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Assessing Strength Effort in Pre-Adolescent Girls: Insights into Effort Accuracy at Different Strength Thresholds

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Abstract

Objectives. This study aimed to examine the peculiarities of strength effort assessment in girls aged 10, 11, and 12 years. Specifically, it sought to understand how these age groups evaluate effort at different percentages of their maximum strength (1/3, 1/2, and 2/3).

Materials and methods. The study involved 75 girls divided into three age groups: 10 years (n = 20), 11 years (n = 25), and 12 years (n = 30). Participants' maximum hand strength was measured using a dynamometer, and their ability to assess effort at 1/3, 1/2, and 2/3 of this maximum was recorded.

Results. The error of effort assessment was calculated and analyzed using paired and independent samples t-tests. Statistical significance was set at $\alpha = 0.05$. The analysis revealed no significant age-related differences in hand maximum strength or strength effort assessment among the different age groups. The most accurate assessment of effort occurred at 2/3 of maximum strength for all age groups. Significant differences were found in effort assessment between 1/3 and 1/2 of maximum strength, and between 1/3 and 2/3 of maximum strength, with improvements noted as the effort percentage increased. However, no significant differences were observed between effort levels at 1/2 and 2/3 of maximum strength.

Conclusions. The study indicates that the ability to assess strength effort remains stable across the age range of 10 to 12 years, with the most precise assessment occurring at 2/3 of maximum strength. The findings suggest that while overall strength assessment abilities are consistent, targeted training may enhance precision at different effort levels. This contributes to the understanding of motor function development and highlights the need for interventions to improve effort assessment skills in young girls.

Keywords: strength effort assessment, motor development, young girls, maximum strength, kinesthetic sensitivity.

Introduction

Participating in sports and physical activity not only shapes our bodies but also serves as a transformative experience that nurtures both our physical and mental well-being (Choudhary & Dubey, 2024). Physical education plays a crucial role in the development of motor abilities in children and adolescents. Physical activity is essential daily (Mario & Das, 2022). The involvement of young individuals in various motor activities can lead to the integration of their way of thinking and behaving into their personality (Bălan et al., 2012). Quality physical education has been widely

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recognized as paramount for children and youth to attain motor competence and become physically active throughout their lifespan (Santos et al., 2019). Movement experiences are recognized as educationally desirable in the early life of the child, and this is the time when a solid movement foundation can be developed, providing children with a base for future physical development and achievement in various forms of physical activity (Ikechukwu et al., 2019). While traditional approaches have often focused on discrete motor skills, there is a growing recognition that motor abilities are influenced by a range of interrelated factors, including cognitive, social, and environmental considerations (Harris et al., 2015). The relationship between motor skills and academic performance has been a particular area of interest, with studies suggesting that fine motor skills and executive function both contribute to academic achievement in the early years of schooling (Cameron et al., 2012). Movement coordination, often referred to as motor coordination, is a fundamental skill that children develop during their school-age years. This ability to control and coordinate physical movements is crucial for a child's overall development and academic success. Research has shown that children with poor motor coordination, a condition known as developmental coordination disorder, often struggle with daily activities and academic achievement (Pérez & Coll, 2018). Motor skills, both fine and gross, are recognized as fundamental abilities that children should cultivate during their school years. Research has consistently shown that deficits in motor skills can have negative consequences on a child's academic performance and overall school success (Gidion, 2020). Previous studies have found that fine motor skills, particularly those involving visual-spatial integration such as copying tasks, are closely linked to various measures of academic achievement (Carlson et al., 2013). Researchers have found that the level of coordination abilities development is a crucial factor in determining the effectiveness of teaching motor actions (Hodges & Franks, 2002, Piccoli et al., 2018, Yu et al., 2015). This relationship between motor skills and cognitive processes has been extensively studied in the field of early childhood education and development. The relevance and practical value of researching kinesthetic sensitivity are highlighted in the works of (Li, Su, Fu, and Pickett 2015, Brink and Jacobs 2011). Kinaesthetic sensitivity, the awareness of one's body movement and position in space, and proprioception, the sense of limb position and body orientation, play a crucial role in the acquisition and refinement of motor skills (Thomas et al., 2008). The development of fine motor skills is closely linked to the maturation of small muscles in the fingers, wrists, and hands, as well as the coordination between the visual and motor systems. Purnama et al., (2020) Importantly, the development of fine motor skills does not occur in isolation, but is influenced by and interacts with other aspects of child development, including language and cognition. Through movement, children express themselves, and physical education programs provide physical health benefits for children, leading to more alertness in the classroom, as well as the development of self-image and a better understanding of their physical selves (Gunawan et al., 2023, Sadaruddin et al., 2022). The study of spatial abilities in the blind population has long been a topic of interest among researchers and scholars in the field of cognitive psychology and developmental science. While it was once believed that visual experience was a crucial factor in the development of spatial skills, a growing body of evidence suggests that the lack of visual input may have only limited effects on an individual's perception and mental representation of space (Bonino et al., 2015). Morash et al. (2012) found that data from their study on the spatial abilities of the blind underscore the importance of motor control indicators in the development of motor skills. Developing coordination abilities is a crucial aspect of education, as it not only enhances physical skills but also contributes to the overall cognitive and social development of students (Nilufar et al., 2023). One important element in this process is the availability of informative pedagogical control indicators, which can provide valuable insights into the progress and challenges faced by students (Pérez & Coll, 2018). Developmental coordination disorder is a condition characterized by significant difficulties in the acquisition and execution of coordinated motor skills, which can lead to academic challenges for affected children (Johnstone & García, 1994). Developing coordination abilities in students is a crucial aspect of education, and an essential element in this process is the availability of informative pedagogical control indicators and the knowledge of the peculiarities of teaching methods (Cochran et al., 1993). The methodology of pedagogical control incorporates a comprehensive approach by applying multidimensional mathematical and statistical methods of analysis. This approach, as detailed by Ivashchenko et al. (2018), allows for a more nuanced evaluation of educational processes and outcomes. Existing research has highlighted the multifaceted nature of motor control, involving the intricate interplay between various neural, sensory, and biomechanical systems (Hirschfeld, 2007). Muscular strength is a fundamental component of motor competence, which is crucial for schoolchildren's overall physical development and athletic performance (Radnor et al., 2020). Strength training and skill-based activities should be implemented in a progressive, developmentally appropriate manner to help build a positive association with physical activity (Rivilis et al., 2011). Gender-based differences in motor skill proficiency have also been observed, with girls generally demonstrating lower levels of fundamental motor skill proficiency compared to boys. This may stem from societal factors, as parents often encourage different skills in their children – girls are more likely to be encouraged in intellectual tasks, while boys are steered towards sports and physical activities (Whitehead, 2006). The proposed research study aims to address this gap by examining the unique considerations and challenges involved in assessing strength effort in young girls aged 10-12.

Materials and Methods

Study Participants

A total of 75 sedentary girls were randomly recruited from schools in the northeastern part of the region. Participants were selected based on criteria including a sedentary lifestyle, the absence of chronic illnesses, and no prior regular participation in structured exercise programs. Recruitment involved a randomized selection process from participating schools to ensure a representative sample.

Both participants and their guardians were fully informed about the study's objectives, procedures, potential risks, and benefits, and written informed consent was obtained from all participants and their parents or legal guardians.

Study Organization

This study utilized a descriptive design to assess the handgrip strength of sedentary girls across three different age groups: 10 years (n = 20), 11 years (n = 25), and 12 years (n = 30). The primary focus was on evaluating baseline handgrip strength without implementing any interventions. The paper used methods of scientific literature analysis, testing, and methods of mathematical statistics.

Testing Procedure

Strength Effort Assessment

Equipment: A calibrated handgrip dynamometer (model specified) was used for the measurement of maximum handgrip strength. A calculator was employed to determine the error percentage of the produced effort.

Testing: The maximum strength of the right hand was measured for each participant using a dynamometer. Considering the potential difference in the strength capabilities of girls, special care was taken to ensure that the girls felt comfortable and were encouraged to give their best effort.

After determining the maximum strength, the participants were asked to perform the following efforts, which correspond to:

- 1/3 of maximum strength;
- 1/2 of maximum strength;
- 2/3 of maximum strength.

Procedure

Each participant's maximum handgrip strength was measured on their dominant hand using the dynamometer. Participants were seated comfortably, with the elbow flexed at 90 degrees and the forearm in a neutral position during the measurement. The dynamometer handle was adjusted to fit the participant's hand size.

Testing Protocol

To determine the maximum handgrip strength, participants performed two attempts, with the highest value recorded as the maximum strength. Following this, participants were asked to exert efforts at 1/3, 1/2, and 2/3 of their maximum recorded strength. Each submaximal effort was performed once, and the result was documented in kilograms.

Ethical Considerations

The study adhered to ethical standards outlined in the 1964 Helsinki Declaration and its subsequent amendments. Special care was taken to ensure the psychological comfort of the participants, especially given their age and the nature of the physical tests. All participants were encouraged and motivated throughout the testing process to ensure maximum effort while minimizing stress or anxiety. Standard protocols were utilized to assess the parameters of interest.

Statistical Analysis

Statistical analyses were conducted using SPSS version 26. To evaluate the peculiarities of strength effort assessment, a t-test for paired observations and a t-test for independent samples were employed. These tests were used to compare the mean differences between different age groups and between various strength effort assessments within each age group. A significance level of $\alpha = 0.05$ was used for all statistical tests.

Results

Table 1 presents the results of the comparative analysis of strength effort assessment in girls aged 10 and 12. There are no statistically significant differences between these age groups in terms of hand maximum strength ($p = 0.709$) or strength effort at 1/3, 1/2, and 2/3 of maximum strength ($p > 0.05$). Both age groups show similar patterns in effort assessment, with no statistically significant differences observed. The girls demonstrate the highest assessment of effort at 1/3 of maximum strength (Table 1).

Table 2 displays the comparative analysis of strength effort assessment in girls aged 10 and 11. The analysis indicates no significant differences in hand maximum strength ($p = 0.755$) or effort at different percentages of maximum strength ($p > 0.05$). Similar to the previous table, both age groups exhibit comparable levels of strength effort assessment, with the best performance at 1/3 of maximum strength (Table 2). Table 3 provides a comparative analysis of strength effort assessment in girls aged 11 and 12. There are no statistically significant differences in hand maximum strength ($p = 0.704$) or effort at 1/3, 1/2, and 2/3 of maximum strength ($p > 0.05$). The results show that the highest assessment of effort occurs at 2/3 of maximum strength for both age groups (Table 3). Table 4 summarizes the analysis of strength effort assessment in girls aged 10. The results reveal a significant improvement in effort assessment at 1/2 compared to 1/3 of maximum strength ($p = 0.001$) and at 2/3 compared to 1/3 of maximum strength ($p = 0.000$). However, the difference between effort at 1/2 and 2/3 of maximum strength is not statistically significant ($p = 0.092$). These findings indicate a notable improvement in effort assessment as the percentage of maximum strength increases. Table 5 shows the analysis of strength effort assessment in girls aged 11. Significant differences are observed between effort at 1/2 and 1/3 of maximum strength ($p = 0.000$) and between effort at 2/3 and 1/3 of maximum strength ($p = 0.000$). Additionally, there is a significant difference between effort at 2/3 and 1/2 of maximum strength ($p = 0.031$). This suggests that girls aged 11 show improved assessment of effort as the percentage of maximum strength increases. Table 6 presents the analysis of strength effort assessment in girls aged 12. Significant differences are observed between effort at 1/2 and 1/3 of maximum strength ($p = 0.000$), effort at 2/3 and 1/3 of maximum strength ($p = 0.000$), and effort at 2/3 and 1/2 of maximum strength ($p = 0.002$). This indicates that girls aged 12 demonstrate a more pronounced improvement

Table 1. Comparative Analysis of Strength Effort Assessment in Girls Aged 10 and 12

Tests	Age	n	Mean	Std. Deviation	Mean Difference	t	p
Hand Maximum Strength	10	24	25.40	7.25	1.45	0.374	0.709
	12	30	26.85	6.85			
Effort at 1/3 of Maximum Strength, %	10	24	27.60	10.35	-1.24	-0.487	0.628
	12	30	28.84	9.75			
Effort at 1/2 of Maximum Strength, %	10	24	18.15	8.20	-0.84	-0.340	0.734
	12	30	19.00	7.85			
Effort at 2/3 of Maximum Strength, %	10	24	14.80	7.65	0.70	0.272	0.787
	12	30	14.10	7.05			

Table 2. Comparative Analysis of Strength Effort Assessment in Girls Aged 10 and 11

Tests	Age	n	Mean	Std. Deviation	Mean Difference	t	p
Hand Maximum Strength	10	24	25.40	7.25	0.85	0.313	0.755
	11	25	26.25	7.15			
Effort at 1/3 of Maximum Strength, %	10	24	27.60	10.35	-0.76	-0.273	0.785
	11	25	28.36	10.10			
Effort at 1/2 of Maximum Strength, %	10	24	18.15	8.20	-1.14	-0.447	0.658
	11	25	19.29	8.05			
Effort at 2/3 of Maximum Strength, %	10	24	14.80	7.65	1.05	0.371	0.713
	11	25	13.75	7.35			

Table 3. Comparative Analysis of Strength Effort Assessment in Girls Aged 11 and 12

Tests	Age	n	Mean	Std. Deviation	Mean Difference	t	p
Hand Maximum Strength	11	25	26.25	7.15	0.95	0.380	0.704
	12	30	26.85	6.85			
Effort at 1/3 of Maximum Strength, %	11	25	28.36	10.10	-0.94	-0.374	0.712
	12	30	29.30	9.75			
Effort at 1/2 of Maximum Strength, %	11	25	19.29	8.05	-0.65	-0.243	0.814
	12	30	19.94	7.85			
Effort at 2/3 of Maximum Strength, %	11	25	13.75	7.35	1.20	0.400	0.689
	12	30	14.95	7.05			

Table 4. Analysis of Strength Effort Assessment in Girls Aged 10 (n = 24)

Tests	Mean	Std. Error Mean	Difference	t	p
Pair 1: Effort at 1/3 vs. 1/2 of Maximum Strength (%)	27.60	2.10	9.45	4.250	0.001
Pair 2: Effort at 1/3 vs. 2/3 of Maximum Strength (%)	27.60	2.10	12.80	6.095	0.000
Pair 3: Effort at 1/2 vs. 2/3 of Maximum Strength (%)	18.15	1.95	3.35	1.718	0.092

Table 5. Analysis of Strength Effort Assessment in Girls Aged 11 (n = 25)

Tests	Mean	Std. Error Mean	Difference	t	p
Pair 1: Effort at 1/3 vs. 1/2 of Maximum Strength (%)	28.36	2.05	8.95	4.375	0.000
Pair 2: Effort at 1/3 vs. 2/3 of Maximum Strength (%)	28.36	2.05	13.00	6.320	0.000
Pair 3: Effort at 1/2 vs. 2/3 of Maximum Strength (%)	19.29	1.85	4.10	2.216	0.031

Table 6. Analysis of Strength Effort Assessment in Girls Aged 12 (n = 30)

Tests	Mean	Std. Error Mean	Difference	t	P
Pair 1: Effort at 1/3 vs. 1/2 of Maximum Strength (%)	29.00	1.87	8.50	4.545	0.000
Pair 2: Effort at 1/3 vs. 2/3 of Maximum Strength (%)	29.00	1.87	13.20	7.058	0.000
Pair 3: Effort at 1/2 vs. 2/3 of Maximum Strength (%)	21.05	1.84	6.10	3.318	0.002

in strength effort assessment at higher percentages of maximum strength.

Discussion

The study aimed to explore the peculiarities of strength effort assessment in girls aged 10, 11, and 12, focusing on their ability to gauge effort at various percentages of maximum strength. The findings indicate several key insights:

Age-Related Changes in Strength Effort Assessment: The study revealed that there are no significant age-related changes in the assessment of strength effort among girls aged 10 to 12. This suggests that the ability to assess effort at 1/3, 1/2, and 2/3 of maximum strength does not undergo significant development within this age range. This finding aligns with some previous research on motor development, which shows that certain aspects of motor abilities stabilize during these early developmental years.

Effort Assessment at 2/3 of Maximum Strength: Consistent with findings from previous studies on boys, girls aged 10 to 12 also demonstrated the most accurate assessment of effort at 2/3 of maximum strength. This result supports the data from Ivashchenko (2018) and Liakh (2000), which suggest that children and adolescents generally excel in evaluating efforts at higher percentages of their maximum strength. This trend underscores the relative stability and reliability of strength assessment at this level.

Differences in Effort Assessment Across Age Groups: Although no significant differences were found between age groups in the overall assessment of strength effort, specific findings highlight notable differences in the way girls assess effort at various levels. For instance, girls aged 10 showed significant differences in effort assessment between 1/3 and 1/2 of maximum strength, and between 1/3 and 2/3 of maximum strength. Similar patterns were observed in the assessments for girls aged 11 and 12. These results align with the notion that while the overall ability to assess strength may be stable, the precision of this assessment can vary across different effort levels and age groups.

The study's results highlight the importance of understanding and developing kinesthetic sensitivity among young girls. The observed patterns emphasize the need for targeted training programs that focus on improving the ability to assess and manage effort at various levels of strength. This aligns with the conclusions of previous studies suggesting that specialized training can enhance motor control and effort assessment abilities, as noted by Farfel (2011).

The findings contribute to the body of research on motor function development, particularly in the context of strength effort assessment. They extend the work of Li, Su, Fu, and Pickett (2015), Brink and Jacobs (2011), and Morash, Pensky, Alfaro, and McKerracher (2012) by providing new insights into how young girls assess strength effort and by underscoring the need for further research in this area. Our study on strength effort assessment in girls aged 10–12 revealed that, similar to the findings by Ivashchenko et al. (2019), there are no significant age-related differences in muscular effort assessment within this age range. Both studies found that the most accurate assessment of effort occurs at 2/3 of maximum strength, reflecting the stability of muscular control at this level. Additionally, neither study observed significant correlations between effort levels at 1/3, 1/2, and 2/3 of maximum strength, suggesting that errors in effort assessment are independent across these intensities. These results underscore the importance of focusing on strength assessment training at 2/3 of maximum strength and highlight the need for targeted interventions to improve effort assessment skills in young girls. By considering the interplay between motor skills, cognitive processes, and academic performance, researchers and educators can gain a more comprehensive understanding of the factors that contribute to the overall development and well-being of students (Carlson et al., 2013; Cameron et al., 2012). Educators must possess the necessary pedagogical competencies to effectively utilize technology in the learning environment, as it can significantly impact student achievement and motivation (Huda, 2019).

Conclusions

The study explored strength effort assessment among girls aged 10, 11, and 12, revealing that age does not significantly influence the ability to gauge effort at 1/3, 1/2, and 2/3 of maximum strength. Across all age groups, the most accurate assessment of effort was observed at 2/3 of maximum strength, indicating a consistent level of performance in this area. Although no significant differences in overall strength assessment were found between age groups, distinct patterns emerged in effort assessment at various levels. Specifically, significant differences in effort assessment were noted between 1/3 and 1/2 of maximum strength, and between 1/3 and 2/3 of maximum strength for girls aged 10, 11, and 12. These findings emphasize the stability of strength assessment capabilities within this age range while highlighting the need for targeted training programs to enhance precision in effort evaluation. The results contribute to a broader understanding of motor function development and underscore the importance of specialized interventions to improve strength effort assessment skills in young girls.

Conflict of Interest

The author declares no conflict of interest.

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Оцінка силових зусиль у дівчат передпідліткового віку: Аспекти точності визначення зусиль на різних порогових рівнях сили

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 6 табл., 33 джерела.

Мета дослідження. Метою цього дослідження було вивчити особливості оцінки силових зусиль у дівчат віком 10, 11 та 12 років. Зокрема, з'ясувати, яким чином у даних вікових групах визначається оцінка зусиль на рівні різних відсотків від максимальної сили (1/3, 1/2 та 2/3).

Матеріали та методи. У дослідженні взяли участь 75 дівчат, розподілених на три вікові групи: 10 років (n = 20), 11 років (n = 25) і 12 років (n = 30). За допомогою динамометра вимірювали максимальну силу кистей рук досліджуваних осіб, а також фіксували їхню здатність оцінювати зусилля на рівні 1/3, 1/2 і 2/3 від цього максимуму.

Результати. Похибка оцінки зусиль була розрахована та проаналізована з використанням t-критеріїв для парних та незалежних вибірок. Статистична значущість була встановлена на рівні α = 0,05. Аналіз не виявив суттєвих пов'язаних з віком відмінностей в оцінці максимальної сили кистей рук або силових зусиль між різними віковими групами. Найточніша оцінка зусиль відбувалася на рівні 2/3 від максимальної сили для всіх вікових груп. Значні відмінності встановлено в оцінці зусиль між 1/3 і 1/2 від максимальної сили, а також між 1/3 і 2/3 від максимальної сили, при цьому покращення показників відзначалося зі збільшенням відсотка зусиль. Однак значних відмінностей між показниками зусиль на рівні 1/2 і 2/3 від максимальної сили не спостерігалося.

Висновки. Дослідження показало, що здатність оцінювати силові зусилля у віковому діапазоні від 10 до 12 років залишається стабільною, а найточніша оцінка відбувається на рівні 2/3 від максимальної сили. Отримані дані вказують на той факт, що незважаючи на незмінний характер загальних здібностей щодо оцінки силових показників, цілеспрямовані тренування можуть підвищити точність визначення на різних рівнях зусиль. Це сприяє розумінню розвитку рухової функції та підкреслює необхідність впровадження інтервенцій з метою поліпшення навичок оцінки зусиль у юних дівчат.

Ключові слова: оцінка силових зусиль, руховий розвиток, юні дівчата, максимальна сила, кінестетична чутливість.

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