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Differences in Flexibility Between Urban and Rural Elementary School Children: A Pilot Study

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Abstract: *Flexibility is an important component of health-related physical fitness in childhood and may be influenced by both biological and environmental factors. The aim of this pilot study was to compare flexibility levels in younger school-aged children attending urban and rural elementary schools and to explore potential sex-related differences. The sample consisted of 60 children aged 6–10 years (30 urban and 30 rural pupils; equal numbers of boys and girls). Flexibility was assessed using five standardized motor tests: Sit and Reach, Shoulder Mobility, Trunk Rotation with Stick, Deep Squat, and Wide Straddle Sit with Elbows on the Floor. An overall flexibility index was calculated as the sum of ordinal scores across all tests. Descriptive statistics, independent samples t-tests, and effect-size analysis (Cohen's d) were applied. Children attending the urban school achieved better results across all assessed flexibility tests. Statistically significant differences were observed in the Sit and Reach Test and the Wide Straddle Sit Test ($p < 0.05$). The largest between-group difference was found for the overall flexibility index (Cohen's $d = 0.95$), indicating better overall flexibility among urban children. Girls demonstrated more favourable flexibility outcomes than boys across all assessed tests. The findings suggest that flexibility outcomes may differ between children attending urban and rural schools; however, due to the pilot nature of the study and the absence of controlled variables, the results should be interpreted with caution.*

Keywords: *flexibility; physical fitness; school-aged children; urban-rural differences; motor performance*

Introduction

Flexibility is commonly considered a component of health-related physical fitness (American College of Sports Medicine, 2021) and an important prerequisite for the effective execution of movement, maintenance of proper posture, and prevention of musculoskeletal disorders. It represents the capacity of joints to move through an optimal range of motion and is influenced by factors such as age, sex, body composition, and level of physical activity. From a health-related perspective, physical fitness in childhood, including flexibility, is increasingly recognized as an important marker of current and future health status (Ortega et al., 2008). Global trends in physical fitness in children have also been documented, indicating changes in fitness levels across populations over time (Tomkinson et al., 2019).

Childhood and early school age represent critical periods for the development of motor abilities. During this stage, growth, maturation, and environmental factors interact to shape physical fitness and movement competence. Research has shown that physical fitness develops dynamically during childhood and adolescence and is influenced by biological as well as behavioral determinants (Armstrong, 2019). At the same time, global evidence indicates that a substantial proportion of children do not meet recommended levels of physical activity, which may negatively affect their physical fitness and overall health (Guthold et al., 2020).

Sex differences in physical fitness are also well documented, with girls generally demonstrating higher flexibility than boys even at younger ages. These differences are often attributed to biological factors such as joint structure, muscle elasticity, and hormonal influences, as well as differences in physical activity patterns. Flexibility, in particular, tends to be higher in girls across childhood and adolescence, which has been consistently reported in both classical and contemporary research (Badrić, 2011; Ortega et al., 2008).

In addition to individual characteristics, the environment in which children live and attend school may influence their physical activity patterns and subsequently their level of physical fitness. Previous research suggests that physical activity in children is shaped by a complex interplay of social, environmental, and behavioral factors (Sallis et al., 2000). Differences between urban and rural environments have been associated with variations in opportunities for structured and unstructured physical activity, access to sports facilities, and lifestyle habits. Furthermore, time spent outdoors has been positively associated with physical activity levels and physical fitness in children (Gray et al., 2015).

Despite the extensive body of literature addressing physical fitness in youth, relatively little attention has been paid specifically to flexibility in relation to school environment. While many studies have focused on overall fitness levels, cardiorespiratory fitness, or physical activity patterns, fewer have examined whether the locality of the school (urban vs. rural) is associated with differences in joint mobility and flexibility in younger school-aged children.

Therefore, the aim of this study was to compare the level of flexibility in younger school-aged children (6–10 years) attending an urban and a rural elementary school in the Czech Republic. Sex-related differences were explored as a secondary objective.

Material & methods

Study design

The study was designed as a cross-sectional quantitative pilot study aimed at comparing flexibility levels in younger school-aged children from two different school environments. The research focused on descriptive and comparative analysis of flexibility outcomes between groups defined by school locality (urban vs. rural).

Participants

The research sample consisted of 60 primary school children aged 6-10 years. The sample included 30 pupils (15 girls and 15 boys) from an urban elementary school located in a town with approximately 25,000 inhabitants and 30 pupils (15 girls and 15 boys) from a rural elementary school situated in a village with approximately 567 inhabitants (Table 1).

Participants were selected using purposive sampling to ensure balanced representation by sex and comparable age distribution between groups. The mean age of the participants was 7.9 ± 1.3 years, with an average body height of 137.2 ± 10 cm and body weight of 31.9 ± 8.6 kg. All participants were reported as healthy and free from acute or chronic musculoskeletal disorders.

Prior to data collection, informed consent was obtained from the parents or legal guardians of all children. The study was conducted in accordance with ethical standards and approved by the Ethics Committee of the Faculty of Education, Charles University. All procedures followed the principles of the Declaration of Helsinki.

Table 1. *Characteristics of Participants*

Variable	Urban school (n=30)	Rural school (n=30)
Age, years (mean± SD)	8.1 ± 1.24	7.8 ± 1.34
Height, cm (mean± SD)	140 ± 10	135 ± 9.61
Weight, kg (mean± SD)	34.4 ± 9.01	29.6 ± 7.57
Girls, n (%)	15 (50.0)	15 (50.0)
Boys, n (%)	15 (50.0)	15 (50.0)

Flexibility assessment

Flexibility was assessed using a battery of five standardized motor tests selected with regard to the age of participants and feasibility within school conditions (Mekota & Novosad, 2005). For each participant, an overall flexibility index was calculated as the sum of scores across all five tests, with lower values indicating better overall flexibility.

The execution of individual tests is illustrated in Figures 1–5.

Sit and Reach Test: measures flexibility of the lower back and hamstrings; results were recorded in centimeters (Figure 1).

Shoulder Mobility Test: assesses shoulder flexibility by measuring the grip width (cm) required to pass a stick behind the back (Figure 2). For the purposes of the overall flexibility index, shoulder mobility performance was classified into a five-point ordinal scale (>4 cm = 1 point; 1-4 cm = 2 points; 0 to -4 cm = 3 points; -5 to -9 cm = 4 points; <-9 cm = 5 points), with lower ordinal scores indicating better flexibility.

Trunk Rotation Test with Stick: assesses trunk and shoulder girdle mobility by measuring the minimum grip width (cm) required to perform a full stick rotation around the body (Figure 3). For the purposes of the overall flexibility index, trunk rotation performance was classified into a five-point ordinal scale (<50 cm = 1 point; 50-59 cm =

2 points; 60-69 cm = 3 points; 70-79 cm = 4 points; >79 cm = 5 points), with lower scores indicating better flexibility.

Deep Squat Test: assesses lower-limb mobility based on the ability to perform a full squat while maintaining heel contact with the floor. Successful performance was assigned 1 point and unsuccessful performance 5 points (Figure 4).

Wide Straddle Sit with Elbows on the Floor: evaluates hip joint flexibility and adductor extensibility based on the ability to touch the floor with the elbows. Successful performance was assigned 1 point and unsuccessful performance 5 points (Figure 5).

Each test was demonstrated by an experienced instructor prior to execution to ensure correct technique. The children performed the tests under standardized conditions during regular physical education lessons, under comparable environmental conditions and at a similar time of day.

Individual test performances were converted into ordinal scores based on predefined performance criteria, where 1 represented the highest level of flexibility and 5 the lowest. The scoring system was applied consistently across all participants.

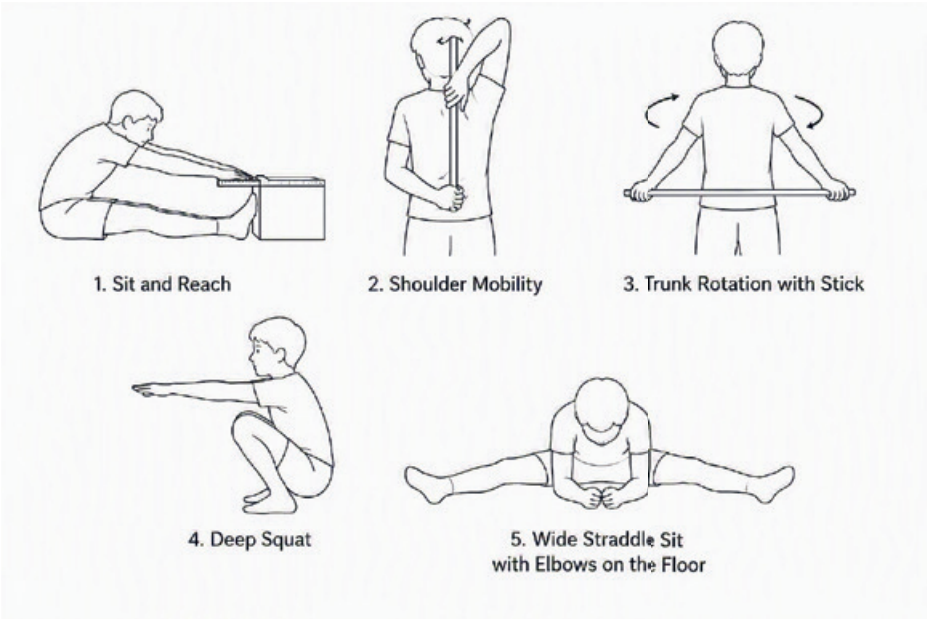

Figure 1. *Battery of five standardized motor tests (Mekota & Novosad, 2005)*

Statistical analysis

Data were processed using descriptive and inferential statistical methods (SPSS). Descriptive statistics included arithmetic mean and standard deviation. The normality of data distribution was verified using the Shapiro-Wilk test.

Differences between groups (urban vs. rural) were evaluated using Student's t-test for independent samples. The level of statistical significance was set at $\alpha = 0.05$. Although the flexibility scores were based on an ordinal scale, parametric tests were applied due to the approximately normal distribution of the aggregated data and for consistency with similar studies. Additional non-parametric analyses (Mann-Whitney test) yielded comparable results and did not alter the interpretation of the findings.

No additional variables such as extracurricular physical activity, socioeconomic background, or detailed characteristics of physical education lessons were controlled within the study design.

Given the pilot nature of the study and the limited sample size, the analysis should be considered primarily descriptive and exploratory. The findings should therefore be interpreted with caution.

Results

The results of the flexibility tests are presented for individual test outcomes and the overall flexibility index. Comparisons are reported between children from urban and rural schools. The results of the flexibility tests are presented in Table 2.

Sit and Reach Test

Children from the urban school achieved an average value of 4.03 ± 6.74 cm in the sit and reach test, whereas children from the rural school achieved -0.10 ± 7.95 cm. The difference between groups was statistically significant ($p < 0.05$) and corresponded to a moderate effect size (Cohen's $d = 0.56$).

Shoulder Mobility Test

In the shoulder mobility test, children from the urban school achieved a mean value of -0.53 ± 6.63 cm, whereas children from the rural school achieved -1.73 ± 6.03 cm. Higher values indicate greater shoulder flexibility. The difference between groups was not statistically significant ($p > 0.05$).

Trunk Rotation Test with Stick

In the trunk rotation test, children from the urban school achieved a mean value of 55.6 ± 13.4 cm, whereas children from the rural school achieved 65.6 ± 12.2 cm. Lower values indicate better flexibility performance. According to the evaluation criteria, urban children demonstrated better trunk and shoulder girdle mobility than rural children. The between-group effect size was moderate to large (Cohen's $d = 0.78$), although the difference did not reach statistical significance ($p > 0.05$).

Deep Squat Test, Wide Straddle Sit with Elbows on the Floor

In the Deep Squat Test, successful performance was observed in 73% of urban children and 47% of rural children. Similarly, in the Wide Straddle Sit Test, 80% of urban children met the assessment criteria compared with 47% of rural children.

Overall Flexibility Index

The overall flexibility index was calculated as the sum of scores across all five tests. Urban children achieved a mean score of 10.30 ± 3.53 points, whereas rural children achieved a mean score of 13.70 ± 3.64 points, indicating better overall flexibility in the urban group. The between-group effect size was large (Cohen's d = 0.95).

Across all tests, girls demonstrated more favourable flexibility outcomes than boys; however, these differences were not analysed as a primary focus of the study.

Table 2. *Flexibility tests performance in urban and rural school children. Values are presented as mean ± SD, median, minimum and maximum values. Cohen's d was calculated using pooled standard deviation. For the Shoulder Mobility Test and Trunk Rotation Test, lower values indicate better flexibility performance. For the Sit and Reach Test, higher values indicate better flexibility performance*

Test		Urban school (n=30)	Rural school (n=30)	Cohen´s d
Sit and Reach (cm)	mean± SD	4.03 ± 6.74	-0.10 ± 7.95	0.56
	median	2.5	2.5	
	min	-12	-22	
	max	19	13	
Shoulder mobility (cm)	mean± SD	-0.53 ± 6.63	-1.73 ± 6.03	0.19
	median	1.5	1	
	min	-23	-20	
	max	8	5	
Trunk rotation with stick (cm)	mean± SD	55.6 ± 13.4	65.6 ± 12.2	0.78
	median	54	64.5	
	min	38	33	
	max	79	92	

Overall flexibility index (points)	mean± SD	10.30 ± 3.53	13.70 ± 3.64	0.95
	median	10	13.5	
	min	5	7	
	max	21	20	

Discussion

The findings indicate that children from the urban school achieved better flexibility outcomes across all assessed tests. The largest difference was observed for the overall flexibility index (Cohen's d = 0.95), indicating a large effect in favour of urban children. Moderate differences were also found in the Trunk Rotation Test with Stick (d = 0.78) and the Sit and Reach Test (d = 0.56). Girls demonstrated higher flexibility levels than boys across all assessed tests.

The present findings suggest that flexibility outcomes may differ between children attending urban and rural schools. Children from the urban school achieved better results across all assessed flexibility tests, with the largest difference observed for the overall flexibility index (Cohen's d = 0.95). Although statistically significant differences were identified only for selected tests, the consistency of the observed pattern across all assessments suggests that the difference was not limited to a single dimension of flexibility. Previous research has shown that children's physical activity behaviour is influenced by a complex interaction of environmental, social, and behavioural determinants (Sallis et al., 2000). Similarly, opportunities for outdoor play and physical activity have been associated with higher levels of physical fitness (Gray et al., 2015). However, because flexibility was the primary outcome of the present study and detailed information regarding physical activity participation was not collected, the mechanisms underlying the observed differences remain unclear.

Although rural environments are frequently perceived as favourable for spontaneous physical activity, the relationship between living environment and physical fitness appears to be more complex. Physical activity alone may not fully explain flexibility development, which is likely influenced by the type, frequency, and specificity of movement experiences. It is therefore possible that differences in participation in organised sports or movement programmes contributed to the observed outcomes. However, these factors were not assessed in the present study and should be considered as possible explanations rather than established causes.

Girls demonstrated more favourable flexibility outcomes than boys across all assessed tests. This observation is consistent with previous findings reporting higher flexibility levels in girls during childhood and adolescence (Badrić, 2011). Differences between sexes have commonly been attributed to anatomical and physiological factors, including differences in joint structure, connective tissue characteristics, and muscle elasticity. The present findings are therefore in agreement with broader evidence showing that sex-related differences in physical fitness components emerge already in early school age (Ortega et al., 2008).

The effect-size analysis suggests that the observed differences were not only statistically detectable but also practically meaningful. The largest effect was found for the overall flexibility index (Cohen's d = 0.95), while moderate effects were observed for the Trunk Rotation Test with Stick (d = 0.78) and the Sit and Reach Test (d = 0.56). These findings indicate a relatively consistent advantage of the urban group across different flexibility assessments despite the limited sample size and exploratory nature of the study.

The present findings should be interpreted in the context of several limitations. First, the study was conducted with a relatively small sample of children from only two schools, which limits the generalizability of the results. In addition, the inclusion of only one urban and one rural school limits the external validity of the findings and prevents broader generalization to urban and rural child populations. Second, the study design did not include control of potentially important variables such as extracurricular physical activity, socioeconomic background, or the content and quality of physical education. These factors may have influenced the observed differences between groups. Third, flexibility was assessed using a set of field-based tests evaluated on an ordinal scale, which, although practical for school conditions, may limit the precision of measurement. Finally, the cross-sectional and pilot nature of the study does not allow for causal interpretation of the findings.

Despite these limitations, the study provides an initial contribution to the understanding of flexibility differences in younger school-aged children in relation to school environment. The results highlight that differences in flexibility may exist even within relatively small and homogeneous populations and emphasize the importance of considering

contextual factors when evaluating motor abilities in children. Further research with larger and more diverse samples, as well as with more comprehensive assessment of physical activity and environmental variables, is needed to better understand the determinants of flexibility in this age group.

Conclusions

The present pilot study examined differences in flexibility between younger school-aged children attending urban and rural elementary schools and explored potential sex-related differences. Children from the urban school achieved better results across all assessed flexibility tests, with statistically significant differences observed in the Sit and Reach Test and the Wide Straddle Sit Test. In addition, girls demonstrated more favourable flexibility outcomes than boys across all assessed tests.

The most pronounced difference between groups was observed for the overall flexibility index, which showed a large effect size (Cohen's d = 0.95), indicating better overall flexibility among children attending the urban school. These findings suggest that flexibility outcomes may be associated with environmental and contextual factors related to the school setting. However, due to the pilot and exploratory nature of the study, the small sample size, and the absence of controlled variables, the findings should not be interpreted as evidence of a causal relationship.

The study contributes to the limited body of research addressing flexibility in younger school-aged children in relation to school locality and highlights the potential importance of contextual influences on flexibility development. Future research should include larger and more diverse samples and incorporate additional variables, such as physical activity participation, socioeconomic factors, and characteristics of school physical education, to provide a more comprehensive understanding of the determinants of flexibility in this age group.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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