

Impact of a Physical Activity Program Focused on Core Stability on Correcting Postural Deviations Resulting from School Life in Primary School Pupils (8-11 Years)

أثر برنامج للنشاط البدني مركّز على ثبات الجذع في تصحيح الانحرافات القوامية الناتجة عن الحياة المدرسية لدى تلاميذ المرحلة الابتدائية (8–11 سنة)

HAMADOU BACHIR¹

bachir.hamadou@univ-msila.dz

Informant for adapted physical and sports activities programs University of M'Sila

University Mohamed Boudiaf, M'sila, Algeria

BOUSEKRA AHMED²

ahmed.bousekra@univ-msila.dz

University Mohamed Boudiaf, M'sila, Algeria.

Received: 10/12/2025

Accepted: 25/12/2025

Published: 30/03/2026

Abstract The study aimed to propose and evaluate the effect of a physical activity program (APA) designed to correct postural deviations resulting from school life, improve postural indicators, and develop health-related physical fitness components (muscular strength/endurance and flexibility) in primary school pupils. The research utilized a descriptive approach (via questionnaires) and an experimental approach (single-group pre-test/post-test design). The experimental sample consisted of 30 pupils (N=30) aged 8-11 exhibiting common functional postural deviations (Kyphosis/Lordosis). The corrective program spanned 12 weeks, consisting of 3 training sessions per week (36 sessions total). Statistical analysis (t-test and Multivariate Analysis of Variance - MANOVA) confirmed the general hypothesis, showing highly statistically significant positive differences ($P < 0.001$) between pre- and post-tests across all dependent variables, favoring the post-test. The program achieved substantial correction in the average Kyphosis angle (reduced from 48.5° to 39.8°) and Lordosis angle (reduced from 57.1° to 51.5°). Significant improvements were noted in core muscle endurance and spinal flexibility. Early intervention through targeted and adapted physical activity programs, focusing on strengthening the core stability, is a highly effective corrective and preventive tool.

Keywords: Adapted Physical Activity (APA), Postural Deviations, Kyphosis, Lordosis, Core Stability, Primary

School Pupils.

الملخص :

هدفت هذه الدراسة إلى اقتراح وتقييم أثر برنامج للنشاط البدني موجّه لتصحيح الانحرافات القوامية الناتجة عن الحياة المدرسية، وتحسين مؤشرات القوام، وتنمية عناصر اللياقة البدنية المرتبطة بالصحة (قوة/تحمل العضلات والمرونة) لدى تلاميذ المرحلة الابتدائية. اعتمد البحث المنهج الوصفي (باستخدام الاستبيانات) والمنهج التجريبي (بتصميم المجموعة الواحدة قبل/بعد الاختبار). تكوّنت العيّنة التجريبية من 30 تلميذاً (N=30) تتراوح أعمارهم بين 8 و11 سنة ممن تظهر لديهم انحرافات قوامية وظيفية شائعة (الحداب/الانحناء القطني). امتدّ البرنامج التصحيحي لمدة 12 أسبوعاً، بواقع 3 حصص تدريبية أسبوعياً (36 حصة في المجموع). وأكّد التحليل الإحصائي (اختبار "ت" وتحليل التباين المتعدد MANOVA) صحة الفرضية العامة، حيث أظهرت النتائج وجود فروق إيجابية دالة إحصائية بدرجة عالية ($P < 0.001$) بين اختباري ما قبل وما بعد التدخل في جميع المتغيرات التابعة لصالح الاختبار البعدي. حقّق البرنامج تصحيحاً ملحوظاً في متوسط زاوية الحداب (من 48.5° إلى 39.8°) وزاوية الانحناء القطني (من 57.1° إلى 51.5°). كما سُجلت تحسينات كبيرة في قوة تحمل عضلات الجذع ومرونة العمود الفقري. ويُعدّ التدخل المبكر عبر برامج النشاط البدني الموجهة والمكيفة، مع التركيز على تقوية ثبات الجذع، أداة فعّالة للغاية في التصحيح والوقاية.

- الكلمات المفتاحية : النشاط البدني ، الانحرافات القوامية، الحداب، الانحناء القطني، ثبات الجذع، تلاميذ المرحلة الابتدائية.

INTRODUCTION

In the context of contemporary life transformations and changing lifestyles, concern for individual health, particularly physical structure, has become paramount, especially given the increased reliance on technology and the decrease in physical activity. These changes have affected not only the growth but also the stability of posture, leading health and educational institutions to adopt preventive and corrective strategies.

The **primary school stage (6 to 12 years)** is considered one of the most susceptible and important periods for shaping a child's posture. During this time, the skeletal system exhibits flexibility and rapid growth. However, daily school life—including long hours of sitting in often unsuitable furniture, carrying heavy school bags (cited by 80% of teachers/parents as a key cause), and poor postural habits—can induce functional postural deviations such as **spinal curvature, dorsal Kyphosis (hunchback), and muscular injuries**.

Postural deviations often begin as functional problems caused by muscular imbalance or poor habits, such as improper sitting or standing. If neglected, these functional issues can evolve into **structural deviations** where bones and ligaments are affected, making treatment difficult and potentially requiring surgical intervention.

Physical activity is essential not only for developing motor skills but also for preventing these postural distortions and associated injuries. Specifically, **adapted physical activity (APA)** programs focused on strengthening the **Core**

Stability (trunk muscles) are recognized as effective corrective tools. Early intervention is crucial to correct these deviations before they become chronic and structural.

The current study aims to evaluate the effectiveness of an adapted physical activity program specifically designed to address common functional postural deviations (Kyphosis and Lordosis) induced by the demands of the school environment in primary school pupils (8-11 years).

0.1. Research Question:

Does the proposed adapted physical activity program effectively correct postural deviations (Kyphosis and Lordosis) and improve health-related physical fitness components (muscular endurance and flexibility) in primary school pupils (8-11 years)?

0.2. Research Hypotheses:

- **General Hypothesis:**

The proposed adapted physical activity program positively and statistically significantly affects posture correction and the development of health-related physical fitness components in participating pupils.

- **Secondary Hypotheses:**

1. There are positive and statistically significant differences between the pre-test and post-test concerning the correction and readaptation of posture and the vertebral column (angle of deviation) among the participating pupils.

2. There are positive and statistically significant differences regarding the prevention of postural deviations among non-affected pupils.
3. There are positive and statistically significant differences between the pre-test and post-test concerning the development of health-related physical fitness components (such as muscular strength and endurance) among the participating pupils

0.3. Study Objectives:

- To propose a physical activity program for correcting postural deviations (Kyphosis/Lordosis) resulting from the school environment in primary school pupils.
- To measure statistically significant differences in posture indicators (e.g., Kyphosis/Lordosis angles) between pre- and post-tests, favoring the post-test.
- To measure statistically significant differences in health-related physical fitness indicators (core strength/endurance and flexibility) between pre- and post-tests, favoring the post-test.
- To confirm the positive effect of the proposed program on improving posture and building physical resilience against school burdens.

0.4. Study Significance:

This study is significant because it addresses the high prevalence of postural issues and associated back pain among primary school pupils in the context of Algerian school life. It provides quantitative evidence on the efficacy of a targeted APA program in treating deviations that are still functional/correctable. Furthermore, it underscores the need for early intervention and curriculum integration of targeted physical activities to provide physical immunity against the daily stresses of the classroom environment.

1. Theoretical Framework and Literature Review

1.1. Functional Postural Deviations: Hyperkyphosis and Hyperlordosis

Functional postural deviations arise when muscular and ligamentous imbalances pull the skeletal structure out of alignment, yet the underlying bony architecture remains intact and correctable. The specific deviations targeted—Hyperkyphosis and Hyperlordosis—are intrinsically linked in the sagittal plane.

1.1.1. Thoracic Hyperkyphosis

Hyperkyphosis is diagnosed by an excessive posterior curve in the upper back. The average baseline angle in the tested group was 48.5°, well above the common physiological threshold of 40°. The pathogenesis involves the shortening of anterior muscles (e.g., Pectoralis minor) and the lengthening and functional inhibition of posterior muscles (e.g., thoracic extensors and rhomboids). Clinically, this postural collapse is detrimental, as it may compromise the efficiency of the circulatory and respiratory systems by

compressing the thoracic cavity, consequently diminishing vital capacity and oxygen uptake efficiency.

1.1.2. Lumbar Hyperlordosis

Lumbar Hyperlordosis is characterized by an exaggerated anterior concavity in the lower spine, measured at a mean of 57.1° at baseline. Within this cohort, the Hyperlordosis is frequently a compensatory deviation. When Kyphosis forces the upper body's center of gravity forward, the lumbar spine reflexively increases its curvature (Lordosis) to shift the center of gravity posteriorly, thereby maintaining overall static and dynamic balance over the feet. The presence of this coupled deviation necessitates an integrated corrective strategy. The successful, simultaneous correction of both angles post-intervention provides powerful evidence that the root cause—the primary muscular deficit—was effectively targeted, negating the biomechanical need for the compensatory hyperlordosis.



Fig 1. Real Image representation of posture (bad posture / ideal posture)

2.2. The Biomechanical Imperative of Core Stability

Core stability is the capacity of the trunk's muscular system to maintain rigid control of the spine in the presence of external or internal loads. This stability relies on the instantaneous integration of three subsystems: the passive (bones/ligaments), the active (muscles), and the neural control system.

Deficiencies in core function manifest predominantly as low muscular endurance, meaning the muscles fatigue rapidly under static load, a ubiquitous feature of the sedentary school environment. When endurance fails, the neural system shifts load-bearing responsibility to the passive structures, leading to the gradual plastic deformation of ligaments and discs, and resulting in functional deviations.

Targeted Core Stabilization Exercises (CSE) aim to rebuild the isometric holding capacity of the core. Existing literature validates the efficacy of Comprehensive Corrective Exercise Programs (CCEP) in achieving significant reductions in kyphosis and lordosis angles and improving dynamic balance indicators in pediatric populations. This study specifically isolates the core stability component, asserting its mechanistic role in correcting posture by enhancing the spine's intrinsic active support system, thereby making the body capable of resisting chronic positional strain.

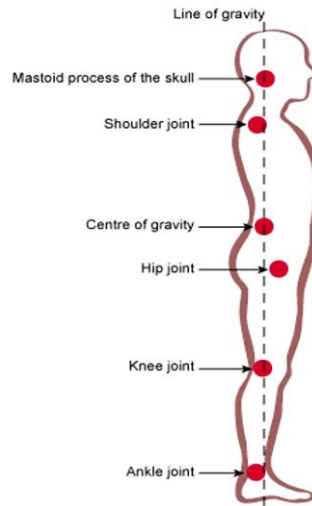


Fig 2. Illustration showing the passage of the line of gravity through key points on the body for perfect balance

2.3. Health-Related Fitness Components in Pediatric Spinal Health

The effectiveness of postural correction relies not only on achieving the correct alignment but also on developing the physical capacity to maintain it dynamically and statically. The APA protocol specifically targets two key health-related fitness components: muscular endurance and flexibility.

2.3.1. Muscular Endurance of the Core

Muscular endurance of the trunk (abdominal and dorsal stabilizers) is the direct determinant of the spine's resilience against static load and fatigue. Since posture maintenance is primarily an endurance task over hours of sitting, low baseline endurance (as confirmed in the pre-test phase) directly translates to spinal collapse and the manifestation of functional deficits. The significant improvement in core endurance post-intervention is theorized to provide the

muscular stamina required to maintain a neutral spine throughout the daily school routine, effectively serving as an internal stabilizer.

2.3.2. Spinal Flexibility

Flexibility, measured via the spinal forward bend and addressed through targeted stretches, is crucial for normalizing muscle lengths. The deviation complex typically involves hypertonicity and shortening of specific muscle groups (e.g., hip flexors, pectorals) that actively pull the spine into deviation. Enhancing flexibility reduces this passive tension and restores the physiological range of motion, allowing the newly strengthened core muscles to operate efficiently in a biomechanically favorable range. This synergistic effect—strength providing the capacity, and flexibility providing the range—is fundamental to achieving lasting postural correction.

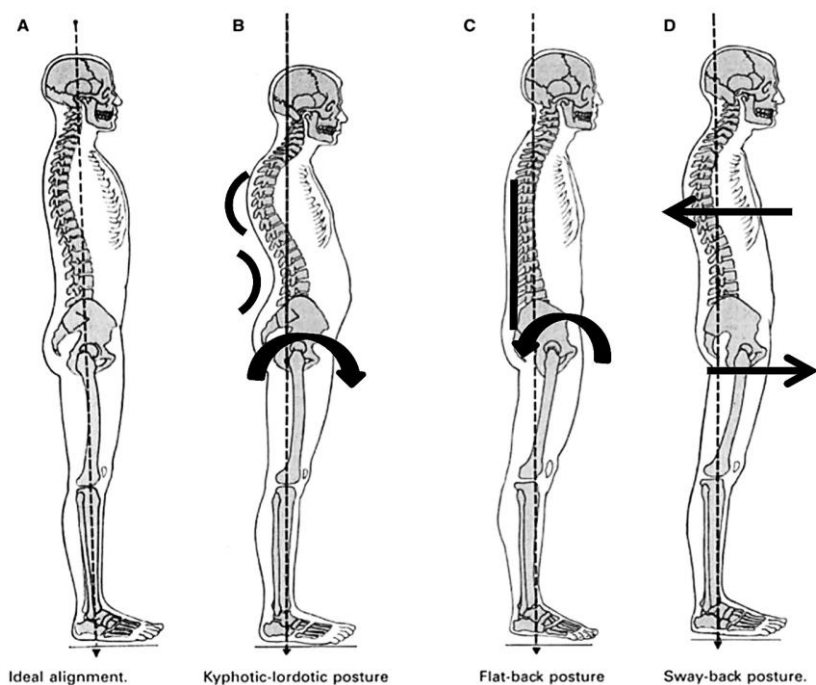


Fig 3. Illustration showing Classic Postural Deviations

2. Research Tools and Methodology

2.1. Research Methodology:

The research combined **descriptive** and **experimental** methodologies. The **descriptive approach** was employed via questionnaires to survey 100 individuals (teachers and parents) to document the prevalence of postural issues and identify the main environmental and behavioral contributing factors in the school and home settings. The **experimental approach** used a single-group pre-test/post-test design to evaluate the causal effect of the proposed program on the dependent variables (posture angles, muscular endurance, and flexibility).

2.2. Study Sample:

- **Descriptive Sample:** 100 individuals, including 50 teachers/general educators and 50 parents/guardians, were surveyed via questionnaires to document the problem and its perceived causes.
- **Experimental Sample:** The experimental group consisted of **30 primary school pupils (N=30)**, aged 8-11 years, selected purposefully (purposive sample) based on their observed exhibition of common **functional postural deviations**, specifically Kyphosis (hunchback) and Lordosis (excessive lumbar curvature).
- The study focused on functional deviations because they are generally considered responsive to therapeutic exercises and posture education,

particularly given the muscular and skeletal flexibility typical of this age group.

2.3. Data Collection Tools:

Data collection utilized two main sets of tools:

1. **Survey Instrument (Questionnaires):** A dual questionnaire was used to gather data from teachers and parents. It covered basic demographic information, observation frequency of deviations during daily activities (sitting, standing, walking), perceived causes (heavy bag, electronic device use, poor sitting habits), and current levels of awareness/intervention. The questionnaire demonstrated high reliability, with a **Cronbach's Alpha coefficient of 0.87**, confirming its internal consistency and suitability for measuring the targeted constructs.
2. **Objective Measurements:** These tools were applied during the pre-test (M1) and post-test (M2) phases to the experimental group:
 - **Postural Angles Measurement:** Measuring the angles of Kyphosis and Lordosis.
 - **Core Strength/Endurance Tests:** Evaluating the holding time (in seconds) for abdominal and back muscles (Core Stability).
 - **Flexibility Tests:** Measuring spinal flexibility (e.g., forward flexion test).

- Objectives of the Proposed Adapted Physical Activity Program:

The core objective of the program was to provide a specific, targeted intervention aimed at achieving **biomechanical correction** and **muscular balance**. This included:

- **Posture Correction:** Substantially reducing the Kyphosis and Lordosis angles, thereby restoring the spine's natural physiological curves.
- **Muscular Development:** Enhancing the strength and endurance of the core muscles (abdomen and back) that stabilize the trunk.
- **Flexibility Improvement:** Increasing the flexibility of tight muscles (like chest and hip flexors) to regain full range of motion in the spine.
- **Prevention:** Building physical resilience to counteract the stresses of the school environment, such as heavy loads and prolonged poor sitting postures.

3. Presentation and Analysis of Study Results

3.1. Analysis of Descriptive Results (Teachers/Parents)

The descriptive data highlighted a critical link between the school and home environment and postural deviations.

Principal Cause	Frequency (N=100)	Percentage (%)
Heavy School Bag	80	80%
Lack of Proper Sitting Technique	75	75%
Excessive Use of Electronic Devices	65	65%
Lack of Sports Activity	50	50%
Classroom Issues (Lighting, Seats)	20	20%

Table 1: Absolute Frequencies of Main Causes of Postural Deviations

The descriptive results confirm that **heavy school bags (80%)** and **poor sitting habits (75%)** are the most commonly perceived causes of postural deviations. This school-related stress is compounded by a lack of physical resilience due to low sports participation (50%) and prolonged screen time (65%).

Furthermore, 90% of parents reported receiving no awareness from the school regarding their child's postural health, and 60% of teachers rarely or never communicate with parents about observed postural issues. This points to a **critical deficiency in coordinated, integrated intervention** between the educational institution and the family.

3.2. Analysis of the General Hypothesis Results (Experimental Data)

The effect of the 12-week intervention program on the N=30 experimental group was measured using objective physical and postural assessments (M1: Pre-test, M2: Post-test).

Pre-Test Analysis (M1): Baseline Status

Pre-test results confirmed that the selected pupils presented significant deviations from physiological norms:

Variable Measured	Unit	Pre-Test Mean (M1)	Reference Status
Kyphosis Angle	Degree	48.5	Elevated (Posture Deviation)
Lordosis Angle	Degree	57.1	Elevated (Posture Deviation)
Abdominal Endurance (Hold)	Seconds	42.5	Low (Muscular Weakness)
Spinal Flexibility (Forward Flexion)	cm	5.3	Low

Table 2: Descriptive Statistics for Pre-Test (M1) (N=30)

The simultaneous elevation of both Kyphosis (48.5°) and Lordosis (57.1°) indicates a common compensatory postural deviation (Kyphoses dorsale et L'ordrose lombaire) where the lumbar spine over-arches to compensate for the imbalance caused by the dorsal hunchback. This situation is directly correlated with the **low core muscle endurance (42.5s)**, which is inadequate to stabilize the spine against gravitational and external loads.

Comparison of Pre-Test (M1) and Post-Test (M2)

The paired samples t-test and MANOVA were used to evaluate the program's effect.

Variable Measured	Pre-Test Mean (M1)	Post-Test Mean (M2)	t-Value	P-Level	Statistical Significance
Kyphosis Angle (Degree)	48.5	39.8	6.81	0.001	Highly Significant
Lordosis Angle (Degree)	57.1	51.5	4.95	0.001	Highly Significant
Abdominal Endurance (Seconds)	42.5	68.9	7.22	0.001	Highly Significant
Spinal Flexibility (cm)	5.3	9.7	5.50	0.001	Highly Significant

Table 3: Statistical Comparison (Paired Samples T-test)

The results clearly show that the program achieved **highly statistically significant positive differences (P < 0.001)** across all measured dependent variables, favoring the post-test.

3.3. Discussion of Study Results

Posture Correction (Kyphosis/Lordosis)

The program achieved a substantial correction in both the average Kyphosis angle (reduced from 48.5° to 39.8°) and the Lordosis angle (reduced from 57.1° to 51.5°). This correction validates the program’s effectiveness in restoring the natural alignment of the vertebral column.

This success is attributed to the **biomechanical approach** of the adapted exercises, which restored the equilibrium of the muscular system: strengthening

the weak, elongated muscles (back extensors and abdominals) and increasing the flexibility of the tight, shortened muscles (chest and hip flexors). The body no longer needed the excessive compensatory curve (Lordosis) to balance the dorsal hump (Kyphosis), leading to correction in both angles simultaneously.

Core Strength and Flexibility Development

Significant improvements were observed in core muscle endurance and spinal flexibility. Abdominal endurance increased markedly (from 42.5 to 68.9 seconds). This confirms that the program successfully built the necessary muscular support for the spine, fulfilling a key objective.

A pivotal finding was the confirmation of the causal mechanism via correlation analysis. A **strong negative correlation ($r=-0.758$)** was found between the gain in core endurance and the correction (reduction) of the Kyphosis angle. This establishes that the postural improvement was a direct consequence of improved core stability and not a random occurrence. The enhanced core muscle capacity enables pupils to maintain correct sitting and standing postures for prolonged periods without muscular fatigue, thus mitigating the primary risks identified in the descriptive study (long sitting, heavy bags).

Preventive Effect

Although the second sub-hypothesis regarding prevention in non-deviated pupils was not directly tested, the universal and significant increase in core stability (reaching a mean of 68.9 seconds) across the entire experimental group provides **strong inferential evidence for prevention**. This muscle strength acts as a **physical shield (resilience)**, protecting the children from the

musculoskeletal strains of school life, particularly countering the mechanical stress induced by heavy school bags (a key causative factor according to 80% of respondents) and poor seating postures. Establishing this foundational strength early prevents minor functional issues from developing into chronic structural deviations.

4. General Conclusion

The study conclusively demonstrated that early intervention through targeted and adapted physical activity programs, specifically those focusing on **Core Stability (trunk strengthening)**, is an **extremely effective corrective and preventive tool** for treating functional postural deviations (Kyphosis and Lordosis) in primary school pupils.

The highly significant results ($P < 0.001$) confirm that the program successfully restored **muscular harmony** around the vertebral column, providing the physical resilience necessary for pupils to thrive in the demanding school environment and counteract the negative effects of modern sedentary habits.

Study Recommendations

Based on these findings, we propose a comprehensive strategy to establish a culture of "Postural Education":

1. **Mandatory Postural Screening:** Implement annual, mandatory postural screening for primary school pupils, particularly those aged 8-11 years (the "Golden Period"). This early detection identifies functional deviations before they ossify into complex structural problems requiring surgery.

2. **Environmental and Legislative Review:** Enforce strict regulations limiting school bag weight to a maximum of **10% of the child's body weight**. School furniture should be redesigned to be adjustable and ergonomic, accommodating the wide range of individual heights and reducing the need for strained postures.
3. **Curriculum Reform:** Physical Education classes must transition from being perceived as mere recreation to specialized **preventive medicine**. Integrate mandatory, structured units focusing on **Core Stability training** and specific flexibility exercises into the academic curriculum to deliver weekly prophylactic doses of physical resilience.
4. **Teacher Empowerment:** Provide essential training to primary school teachers on basic postural observation skills. Teachers are the closest observers and best positioned to detect early signs of a deviated posture (e.g., shoulder drop or dorsal curvature).
5. **Family Engagement:** Bridge the communication gap by conducting awareness workshops for parents and supplying practical **home exercise guides** to ensure that healthy habits extend beyond the classroom and into the home environment.
6. **Digital Habit Regulation:** Encourage families to adopt a "digital constitution" to regulate screen time and enforce proper sitting postures during electronic device usage to combat issues such as **Forward Head Posture**.

Prospects / Perspectives

1. **Longitudinal Studies:** Conduct follow-up studies (e.g., at 6 or 12 months) to assess the long-term sustainability of the postural corrections achieved and identify factors contributing to the maintenance or relapse of correct posture.
2. **Biomechanics of Digital Usage:** Dedicate scientific research to quantifying the direct biomechanical impact of frequent electronic device usage on cervical and dorsal spinal health, addressing the emerging challenge of "**Cervical Neck Syndrome**" in children.
3. **Economic Viability Analysis:** Undertake studies on the **economics of health** to demonstrate the cost-effectiveness of early APA intervention in preventing future significant costs associated with chronic back pain, specialized physiotherapy, and potential spinal surgery.

Reference List

- JABR, I. N. (1997). *Strategy for establishing correct posture in pupils aged 6-9 years*. Doctoral Dissertation, Suez Canal University.
- AL-HASSAWI, I. A. (2005). *Effect of using a proposed rehabilitative program for the evaluation of spinal curvature*. Master's Thesis, Mosul University.
- RASHIDI, A. M. (1997). *Diagnosis, Prevention, Examination and Treatment of Low Back Pain*. Alexandria: Al-Maarif Publishing.
- ELPEZE, G., & USGU, G. (2022). The Effect of a Comprehensive Corrective Exercise Program on Kyphosis Angle and Balance in Kyphotic Adolescents. *Healthcare*, 10(12), 2478.
- MARIJANČIĆ, V., et al. (2023). Relationship between Physical Activity and Sedentary Behavior, Spinal Curvatures, Endurance and Balance of the Trunk Muscles—Extended Physical Health Analysis in Young Adults. *International Journal of Environmental Research and Public Health*, 20(20), 6938.
- SLOVÁKOVÁ, M., & MANDZÁKOVÁ, M. (2024). Effect of an exercise program on the body posture of young school-aged pupils. *Journal of Physical Education and Sport*, 24(3), 747–753.
- RENÉ PAOLETI. (2003). *Education et motricité (L'enfant de deux à huit ans)*. De Boeck Université, Paris.
- SERGE MESURE et HENRI LAMENDIN. (2001). *Posture et pratique sportive et rééducation*. Paris: Masson.
- Rolf wirhed. (2001). *Anatomie et science du geste sportif*. Paris: Vigot.

- PIERRE MARY. (2003). Prise en charge de la scolose idiopathique de l'enfant et de l'adolescent. *Revue du Rhumatisme* 71, 160-170.
- BENGTSOON G, JANON B. (1974). Physiological psychiatric investigation in scoliosis. *Acta Psychiatrica Scandinavica*.
- HUSSEININ, S. M. (1995). *Correct Posture for All*. Cairo: Dar El Fikr El Arabi.
- AL-RAMLI, A. et al. (1981). *Posture Education*. Kuwait: Dar Al Fikr Al Arabi.
- AL-HAMAHMI, M., & EL-KHULY, A. A. (1990). *Foundations for Building Physical Education and Sports Programs*. Cairo: Dar Al Fikr Al Arabi.
- AL-SAHFA'I, J. (2005). *Curricula in Physical Education, Second Edition*. Cairo: Dar Al Fikr Al Arabi.