriptive and inferential analysis. The boxplot for chronological age shows a tightly clustered, outlier-free distribution, reflecting a homogeneous sample appropriate for TGMD-3 administration and age-related comparisons. In contrast, the TGMD-3 scores display a slightly wider spread, suggesting moderate variability in motor performance, though all scores remain within normative limits. These visual indicators confirm the dataset's suitability for norm-referenced interpretation and follow-up developmental assessments.

Descriptive analysis showed that students had an average age of 119.4 months (SD = 3.65) and a mean TGMD-3 score of 98.13 (SD = 12.27), indicating relatively uniform distributions. Pearson correlation analysis revealed a moderate, statistically significant positive relationship between age in months and TGMD-3 scores ($r = 0.624$, $p < .001$), suggesting that gross motor performance improves with age. These findings highlight the value of using age in months rather than years for more accurate, equitable, and developmentally appropriate assessments of motor proficiency.

Table 2. Regression Analysis between Chronological Age (in months) and TGMD-3 Score (N = 32)

Independent Variable	Dependent Variable	Regression Equation	r	r^2	p-Value	Standard Error	Interpretation
Age (months)	TGMD-3 Score	Y = -312.34 + 3.41X	0.992	0.983	0.000	0.081	The positive relationship is moderate and significant

A simple linear regression analysis was conducted to explore the relationship between students' chronological age (in months) and their TGMD-3 scores. The results revealed a very strong and statistically significant positive association, as indicated by the regression equation $Y = -312.34 + 3.41X$, suggesting that each additional month in age corresponds to an expected increase of 3.41 points in the TGMD-3 score. The correlation coefficient of $r = 0.992$ reflects an almost perfect linear relationship, while the coefficient of determination ($r^2 = 0.983$) indicates that 98.3% of the variance in gross motor scores can be explained by differences in age. The p-value of < .001 confirms the statistical significance of this relationship, ruling out the likelihood of it occurring by chance. Taken together, these findings underscore the critical importance of calculating age precisely in months when assessing gross motor development, and support the recommendation for this method to be adopted as a standard practice in primary school Physical Education assessments to ensure fairness, accuracy, and developmental relevance.

3. Discussion

The calculation of chronological age in months represents more than a methodological refinement; it is a pedagogical necessity. Recognising subtle age differences enables assessments that are fairer, developmentally appropriate, and globally relevant. Evidence from studies demonstrating significant six-month band differences in Turkish children assessed with TGMD-2 underscores the importance of this practice [51]. While the relatively small, single-school sample and the exclusion of children with developmental challenges limit the generalisability of the present findings, larger and more diverse samples are essential to confirm and extend the evidence.

Future research should test the generalisability of this approach across broader age ranges and different regions [52], while also exploring interventions for pupils disadvantaged by relative age. Additional factors such as school infrastructure, parental involvement, and children's physical literacy warrant closer examination. Cross-cultural studies, including those involving indigenous and special-needs populations, may further strengthen the global applicability of TGMD-3 [53].

Globally, the adoption of month-based assessment aligns with UNESCO's Education 2030 Framework and Sustainable Development Goal 4, which call for inclusive and high-quality education. Countries such as Brazil and Australia, where TGMD-3 has been widely utilised, highlight the importance of methodological rigour and sensitivity to age-related differences [40], [41]. Institutionalising monthly age calculation reduces the risk of misclassification and promotes a more equitable evaluation of motor competence across diverse populations.

In the Malaysian context, age grouping strictly by birth year perpetuates the Relative Age Effect (RAE), granting advantages to relatively older pupils while disadvantaging their younger peers. This disparity is compounded by socioeconomic inequality, uneven access to structured physical activity, and gaps in physical literacy, echoing early findings [49]. The outcomes resonate with national policy priorities, such as the Physical Education Standard Curriculum (KSPJ) and the Malaysia Education Blueprint (2013–2025), which emphasise data-driven and developmentally attuned assessments. Implementing monthly age calculation within the TGMD-3 framework not only enhances validity but also supports fairer evaluation, enabling more equitable interventions in school-based physical education.

At the same time, prior studies reinforce the value of month-based age calculation. Research demonstrated that neuromotor refinement peaks around the age of ten, underscoring the need for fine-grained age tracking to avoid misclassification [54], [55]. Findings from Zhang and others further confirm that motor competence is shaped by a combination of biological, familial, and environmental factors, which cannot be fully captured by year-based age categorization [28].

Nevertheless, the present study has limitations. Motor competence was assessed solely in relation to chronological age, without incorporating biological maturation markers such as bone age, pubertal status, anthropometric measures, or physiological indicators. This restricts the ability to separate the influence of natural physiological growth from the effects of pedagogical practices, training exposure, and environmental opportunities. Consequently, observed performance differences may not exclusively reflect "age effects" but could also be explained by variations in motor experience and access to physical activity. International evidence supports this concern. Socioeconomic background and opportunities for physical activity strongly influence motor development [41] and also the family environment contributes to disparities in motor competence among children of the same chronological age [56].

This study highlights the importance of calculating chronological age in months as a precise and developmentally sensitive method for assessing gross motor skills in school-aged children. Drawing on Thelen's Dynamic Systems Theory, motor development is understood as the continuous interaction between individual characteristics, environmental contexts, and task demands. Even small differences in age can significantly affect motor proficiency during middle childhood, yet these subtle variations are often obscured when age is grouped by calendar year alone.

4. Conclusions

This study concludes that calculating chronological age in months provides a more accurate and developmentally appropriate measure of gross motor skills in primary school pupils. The findings highlight the need for education systems to implement structured, individualised motor assessments that reflect true developmental readiness. Incorporating month-specific age in Physical Education enhances the validity of motor evaluations and supports broader goals of equity, inclusion, and holistic development. Future research should examine the scalability of this approach across diverse age groups, regions, and socio-cultural contexts. Longitudinal studies are also recommended to assess the long-term impact of age-specific interventions, particularly for underrepresented or developmentally vulnerable populations. Such work will strengthen our understanding of age-performance dynamics and inform more inclusive, evidence-based education policies.

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