



(RESEARCH ARTICLE)



PREVALENCE OF SPINAL DEFORMITIES AND MUSCULOSKELETAL DISORDERS AMONG STUDENTS OF LYCÉE MODERNE LUCIEN YEBARTH 1, SAN-PEDRO, CÔTE D'IVOIRE

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ABSTRACT

Background: Spinal deformities and musculoskeletal disorders are an emerging public health concern among schooled adolescents in Côte d'Ivoire, yet local data remain unavailable.

Objective: This study aimed to characterise spinal deformities and identify factors associated with the occurrence of spinal disorders among lower-secondary students at Lycée Moderne Lucien Yebarth 1, San-Pedro.

Methods: A cross-sectional, descriptive study was conducted from 9 to 23 March 2026 among 83 students (44 girls, 39 boys) aged 9–18 years, selected through purposive sampling. After weighing average backpack loads, spinal parameters were evaluated using a magnetic plumb line according to Blouet's (1998) standards. Scoliosis and rib-hump deformity

were screened via frontal observation and the Adams forward-bend test, respectively. Associations between variables were tested using the Chi-square test and Cramer's V (significance threshold $p < .05$).

Results: At the thoracic level, 53.0% of students had a flat back and 20.5% presented hyperkyphosis, with only 26.5% showing a normal curvature. Scoliosis prevalence was 27.7% and rib-hump deformity 21.7%. Both scoliosis and rib-hump deformity were significantly associated with earlier onset of post-sitting back pain ($p = .009$ and $p = .008$, respectively).

Conclusion: Spinal deformities are widespread among schooled adolescents in San-Pedro, supporting the need for school-based ergonomic interventions and systematic spinal screening in Ivorian schools.

Keywords: Spinal Deformities; Spinal Musculoskeletal Disorders; Schooled Adolescents; Sitting Posture; School Ergonomics; Côte d'Ivoire

1 INTRODUCTION

School is the environment where students spend the majority of their day in a sitting position to complete reading, writing, or drawing tasks [1]. This posture, far from being physiologically neutral, leads to a significant increase in the pressure exerted on intervertebral discs, estimated at 140% of body weight, representing a load markedly higher than that observed while standing [2].

The spine, acting as the central axis of the skeleton, performs essential functions of support, mobility, and protection of the spinal cord [3]. Its physiological curves—cervical lordosis, thoracic kyphosis, and lumbar lordosis—contribute to overall postural balance and the damping of mechanical stress [4]. Any abnormal deviation of these curves, whether scoliosis, hyperkyphosis, hyperlordosis, or flat back, can lead to chronic pain, functional limitations [5].

In adolescents, whose musculoskeletal system is undergoing a rapid growth phase, the daily repetition of mechanical strain constitutes a major risk factor for spinal disorders [4], particularly among school-aged individuals whose heavy backpack loads can induce spinal deformities [6,7].

In France, the prevalence of spinal deformities in adolescents varies by region [8]. Adolescent idiopathic scoliosis accounts for 90% of cases and affects between 0.5% and 5.2% of adolescents [8]. Scheuermann's disease (kyphosis) affects between 0.4% and 10% of adolescents aged 10 to 14 years, with prevalence reaching up to 40% in certain cohorts [4]. In Bosnia and Herzegovina, 48% of children aged 8 to 12 years reported musculoskeletal pain, including cervical and dorsal spine pain [6]. In Benin, Falola et al. (2014) [2] highlighted the mismatch between school desk dimensions and children's anthropometric measurements, causing spinal disorders in growing children.

In Côte d'Ivoire, despite the consequences of spinal deformities (pain, discomfort, and reduced quality of life), very little work has been conducted on this subject. Available studies primarily focus on the occupational environment among adults. For instance, among secretaries at Yopougon University Hospital, prolonged and uncomfortable sitting postures were shown to frequently cause spinal disorders [9]. Spinal deformities in adolescents, particularly school students, remain poorly documented, with few studies focusing on students in inland cities. However, students at Lycée Moderne Lucien Yebarth 1 in San-Pedro use rigid, backless desks unsuitable for their morphology [2]; furthermore, they carry heavy backpacks over long walking distances and remain seated for hours in class, exposing them to spinal disorders.

This study aims to characterising spinal deformities and determining factors associated with the occurrence of spinal disorders among lower-secondary students at Lycée Moderne Lucien Yebarth 1, San-Pedro.

2 METHODOLOGY

2.1 Setting and Study Design

This was a cross-sectional, descriptive study conducted from 9 to 23 March 2026 at Lycée Moderne Lucien Yebarth 1 in San-Pedro, Côte d'Ivoire.

2.1.1 Population and Sampling

The target population comprised all lower-secondary students (grades 6 to 9 / 6^{ème} to 3^{ème}) at Lycée Moderne Lucien Yebarth 1 in San-Pedro. The sample consisted of 83 students (44 girls and 39 boys) aged 9 to 18 years, recruited through non-random, purposive sampling due to time constraints, participant availability, and resources required for study execution.

Inclusion criteria were: regularly enrolled in grades 6, 7, 8, or 9; aged 9 to 18 years; present throughout the collection period; and having provided, along with their legal guardian, free and informed consent.

2.2 Data Collection Procedure

This research was conducted in compliance with ethical principles. Official authorization was obtained from the National Institute of Youth and Sports (INJS) and forwarded to the Principal of Lycée Moderne Lucien Yebarth 1 in San-Pedro and the head of the local Medical Center. Each participant attended an orientation session detailing study objectives. Written informed consent was obtained from each student and legal guardian. Confidentiality and anonymity were guaranteed, and the right to withdraw without justification or penalty was assured at all stages.

Students were evaluated individually at the San-Pedro Medical Center. A questionnaire regarding sociodemographic data, postural habits, furniture type, and pain location was administered. Anthropometric measurements were taken, followed by spinal parameters evaluation. The evaluation of spinal parameters was performed by a physician specialized in the diagnosis of musculoskeletal disorders.

2.3 Equipment and Techniques

Backpack weight was measured using a SECA 761 medical scale (accuracy: 1 g) across three consecutive days to establish a representative mean, which was compared against the 10% body weight threshold recommended by the World Health Organization [10].

Spinal parameters were evaluated using a magnetic plumb line (Bolema 2-00352-30) and a millimeter-graduated ruler. Students stood with their back to the plumb line, facing forward, feet shoulder-width apart, aligned so the line passed through the occiput, C7, the intergluteal cleft, and dropped between the medial malleoli. Sagittal distances were measured according to Stagnara et al. (1998) [11] standards: cervical and lumbar distances between 25 and 45 mm and thoracic distance of 30 mm were classified as physiological; deviations were recorded as deformities. Scoliosis was screened by frontal observation of shoulder and scapular asymmetry and confirmed by Adams forward-bend test for rib-hump deformity [5]. Spinal status categories included: normal spine, hyperlordosis, hyperkyphosis, flat back, scoliosis (left/right deviation), and rib-hump deformity.

2.4 Statistical Analysis

Data were entered and analyzed using SPSS software (Version 21.0). Qualitative variables were presented as frequencies and percentages; quantitative variables as means $\pm$ standard deviations. Associations were evaluated using Pearson's Chi-square test and Cramer's V coefficient for association strength ($p < .05$).

3 RESULTS

3.1 Sociodemographic and Anthropometric Characteristics

The sample comprised 83 students: 44 girls (53.0%) and 39 boys (47.0%). Mean age was 14.38 ± 1.48 years. The pupils' height and weight were 1.58 ± 0.08 m and 47.06 ± 9.31 kg, respectively and mean body mass index (BMI) was 18.69 ± 2.49 kg/m² (Table 1).

Table 1: Sociodemographic and Anthropometric Characteristics of Students (n = 83)

Parameters	Male (n = 39)	Female (n = 44)	Total Sample (n=83)
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Age (years)	14.35 ± 1.47	14.40 ± 1.51	14.38 ± 1.48
Height (m)	1.59 ± 0.10	1.57 ± 0.07	1.58 ± 0.08
Weight (kg)	46.02 ± 10.96	47.97 ± 7.57	47.06 ± 9.31
BMI (kg/m ²)	17.92 ± 2.51	19.36 ± 2.29	± 2.49

3.2 Backpack Weight

The majority of students (70; 84.3%) carried shcoolbags weighing below the WHO 10% body weight threshold [10]. Thirteen students (15.7%) carried shcoolbags exceeding this threshold (Figure 1).

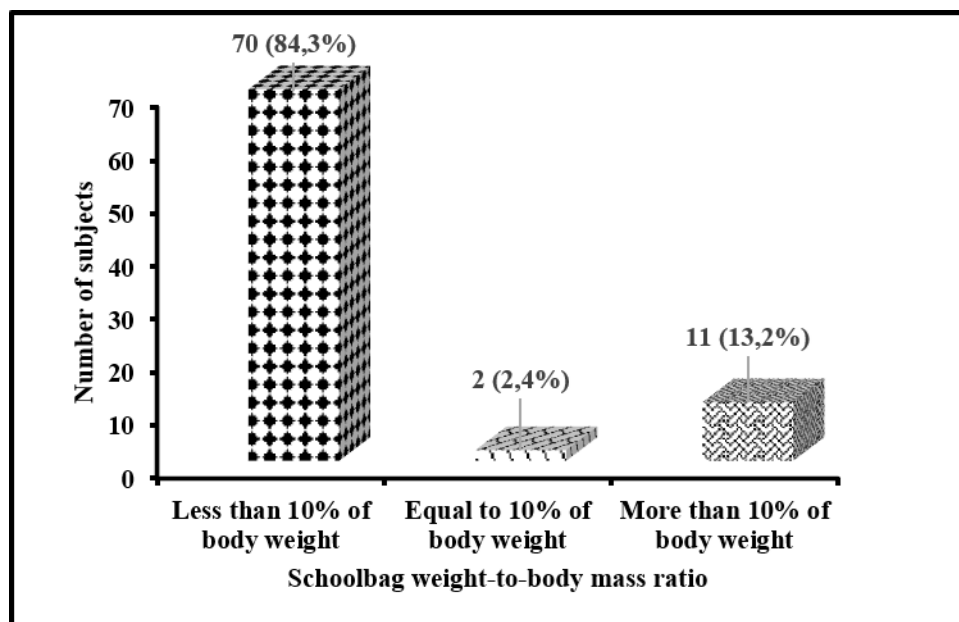


Figure 1: Distribution of students by Schoolbag weight-to-body mass ratio

3.3 Regional spinal deformities

The thoracic region exhibited the highest frequency of deformities: 44 students (53.0%) had a flat back and 17 (20.5%) had thoracic hyperkyphosis. Scoliosis was present in 23 students (27.7%), and rib-hump deformity in 18 (21.7%). Lumbar deformities (hyperlordosis and flat back) affected 8 students (9.6%) (Table 2).

Table 2: Regional Spinal Deformities (n = 83)

Segment	Condition	Frequency (%)
Cervical Zone	Normal	77 (92.8)
	Hyperlordosis	1 (1.2)
	Flat back	5 (6.0)
Thoracic Zone	Normal	22 (26.5)
	Hyperkyphosis	17 (20.5)
	Flat back	44 (53.0)
Lumbar Zone	Normal	75 (90.4)
	Hyperlordosis	5 (6.0)
	Flat back	3 (3.6)
Scoliosis	Normal symmetry	60 (72.3)
	Left deviation	8 (9.4)
	Right deviation	15 (18.1)
Rib-hump Deformity	Present	18 (21.7)
	Absent	65 (78.3)

3.4 Backpack Weight and Thoracic Spinal Health

Thoracic spinal deformities were not statistically associated with the ratio of schoolbag weight to body weight ($p > .05$). Across the sample, 39 (46.98%) cases of flat back and 19 (22.89%) cases of hyperkyphosis were observed (Figure 2).

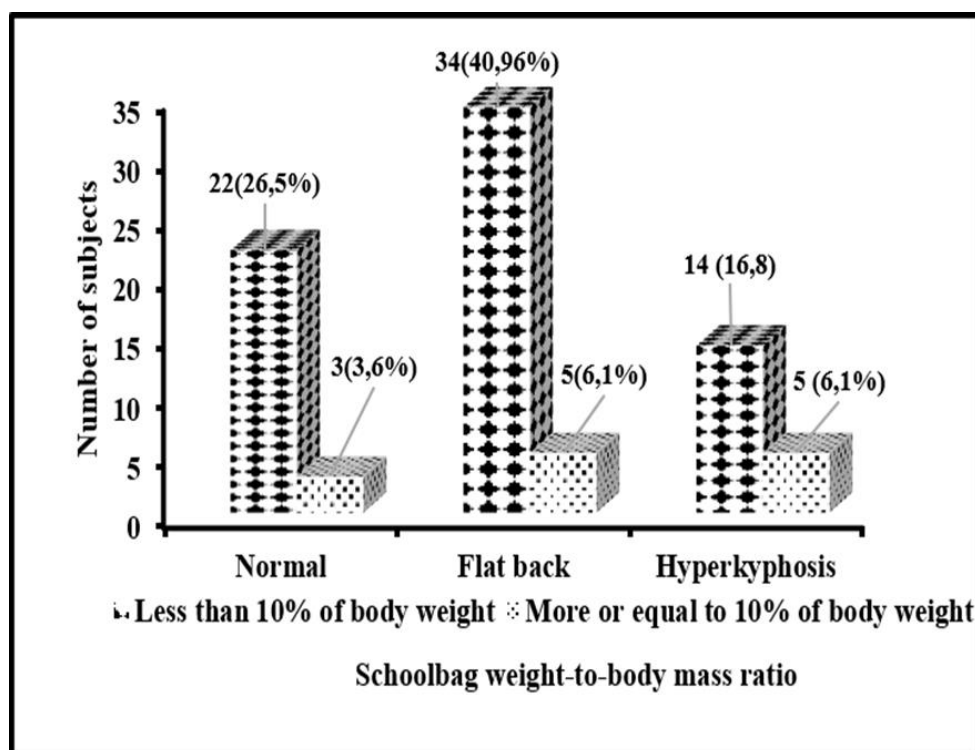


Figure 2: Distribution of students by observed spinal deformities according to schoolbag weight ratio

3.5 Onset Locations of Post-Sitting Pain

Overall back pain was reported by 26 respondents (31.3%). Simultaneous cervical and thoracic pain was reported by 12 students (14.4%), and thoracic and lumbar pain by 5 students (6.0%). Isolated lumbar pain was the single most affected region (25; 30.1%), followed by thoracic pain (11; 13.2%).

Table 3: Locations of post-sitting pain (n = 83)

Spinal Region	Frequency (%)
Cervical zone	3 (3.6)
Thoracic (Dorsal) zone	11 (13.2)
Lumbar zone	25 (30.1)
Cervical and thoracic zones	12 (14.4)
Thoracic and lumbar zones	5 (6.0)
Cervical and lumbar zones	1 (1.2)
Pain across whole back	26 (31.3)

4 DISCUSSION

4.1 Student Characteristics

This study evaluated 83 adolescent students (53.0% female, 47.0% male). This age group corresponds to pubertal growth, a stage of spinal vulnerability during which vertebral bodies remain malleable under repetitive mechanical stress [4,5]. Heavy backpack loads, prolonged sitting, and poor posture increase stresses placed on a growing spine, favoring early onset of vertebral deformities [12,13].

4.2 Regional Spinal Deformities

At the cervical level, 92.8% of students presented normal curvature, while 6.0% exhibited a flat cervical back and 1.2% hyperlordosis. Although infrequent, these anomalies stem from prolonged cervical flexion (notebooks, screens) and can induce muscle tension, headaches, and eventual disc herniations [14, 15].

Thoracic results were notably concerning: 53.0% presented a flat back and 20.5% hyperkyphosis, with only 26.5% retaining normal thoracic curvature. Alteration of thoracic curvature results from prolonged sitting on furniture lacking lumbar support, removing natural dampening and exposing discs to heightened axial pressure [16]. Advanced cases may compress rib structures and impair respiratory capacity [4,16].

At the lumbar level, 90.4% demonstrated normal lordosis, though 6.0% showed hyperlordosis and 3.6% a flat lumbar back. These abnormalities, combined with load carrying and static sitting, predispose individuals to low back pain and future adult functional disability [6].

4.3 Scoliosis, rib-hump deformity, and pain onset

Scoliosis prevalence was 27.7% (18.1% rightward, 9.4% leftward), higher than international estimates placing adolescent idiopathic scoliosis between 0.5% and 5.2% [17,18]. This discrepancy relates to clinical screening with a plumb line (more sensitive than radiography for functional/minor deviations) and unsupportive school environments in San-Pedro. Unsuitable furniture, asymmetrical sitting postures [2], heavy load carrying [6,7], and absence of early screening hinder effective mitigation.

Rib-hump deformity was observed in 21.7% of students, indicating fixed vertebral rotation and true three-dimensional deformation. Writing postures at desks that are too low force forward rounding, causing persistent rotation and asymmetrical paravertebral muscle strain [12]. Without screening protocols in Côte d'Ivoire, condition progression remains unmanaged, contrasting with European settings where mandatory school screening enables early care [5].

4.4 Schoolbag weight and thoracic health

Although 84.3% carried loads below the recommended 10% body weight threshold [10], 15.7% exceeded it. High backpack weight exerts cumulative effects alongside postural factors [6,19]. Hamimi (2011) [19] noted that backpacks represent 21.1% of triggering factors for adolescent spinal pain. In Benin, Falola et al. (2014) [2] showed heavy load carrying was strongly associated with spinal deformities in students. Unlike European schools with lockers [13], Ivorian students transport materials daily over long distances, aggravating spinal strains.

4.5 Post-sitting pain locations

Generalized spinal pain was most prevalent (31.3%), followed by isolated lumbar pain (30.1%), cervico-thoracic pain (14.4%), and isolated thoracic pain (13.2%). Lumbar involvement (isolated or combined) affected 68.7% of students. Sitting increases lumbar intervertebral disc pressure to 140% of standing body weight [2]. Cumulated static hours on rigid, backless benches deteriorate intervertebral discs and paravertebral muscles. Hamimi (2011) [19] identified the lumbar region as the most frequently affected area in students. Generalized spinal pain reported by one-third of students highlights widespread back distress, impacting learning concentration [6,20]. While Azabagic et al. (2016) [6] reported screen-related cervico-thoracic pain in Bosnian adolescents, Ivorian students suffer predominant lumbar and generalized pain due to rigid bench seating.

Unaddressed adolescent spinal pain increases chronic low back pain and early osteoarthritis risks in adulthood [13]. Structural deformities cause sitting discomfort, lowering academic concentration and performance. Establishing early screening systems in San-Pedro schools, along with physical activity correction protocols led by physical education teachers, is critical.

5 CONCLUSION

This study characterized spinal deformities and associated factors among lower-secondary students at Lycée Moderne Lucien Yebarth 1 in San-Pedro. Spinal deformities—including lumbar/cervical hyperlordosis, thoracic hyperkyphosis, rib-hump deformity, scoliosis, and flat back—are widespread. Heavy load transport, unadapted school furniture, and poor classroom postures serve as primary contributing factors. These findings highlight the need to improve ergonomic conditions in Ivorian schools and implement early detection, awareness, and exercise-based intervention programs.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

Authors declare no conflict of interest.

Statement of ethical approval

Approval from the INJS (National Institute of Youth and Sports) of Abidjan was obtained prior to conducting this study (N°: 2026/INJS/DFCR/432-07-02-26). Authorization was also granted by the Principal of Lycée Gnèbarth in San Pédro.

Statement of informed consent

Written informed consent was obtained from all students as well as their parents or legal guardians prior to study participation.

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