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DIFFERENCES IN ANTHROPOMETRIC CHARACTERISTICS AND MOTOR ABILITIES IN CHILDREN WITH NORMAL AND DEVIATED POSTURAL ALIGNMENT IN THE SAGITTAL PLANE

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Abstract
Modern lifestyle habits, including increasingly prevalent physical inactivity among children, contribute to the development of postural disorders and muscular imbalances, which may negatively affect motor performaAlence. The aim of this study was to examine the differences in anthropometric characteristics and motor abilities between children with normal and deviated postural alignment in the sagittal plane (kyphotic and lordotic posture), with emphasis on the strength of the paravertebral muscles and upper limbs. The study included 34 children aged 7 to 14 years, divided into two groups: children with normal posture (N=16) and those with postural deviations (N=18). Postural status was assessed using the Spinal Mouse system, while muscular strength and endurance were evaluated using handgrip dynamometry and motor tests including the frontal and lateral plank, as well as the Biering-Sørensen test for lumbar endurance. Descriptive and inferential statistics were applied. Results indicated that, although no statistically significant differences were found in any of the variables, children with normal posture demonstrated higher values across all motor tests. These findings suggest a potential link between proper postural alignment and greater muscular strength and endurance. The results align with previous research emphasizing the importance of trunk muscle strength for stable postural control. The conclusion highlights the need for early diagnosis and corrective interventions in children with postural deviations, especially during the period of most intensive growth—adolescence.

Key words: *posture, muscle strength, motor abilities, postural status, anthropometric characteristics*

Introduction

Modern social and technological factors have caused significant changes in children's lifestyles, often resulting in reduced levels of physical activity and an increased prevalence of postural disorders. Impaired postural status in children represents a serious health challenge with potential long-term consequences in adulthood, including musculoskeletal pain, reduced respiratory function, and various psychological effects (Johanson, 2012; Bubanj et al., 2012). Additionally, the strength of the upper limb musculature plays an important role in supporting and stabilizing the body's posture (Grissafi, 2007). This study focuses on analyzing the differences in anthropometric characteristics and motor abilities among children with normal and deviated postural alignment in the sagittal plane (specifically kyphotic and lordotic poor posture).

Literature sources show a positive association between the effects of physical activity and the overall health status of children and adolescents. Bouchard (1994) suggests that physical fitness is closely related to health, understood as a broader set of physical, psychological, and physiological attributes that an individual possesses at a given point in life.

In contemporary conditions, where physical inactivity and technological dependence are increasingly recognized as risk factors for proper growth and development, it is essential to study the effects of postural deviations on motor abilities in children. A study conducted on a sample of 1,120 children aged 7 to 12 years from the municipality of Knjaževac (Bubanj et al., 2021) confirmed high rates of scoliosis, hyperlordosis, and kyphosis, with deformities most commonly related to the feet and spinal column. These findings are in direct correlation with the direction of the present study, which focuses on comparing anthropometric characteristics and motor abilities in children with and without postural deformities. Similar to the Knjaževac study, our research employed functional tests for trunk and hand strength, as well as assessments using the Spinal Mouse device, revealing comparable patterns of association between improper posture and reduced muscular function. The specific configuration of the musculoskeletal system in children during phases of intensive growth requires early identification of deformities and targeted interventions a goal shared by both studies.

Recent research increasingly indicates that body posture is not solely determined by orthopedic structure, but rather by the functional condition of the musculature, particularly during the critical stages of growth and development in children. Postural deviations such as kyphosis, lordosis, and scoliosis are frequently observed among elementary school students and are most often caused by muscular imbalance, insufficient physical activity, and non-functional daily habits (Brusa et al., 2020). Early identification of muscular deficits represents a significant parameter for predicting the risk of developing such disorders. In this regard, maximal isometric handgrip strength is recognized as a widely accepted indicator of overall musculoskeletal function and is commonly used as a reliable marker of muscular weakness and disability in both children and adolescents (Brusa et al., 2020; Ortega et al., 2008).

Handgrip strength is a validated method that correlates with overall muscular strength and postural stability, and is typically assessed using a dynamometric test under controlled conditions. Research indicates that this variable serves as a predictive factor for the early identification of muscular deficits, which may negatively impact body stability control and postural alignment. In a comparative study involving children with congenital hypothyroidism (CH), although no statistically significant differences in handgrip strength were observed between the groups, notable impairments in stability and weight distribution were reported. These findings indirectly suggest compromised postural control (Brusa et al., 2020).

The musculature of the trunk represents a fundamental component in maintaining postural stability and ensuring the optimal transmission of forces throughout the kinetic chain. As emphasized by Rivera (2016), the functional integration and strength of these muscles enable efficient transfer of muscular force from the lower extremities to the torso, which constitutes a critical prerequisite for effective motor performance and biomechanical balance. Weak or insufficiently coordinated activation of this musculature not only compromises postural control but also leads to rapid onset of fatigue and a reduction in both static and dynamic endurance, thereby potentially increasing the body’s susceptibility to postural impairments or injuries.

All of these insights confirm the relevance of handgrip strength and trunk muscle endurance as indirect markers for early diagnosis and intervention in children with and without postural deviations in the sagittal plane. Our research, which focuses on motor abilities in children with and without postural disorders during the juvenile and adolescent phases, aims—precisely through these parameters—to identify potential biomechanical differences and provide evidence in support of systematic prevention through physical activity and targeted intervention.

Materials and methods

The sample of participants consisted of children aged 7 to 14 years, based on their chronological age. The testing was conducted at the “Sky Wellness” swimming center in Skopje. In order to achieve the defined aims and objectives of the research, and with the goal of assessing the postural status of the spinal column in the sagittal plane, the “Spinal Mouse” method was employed (Idiag, Fehraltdorf, Switzerland, www.idiag.ch). This method is classified as a non-invasive diagnostic technique for evaluating the postural alignment of the spine. The validity of the instrument has been confirmed through prior studies conducted by Mannion et al., (2004).

Within the framework of the research, the assessment of participants’ postural status included a classification into two primary groups. The first group comprised children with normal spinal alignment in the sagittal plane (NSP – Normal Sagittal Spinal Posture) (N=16), while the second group included participants who were found to have deviations from normal postural alignment in the sagittal plane (DNSP – Deviated Normal Sagittal Spinal Posture) (N=18).

To obtain a more detailed picture of their anthropometric characteristics, standardized anthropometric variables were applied, including body height (H) [Norton, K. I. (2018)], body weight (W) [Willett, W., & Hu, F. (1998)], as well as the calculation of the body mass index (BMI) [Frankenfield, D. C. et al., (2001)]. The measurements of these variables were conducted in accordance with the standards of the International Biological Program.

Specific motor tests were also used to assess muscular strength and endurance, particularly in the region of the upper extremities and the trunk. The static strength of the hand muscles was measured using a hand dynamometer, which provides an objective measurement of the maximum grip strength (HGS). To assess the endurance of the trunk flexors, the frontal plank test (FP) was used; lateral muscular endurance was analyzed through the lateral plank test (LP), conducted separately for the right (LP_R) and left (LP_L) sides. For the evaluation of the static strength of the lumbar extensors, the Biering–Sørensen test (BST) was applied. Each of these tests has been validated and adapted for the population of children and adolescents. The measurements in this study were conducted in accordance with the Declaration of Helsinki from 2008 and the ethical principles for research involving human subjects (World Medical Association,2011).

Results

Table 1. Basic statistical indicators of the anthropometric and motor variables in participants with normal body posture (NSP) (N=16)

Variables	N	X	SD	Min.	Max.	Skj.	Kurt.
H	16	143,81	19,11	119,50	178,00	-,028)	-,739)
W	16	40,18	17,61	19,00	86,20	,352	-,759)
BMI	16	18,77	5,50	13,31	36,82	1,264	1,843
HGS_R	16	144,00	89,28	44,00	324,00	2,532	8,038
HGS_L	16	124,87	91,20	34,00	324,00	,894	-,293)
FP	16	99,06	58,36	17,41	183,61	1,016	,071
LP_R	16	46,70	36,32	4,54	108,14	,164	-1,455)
LP_L	16	36,34	91,20	4,54	51,32	,377	-1,334)
BST	16	38,63	19,11	12,73	69,12	,397	-,256

Table 2. Basic statistical indicators of the anthropometric and motor variables in participants with deviations from normal body posture (DNSP) (N=18)

Variables	N	X	SD	Min.	Max.	Skj.	Kurt.
H	18	141,71	13,28	125,00	164,00	,39	-,52)
W	18	37,03	11,82	22.00	70,40	,44	-1,25)
BMI	18	18,05	3,31	13,70	26,17	1,20	2,51
HGS_R	18	118,38	50,35	39,00	208,00	,82	,45
HGS_L	18	106,77	42,84	52,00	298,00	,28	-,56)
FP	18	68,56	34,86	7,54	151,29	,74	-,33)
LP_R	18	39,34	22,28	9,01	78,87	,44	,52
LP_L	18	35,62	17,01	9,61	57,15	,36	-1,05)
BST	18	32,04	11,72	21,52	43,11	-,20)	-1,08)

Table 3. T-test differences in anthropometric characteristics and motor abilities between children with normal body posture (NSP) (N=16) and those with deviations from normal body posture (DNSP) (N=18)

Variables	NSP. X	NSP. SD	DNSP. X	DNSP. SD	T- test	p
H	143,81	19,11	141,71	13,28	,37	,71
W	40,18	17,61	37,03	11,82	,61	,54
BMI	18,77	5,50	18,05	3,31	,46	,64
HGS_R	144,00	89,28	118,38	50,35	1,04	,30
HGS_L	124,87	91,20	106,77	42,84	,75	,45
FP	99,06	58,36	68,56	34,86	1,87	,07
LP_R	46,70	36,32	39,34	22,28	,72	,47
LP_L	36,34	91,20	35,62	17,01	,09	,92
BST	38,63	19,11	32,04	11,72	-,87)	,38

Discussion

Based on the obtained results presented in Tables 1, 2, and 3, it can be observed that there is no statistically significant difference in any of the applied variables. On the other hand, it is evident that participants with normal body posture demonstrate better results in all 9 applied anthropometric and motor tests. From a methodological point of view, this is highly significant, as it indicates a systemic difference that can be defined as a combined influence of two or more factors (variables) which cannot be measured through this type of univariate differences [Bala, G. (1990)].

In this context, our results can be compared with the findings of Bubanj et al. (2021), where children with impaired postural status exhibited reduced body stability and asymmetrical load distribution, which affects motor performance. Additionally, chronic poor posture may lead to compensatory mechanisms and muscle spasm (Johanson, 2012), which further decrease the functionality of the musculature. These findings emphasize the need for early diagnosis and the implementation of corrective exercise programs, particularly during the period of most intensive growth and development—adolescence.

The evident trend emerging from the analysis of the obtained results indicates that children with proper postural alignment generally demonstrate higher performance in motor tests, particularly in those measuring trunk muscle endurance. Although in most of the analyzed tests the differences between children with and without postural deviations do not reach the level of statistical significance, all values consistently tend to support the hypothesis that optimal body alignment is associated with better motor abilities. This aligns with the findings of Rivera (2016), who emphasizes that the strength and stability of trunk musculature are crucial not only for maintaining good posture but also for the efficient and economical execution of both daily and sports-related movements. Our research also partially corresponds with the study by Brusa (2020), who points out that grip strength may serve as an indirect predictor of general muscular weakness, which, if present, can lead to muscular deficits and an increased risk of postural imbalance or reduced muscular strength in the upper extremities—factors that may contribute to poor body posture or structural impairments.

Conclusion

Based on the obtained results, it can be concluded that there is a clear relationship between proper postural alignment in the sagittal plane and improved motor performance in children, particularly in tests measuring the endurance of the paravertebral musculature. Although the differences were not statistically significant, the overall tendency indicates superior results among children with normal body posture. Impaired posture is associated with functional limitations, asymmetries, and muscular compensatory mechanisms. This highlights the need for and importance of early intervention through corrective programs. The evaluation of postural status and muscular endurance should become a regular part of motor assessments in children.

It is clear that the small number of participants and variables represents a limitation in this study, which in the future should be conducted on a larger sample size and with a greater number of tests and methods. Particularly useful would be the application of a discriminant method, in which orthogonal factors within the space of the applied variables would be isolated in order to reveal group differences within that space [Bala, G. (1990)].

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